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THE ECONOMY OF EU MEMBER COUNTRIES IN 2020 FROM PERSPECTIVE OF MAGIC SQUARE³

The aim of our article is to quantify the impacts of COVID-19 disease on four basic aggregate economic indicators, which are set in Kaldor's magic square in EU member countries in the year 2020, as well as to identify changes in the area of the square compared to the five-year average. The result of our article is the finding that, compared to the five-year average, the area of the magic square decreased by more than 15% in 2020 from the point of view of the entire EU. The drop in real GDP in 2020 is particularly significant. There is a general economic decline and economic recession in the EU, with significant disparities between individual countries. However, there is also one member country, Lithuania, which managed to increase the area of the magic square in 2020 compared to its five-year average.

Keywords: EU; COVID-19; magic square; GDP; balance of payments; HICP; unemployment

JEL: E66; F63; O11; O52

1. Introduction

The COVID-19 disease has exposed the weak points of the globalized world, affecting all sectors of the economy, and all of the countries, and we can see its effects in the political, security, social, environmental and societal levels. All EU member countries also had to face the negative impact of the crisis caused by the COVID-19 disease. From our point of view, we consider identifying the effects of the pandemic primarily important – especially within the economic indicators of the EU countries, because they strongly determine other, even non-economic parameters.

The primary area of our research is to quantify the impacts of the COVID-19 disease into four economic indicators and the area of the magic square in the EU countries in the year

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2020. From a number of potential research methods, we decided to monitor the basic macroeconomic indicators of the economy, which are set in the magic square. The reason for this is their establishment as one of the basic and most frequent economic indicators, which can be used to demonstrate the effects of the COVID-19 disease on the economies of EU countries. At the same time, these four macroeconomic indicators represent a standard platform used by many international organizations for comparing countries (EU, OECD, IMF, WB).

The magic square represents a generalized relationship between four macroeconomic parameters, which basically demonstrate the economic well-being of the state and the level of its economy. We consider N. Kaldor to be the author of this approach with his work from 1971, describing the achieving of selected macroeconomic goals and the role of the state in achieving them, based upon empirical research (Kaldor, 1971). The concept of the magic square was subsequently established very quickly to compare the performance or well-being and economy of individual countries. Since the 70s of the 20th century, economists and international organizations (e.g. OECD) have started using the magic square model to monitor the level of performance of countries and their four basic macroeconomic parameters determining economic growth.

Compared to the originally determined macroeconomic aggregates, our article is based on their modified version, where the original peak GDP growth was modified into the year-on-year change in real GDP growth, the peak trade balance was changed to the balance of the current account within the balance of payments, the peak inflation was replaced by the harmonized index of consumer prices (hereinafter HICP) and the peak unemployment rate remained in its original form. Our approach is therefore based on more specific indicators, tailored for EU countries.

Thanks to this approach, we will certainly be able to quantify the effects of the COVID-19 disease on macroeconomic aggregates, the economy and the total area of the magic square in all EU countries. Our research is also based on the comparison of development trends since 2015 and the comparison with the situation in 2020. This approach brings several positives, such as abstracting from one-year economic fluctuations since 2015, creating a multi-year multi-element base, as well as applying an important theoretical concept to the current situation and its modification to match the specific EU conditions.

In the discussion, we briefly deal with selected factors which, according to the authors, had a dominant influence on the disproportionate economic development in the EU member countries during the pandemic year 2020. We see a lot of room for future research, in the form of identifying the most significant determinants which influenced the development of the four macroeconomic variables in the EU member countries.

2. Literature Review

The impacts of the COVID-19 disease have been elaborated quite widely. Among other things, the analyses, evaluations and predictions were also related to the economic and commercial consequences of the COVID-19 disease. Our contribution focuses on a specific

economic area, due to the atomization of researches mapping certain economic consequences of the COVID-19 disease in EU countries. Most of the current literature and scientific works are focused more on the global situation of the EU in 2020. Several authors dealt with selected macroeconomic aggregate values in 2020, which they compared with the global economic downturn, or with economic leaders such as the USA or China. We can mention, for example, the publication *Economic Policy and the Covid-19 Crisis* (Andreosso-O'callaghan et al., 2021) with the aim of mapping the economic impact of the COVID-19 disease on the EU and selected EU member countries and comparing them with the results from Asian countries and the USA. Baldwin and Di Mauro (2020) examine the globalization of the COVID-19 pandemic and its economic impacts in the EU and Eurozone, France, Germany and Italy. In contrast, Barua (2020) compares the economic impacts of the pandemic in 2020 in the EU, China and the USA. The publication is based on research on the likely macroeconomic shocks of the pandemic, which include economic activities and areas including demand, supply, supply chain, trade, investment, price level, exchange rates and financial stability and risk, economic growth and international cooperation. A global analysis of the pandemic in 2020 and its impact on the economies of the most important economic centres (USA, Japan, China, Russia and the EU) can also be found in other publications (Hošoff et al., 2021).

Welfens (2020) observes macroeconomic impacts and health care in his publication. Again, it is a global analysis of economic shocks in the USA, EU, UK and selected Asian countries, but this time in connection with the role of the health sector. Bretschger et al. (2020) also work with a similar, but expanded, view, which observes the regression between selected economies of OECD countries. Their research includes economic, political, medical and environmental variables.

The dominant direction in the development of scientific research with the aim of mapping the economic impacts of the pandemic in 2020 was to abstract from the position of the EU as part of the global system, thus monitoring selected economic indicators and economic variables from the point of view of the EU's unified economy. The work of De Vet et al. (2021) entitled *Impacts of the COVID-19 pandemic on EU industries* is significant in this regard, as it describes the impact of COVID-19 on the economy of the EU as a whole. Another broadening of the horizon within the analysis of the European semester with an emphasis on the coordination of macroeconomic policies and the solution of future challenges can be found in the publication from D'erman and Verdun (2020).

The historic decline of macroeconomic aggregates in 2020 was initially accompanied by the complete closure of the borders of the entire EU, which significantly affected the economies of the member countries. The EU experienced a decline in real and nominal GDP, falling incomes, a decline in employment and an increase in unemployment (Đukić et al., 2021).

An analysis of the economic consequences of the pandemic in 2020 is followed by Ehnts and Paetz (2021). It turns out that in the Eurozone, the economic crisis has revealed significant shortcomings, and it is recommended that national governments use their regained sovereignty to find a way out of economic recession.

The COVID-19 pandemic has paralyzed the EU economy. Based on the analysis of models of other macroeconomic and market impacts, Marino and Pariso (2021) put previous

macroeconomic concepts into a new context. The scenarios elaborated by SPSS 26.0, highlight that even a contained outbreak could significantly affect the European economy in the middle rung in terms of public social values and these weaknesses could undermine the objectives of building a united Europe in addressing the crisis created by COVID-19.

Zamfir and Iordache (2022) synthesized the results of their research in which they examined macroeconomic indexes for European countries. The main results show that, comparing European countries' economic situation in 2020 with the previous 2 years and considering variables that show the adopted closure measures, the Covid-19 pandemic has influenced the GDP of European countries.

The economic consequences of the COVID-19 pandemic on European economies and the subsequent response of economic policies in the first half of 2020 are described in the study *The COVID19-Pandemic in the EU: Macroeconomic Transmission and Economic Policy Response* (Pfeiffer and Roeger, 2020). The focus of their study is the research of stabilization measures and economic policy responses to economic problems caused by the COVID-19 pandemic.

We can consider the significant macroeconomic impacts of the pandemic in 2020 as a trigger of growing support for a more protective government. Economic supports aimed at solving economic and social problems can lead to the restoration of relations between the state and the market (Bergsen, 2020).

Sapir (2020) investigated the economic reasons for the different impacts of the COVID-19 pandemic on selected economic units (EU member countries). The main indicator was the change in GDP in connection with the severity of blocking measures, the structure of national economies, the fiscal capacity of governments and the quality of governance in all EU countries.

The atomization of research on the COVID-19 effects on European economies is underlined by several studies of individual countries, regions or other territorial administrative units. As an example, there is monitoring of the impacts of COVID-19 pandemic in 2020 within selected economic indicators in Romania (Albu et al., 2020), Visegrad group (Masarova et al., 2022), Visegrad group and Austria (Astrov and Holzner, 2021) Spain (Pedauga et al., 2022), Croatia (Čavrak, 2021), Croatia and Slovenia (Gricar et al., 2022) France, Germany, Spain, Italy and the United Kingdom (Su et al., 2022), Greece (Hazakis, 2021), Belgium, Italy, Spain and the United Kingdom (Cantó et al., 2022), the Czech Republic (Fialová et al., 2021) Slovakia (Frank et al. 2021; Mura et al., 2022), Estonia (Radula, 2021), Lithuania (Černikovaitė and Karazijienė, 2021; Petrylė, 2022), Latvia (Karnite, 2021; Lagzdina 2020) Romania and Bulgaria (Christova-Balkanska, 2021), Cyprus, France, Spain, Greece, Italy, Malta, Croatia and Portugal (Kapitsin and Sykas 2021) or in selected countries of Central and South-Eastern Europe (Avrămescu, 2020).

Economic impact research involving European regions, NUTS 3 or municipalities does, for example, appear within the work of Brada, Gajewski and Kutun, (2021) and Fernández-Villaverde and Jones, (2020).

The literature research indicates a relatively good coverage of the researched issue, but none of the available studies quantify the four basic macroeconomic indicators together, nor does

any focus on tracking the area of the magic squares of all 27 EU countries in 2020, or their five-year average area. From our point of view, the available sources contain atomized research areas, partial results, time series too short, or the study of the problem only from the point of view of a single EU member country, or just a given group of EU countries. There is also an opposite extreme case when the researchers analyse the effects of the COVID-19 disease on the entire EU and monitor aggregate data for the entire EU. Therefore, we see a great opportunity to cover this blank space with our research.

3. Methodology and Data

The aim of our paper is to quantify the impacts of the COVID-19 disease into four basic aggregate economic indicators, which are set in Kaldor's magic square, within EU member countries in 2020 and to identify changes in the area of the square compared to the five-year average.

The object of our research are all EU member countries as of December 31, 2020. During this period, the EU consists of a total of 27 European countries: Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Greece, the Netherlands, Ireland, Lithuania, Latvia, Luxembourg, Malta, Hungary, Germany, Poland, Portugal, Austria, Romania, Slovakia, Slovenia, Spain, Sweden and Italy.

The first monitored macroeconomic economic indicator is the real rate of GDP growth. It expresses the year-on-year percentage change (increase/decrease) of the country's GDP. Our analysis operates with the rate of real GDP growth compared to the previous calendar year and captures the change in GDP in market prices. Of the three possible approaches to defining GDP (production, expenditure, pension), our work is based on the production approach to determining GDP.

The unemployment rate represents the second monitored indicator of the economy, which is based on the magic square model. All persons aged 15 to 74 who were not employed during the reference time frame, were actively looking for work and were ready to start work immediately or within two weeks are considered unemployed in the EU. In our case, the unemployment rate is expressed in percent of the ratio of unemployed persons to the total labour force in percentages.

The third peak of the magic square is inflation. The EU and Eurostat use the HICP to express the rate of inflation and the stability of the price level. This indicator of the net change in the prices of goods and services is calculated as a "Laspeyres-type price index" based on the prices of services available for purchase in the territory of each EU member state for the direct satisfaction of consumer needs (final consumption).

The last monitored macroeconomic indicator, which we use to map the effects of the COVID-19 disease on the economy in EU countries, is the balance of payments. The current account represents the most important and dominant component of the balance of payments. This was the reason for choosing the balance of the current account within the balance of payments as a component that maps the foreign trade position of the member country while summarizing

the export and import balance of the economy. We express the current account balance within the balance of payments as a share of GDP.

The time series begins with the base year 2015. We calculated the five-year average as the arithmetic average of the examined macroeconomic aggregates over a period of five years (2015-2019), and used it for comparison with the year 2020, which we equated with the year when the economic effects of the COVID-19 disease on the economies of EU member countries fully manifested for the first time. We consider the five-year average to be optimal because it exceeds the period of the classic political cycle (4 years) and minimizes short-term disparities.

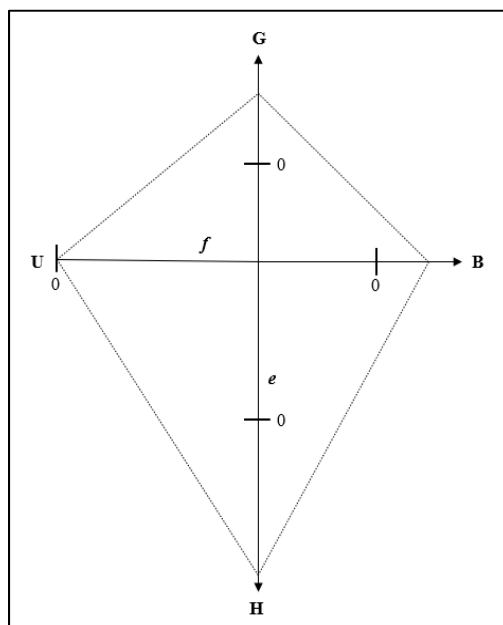
Determining the level of the five-year average of four macroeconomic aggregates (peaks) and their values in 2020 was the first task. Subsequently, our attention was focused on the calculation of the area of the imaginary magic square, while we graphically captured its five-year area as well as the situation in 2020. To calculate the magic square, we used a standard formula (Saavedra-Rivano, Teixeira, 2017) to calculate its area. This is a formula for calculating the area of a convex quadrangle (geometric figure - deltoid) with perpendicular internal diagonals:

$$S = \frac{ef}{2} \tag{1}$$

In the original, as well as our modified magic square, the length of the diagonals (e, f) will be bounded by two points. For the vertical diagonal e, these points will represent the vertices with the values of the real GDP growth rate and the HICP level. The horizontal diagonal f will be bounded by vertices representing the unemployment rate and the current account balance within the balance of payments. The sum of the values of the units on the vertical axis subsequently represents the length of the vertical diagonal of the deltoid, and the sum of the values of the units on the horizontal axis subsequently represents the length of the horizontal diagonal of the deltoid. After substituting this data into the surface/area calculation equation, we get the final data for the area of the magic square in a five-year average in 2020 as well. Depiction of the modified magic square is captured in Figure 1.

During the processing of the documents and the primary analysis of the data, we encountered a complication, which is not reflected in the original magic square. The partial data and the diagonal lengths calculated from them reached differentially negative values as well, which cannot be easily captured graphically. It also brought a problem with the final determination of the area of the magic square, which could not be a negative value. Therefore, with regard to the maximum limit values, we decided to set the intersection of the diagonals and our base point to the numerical constant of 22. The result of our preliminary research was that the constant must have a value higher than the highest partial value of all four variables of the monitored set of countries. A reliable procedure is to set a constant higher than the highest value of the year-on-year change, which is higher by 1 than the highest partial data rounded to the nearest larger whole number. In our case, the highest partial value of the variable is at the level of 20.5 (average unemployment in Greece), which reaches the value of 21 after rounding to the first whole number. Subsequently, the constant represents a value higher by one whole number (22).

Figure 1. Modified magic square



Where: **G** - real growth rate GDP; **B** –current account balance within the balance of payments; **H** – HICP;
U – unemployment rate; **e, f** - diagonals
Source: Own processing

The role of the constant does not end only with the graphical capturing of magic squares. When inserting the data into the formula to calculate the area of the magic square, we must take the constant (intersection of the axes) into account. Without this procedure, it would not be possible to calculate the positive values and graphically capture the results. In order to maintain the basic rules and logical conclusions about the increase and decrease of the area of the square, we need to modify the primary data of the real GDP growth rate, the unemployment rate, the HICP and the balance of the current account within the balance of payments. In the case of two macroeconomic indicators (real GDP growth rate, current account balance within the balance of payments), the constant of 22 was added. In the case of the unemployment rate and the HICP, their five-year average value and the value from 2020 were subtracted from the constant. With this procedure, we stick to the basic premise, according to which a positive economic situation (GDP growth, unemployment reduction, slightly positive trade balance and low inflation rate) increases the area of the magic square. In case of negative economic development (decline in GDP, increase in unemployment and inflation) the area of the magic square reduces.

The research sample (all EU member countries) predicts, that the main source of data for the initial analysis will be the EU Statistical Office (Eurostat). In our research, we focused on a set of data included in the Economy and Finance and Labour Market statistics. The first indicator was the real GDP growth rate. We identified the data on the development of this

indicator in the Eurostat database with the online code TEC00115, and the reference data were labelled (nama10) according to the system of national accounts. The percentage rate of unemployment was the second monitored macroeconomic indicator. The necessary data can be found in Eurostat statistics in the labour market section. According to the main indicators of the LFS, data on the annual unemployment rate fall under the code label (une_rt_a) or (lfsa_urgaed). HICP data were located in the Eurostat folder named Harmonized Index of Consumer Prices and the specific data had the code (prc_hicp_manr). We drew primary data for the last analysed macroeconomic indicator (current balance of payments) from the World Bank Databank. The required data was located in the database of world development indicators in the Economy & growth section (under the code BN.CAB.XOKA.GD.ZS) and after adjustment, it captured the development of the current balance of payments of all EU countries since 2015 as a percentage of GDP. The primary data set for our analysis represented a total of 648 data entries (27 member countries x 6 years x 4 macroeconomic variables). Through secondary calculations, we found out the length of the diagonals of the squares, put them into the formula for calculating the area and obtained data on 27 average areas and 27 areas in 2020.

At the end of our paper, we present a comparison of partial data on economic aggregates and a comparison of the areas of the magic squares of specific countries. Each of the 27 EU countries will have a quantified area of magic squares (average and in 2020) in areal units. We will indicate the resulting area in abstract units u . The larger the area of the magic square (the greater the number of u units), the higher the prosperity of a specific economy of a member country. A lower number of u units, thus also the lower area of the magic square de facto, will indicate to us a worse economic situation of a specific EU member state.

4. Results

We monitored the values of real GDP growth, the current account balance within the balance of payments, the HICP and the unemployment rate from 2015 to 2019 and calculated their arithmetic average. We analysed four macroeconomic aggregates in 2020 and compared them to their long-term average.

Between the years 2015 and 2019, the average rate of real GDP growth across the EU reached 2.2%. Each of the member states also showed a positive average increase during this period, with Ireland (10.0%) and Malta (7.24%) achieving the highest. The lowest average increase in the growth rate of real GDP was recorded in Greece (0.78%) and Italy (1.02%).

The pandemic year 2020 reversed this trend of positive development in all EU countries (except Ireland), which registered a year-on-year decrease in real GDP. The most significant year-on-year decline in 2020 was in Spain, Greece and Italy. The only exception across the EU is Ireland, which also achieved a positive increase in the real GDP growth rate in 2020. In general, the year 2020 represented a significant year-on-year drop in real GDP from the point of view of the entire EU, which reached almost 6%.

Table 1. Macroeconomic aggregates in EU member states (2015-2020)

	REAL GROWTH RATE GDP			CURRENT ACCOUNT BALANCE WITHIN THE BALANCE OF PAYMENTS		
	Average	2020	Difference	Average	2020	Difference
EU (27)	2,20	-5,9	-8,10			
Belgium	1,76	-5,7	-7,46	1,68	1,20	-0,48
Bulgaria	3,18	-4,4	-7,58	0,41	0,83	0,42
Czechia	3,86	-5,8	-9,66	1,75	-0,38	-2,13
Denmark	2,48	-2,1	-4,58	0,89	3,61	2,72
Germany	1,72	-4,6	-6,32	7,96	8,13	0,17
Estonia	3,82	-3,0	-6,82	8,05	7,00	-1,05
Ireland	10,0	5,9	-4,10	1,74	-0,46	-2,20
Greece	0,78	-9,0	-9,78	-0,75	-2,09	-1,34
Spain	2,84	-10,8	-13,64	-1,74	-6,57	-4,83
France	1,64	-7,9	-9,54	2,40	0,84	-1,56
Croatia	3,16	-8,1	-11,26	-0,50	-1,87	-1,37
Italy	1,02	-8,9	-9,92	2,76	0,09	-2,67
Cyprus	5,36	-5,2	-10,56	2,46	3,81	1,35
Latvia	3,22	-3,6	-6,82	-3,84	-10,19	-6,35
Lithuania	3,48	-0,1	-3,58	0,27	2,91	2,64
Luxembourg	2,78	-1,8	-4,58	0,15	7,36	7,21
Hungary	4,04	-4,7	-8,74	4,92	4,02	-0,90
Malta	7,24	-8,3	-15,54	1,71	-1,48	-3,19
Netherlands	2,30	-3,8	-6,10	3,75	-3,07	-6,82
Austria	1,86	-6,7	-8,56	9,05	6,97	-2,08
Poland	4,44	-2,5	-6,94	1,84	1,88	0,04
Portugal	2,56	-8,4	-10,96	-0,59	2,90	3,49
Romania	4,74	-3,9	-8,64	0,74	-1,06	-1,80
Slovenia	3,58	-4,2	-7,78	-3,00	-5,08	-2,08
Slovakia	3,30	-4,4	-7,70	5,36	7,38	2,02
Finland	1,78	-2,9	-4,68	-2,45	0,19	2,64
Sweden	2,64	-2,8	-5,44	-1,15	0,95	2,10
				3,35	5,71	2,36
	HICP			UNEMPLOYMENT RATE		
EU (27)	1,02	0,7	-0,32	8,28	7,1	-1,18
Belgium	1,62	0,4	-1,22	6,96	5,6	-1,36
Bulgaria	0,78	1,2	0,42	6,48	5,1	-1,38
Czechia	1,58	3,3	1,72	3,24	2,6	-0,64
Denmark	0,54	0,3	-0,24	5,64	5,6	-0,04
Germany	1,22	0,4	-0,82	3,80	3,8	0,00
Estonia	2,06	-0,6	-2,66	5,72	6,8	1,08
Ireland	0,34	-0,5	-0,84	7,18	5,7	-1,48
Greece	0,26	-1,3	-1,56	21,32	16,3	-5,02
Spain	0,72	-0,3	-1,02	17,66	15,5	-2,16
France	1,00	0,5	-0,50	9,46	8,0	-1,46
Croatia	0,56	0,1	-0,46	11,12	7,5	-3,62
Italy	0,62	-0,1	-0,72	11,08	9,2	-1,88
Cyprus	-0,14	-1,1	-0,96	10,92	7,6	-3,32
Latvia	1,70	0,1	-1,60	8,38	8,1	-0,28
Lithuania	1,68	1,1	-0,58	7,32	8,5	1,18
Luxembourg	1,16	0,1	-1,06	5,94	6,8	0,86
Hungary	1,84	3,4	1,56	4,64	4,3	-0,34
Malta	1,32	0,8	-0,52	4,28	4,4	0,12
Netherlands	1,18	1,1	-0,08	5,00	3,8	-1,20
Austria	1,52	1,4	-0,12	5,32	5,4	0,08
Poland	0,80	3,7	2,90	5,16	3,2	-1,96
Portugal	0,84	-0,1	-0,94	9,28	6,9	-2,38
Romania	1,52	2,3	0,78	5,14	5,0	-0,14
Slovenia	0,84	-0,3	-1,14	6,64	5,0	-1,64
Slovakia	1,18	2,0	0,82	8,32	6,7	-1,62
Finland	0,66	0,4	-0,26	8,18	7,8	-0,38
Sweden	1,48	0,7	-0,78	6,86	8,3	1,44

Source: Own calculations based on Eurostat (2021).

The average balance of the current account within the balance of payments of the entire EU reached a positive value of 1.68% of GDP between 2015 and 2019. The Netherlands (9.05% of GDP), Germany (8.05% of GDP) and Denmark (7.96% of GDP) reported the highest average value of the current balance within the balance of payments. On the other hand, we identified a total of eight EU member countries whose five-year average was negative. We identified the most significant deficit of the average current account balance within the balance of payments in the case of Cyprus, Romania and Slovakia. In these countries, the average balance of the current account within the balance of payments ranged in the interval of $<-3.84\% \text{ of GDP}; 2.45\% \text{ of GDP}>$.

During 2020, the value of the current account balance within the balance of payments decreased from the point of view of the entire EU and reached 1.2% of GDP. A total of 17 countries achieved a positive current account balance within the balance of payments. Denmark (8.13% of GDP), followed by Slovenia (7.38% of GDP) and Lithuania (7.36% of GDP) achieved the highest value of the current account balance within the balance of payments in the given year. Of the ten EU member states, Cyprus (-10.19% of GDP), Greece (-6.57% of GDP) and Romania (-5.08% of GDP) registered the most significant current account deficit in 2020.

The pan-European HICP average was just above one percent in the period of years 2015-2019. Over five years, the HICP average was the highest in Estonia, where it barely exceeded the 2% mark, followed by Hungary and Lithuania. The lowest HICP was registered in Cyprus, where the five-year average reached a negative value (-0.14%) and this development came close to deflation.

The 2020 HICP level in the member countries was differentiated. Most (19) countries reported a positive HICP value ranging from 3.7% (Poland) to 0.1% (Luxembourg, Lithuania). Other countries reported a decrease in HICP in the range of $<-1.3\% \text{ in } 2020; -0.1\%>$. We found the lowest values in 2020 in Greece and Cyprus. For the entire EU, the HICP reached the level of 0.7% in 2020.

The unemployment rate represents the last monitored macroeconomic aggregate. In the period of years 2015-2019, the average unemployment rate in the EU was 8.28%. The highest average unemployment rate was found in southern EU countries, i.e., in Greece (21.32%) and Spain (17.66%). In the same period, the Czech Republic and Germany achieved an average unemployment rate of under 4%, which was the lowest among all EU member countries.

From the point of view of the unemployment rate, it is typical for the year 2020 that the EU-wide average just exceeded the 7% mark. The two southern EU members Greece (16.3%) and Spain (15.5%) reported the highest unemployment rate again. The unemployment rate in 2020 was below four percent in the Czech Republic, Germany and Poland. In the Czech Republic, the level of unemployment rate was at the level of 2.6%, and this value created the lowest achieved level of unemployment across all EU countries in 2020.

From 2015 to 2019, the average area of the magic square across the EU was 844.91 u. Malta, the Netherlands, Germany and Denmark achieved highly above-average areas of the magic square, exceeding 1000 u. In opposition to them, there are average values of the area of the

magic square in the southern EU countries. We identified the lowest average values in Greece (466.04 u), Spain (662.74 u), Cyprus (723.74 u) and France (759.77 u).

The pandemic year 2020 affected the four monitored macroeconomic aggregates in a significantly different way, hence affecting the areas of the magic squares in the EU countries as well. In general, with one exception, we can observe a decrease in the area of magic squares in all EU countries. The year 2020 is characterized by a decrease in the area of the magic square in 26 EU countries - except Lithuania. These results were also reflected in the average area of the magic square for the entire EU in 2020, which was 712.47 u. The highest area of the magic square within the interval <967.82 u; 912.49 u> was calculated in Denmark, Slovenia, the Netherlands, Germany, Lithuania and Ireland. Greece (383.51 u), followed by Spain (491.44 u) and Cyprus (522.89 u) reported the smallest area of the magic square in the year 2020.

Table 2. Area of the magic square (u) in EU member states (2015-2020)

	Area of the magic square			
	Average 2015 - 2019	2020	Difference	Change %
EU (27)	844,91	712,47	-132,44	-15,68
Belgium	826,57	743,41	-83,16	-10,06
Bulgaria	910,97	739,58	-171,39	-18,81
Czechia	963,83	785,42	-178,40	-18,51
Denmark	1063,92	967,82	-96,10	-9,03
Germany	1073,56	920,40	-153,16	-14,27
Estonia	915,75	764,19	-151,56	-16,55
Ireland	967,70	912,49	-55,21	-5,71
Greece	466,04	383,51	-82,53	-17,71
Spain	662,74	491,45	-171,30	-25,85
France	759,77	607,51	-152,26	-20,04
Croatia	830,51	654,96	-175,54	-21,14
Italy	785,48	679,54	-105,94	-13,49
Cyprus	723,74	522,89	-200,85	-27,75
Latvia	816,77	782,02	-34,74	-4,25
Lithuania	843,45	917,20	73,75	8,74
Luxembourg	980,42	869,74	-110,68	-11,29
Hungary	948,62	686,05	-262,58	-27,68
Malta	1084,96	637,45	-447,51	-41,25
Netherlands	1084,10	922,17	-161,92	-14,94
Austria	898,33	726,62	-171,71	-19,11
Poland	911,21	825,93	-85,28	-9,36
Portugal	810,71	643,31	-167,39	-20,65
Romania	846,75	641,09	-205,66	-24,29
Slovenia	998,32	929,92	-68,40	-6,85
Slovakia	766,28	704,81	-61,47	-8,02
Finland	782,25	756,00	-26,24	-3,35
Sweden	914,31	838,55	-75,76	-8,29

Source: Own calculations.

5. Discussion

What was the development of the four basic macroeconomic aggregates and the area of the magic square in EU member countries in 2020 compared to the five-year average? In principle, we found a very significant drop in real GDP growth in the case of all EU member countries in 2020, compared to the five-year average. The decrease in the real growth rate was quite striking, and in the case of five countries (Malta, Spain, Croatia, Portugal and Cyprus) it was a double-digit decrease. The trend of negative development of individual member countries was also reflected in the value of the drop of the real GDP growth rate in 2020, compared to the five-year average of the entire EU, reaching a value of -8.1%.

The overall negative trend in the development of real GDP was subsequently also reflected in the balance of the current account within the balance of payments. The reason is the methodical adjustment and determination of the balance rate expressed as a percentage of GDP. From this point of view, even if the balance of the current account within the balance of payments decreased in real terms, the macroeconomic indicator was not able to capture this decrease, because it is linked to the development of GDP - which could have decreased more significantly. Therefore, if we want to have a more realistic reflection of the balance of the current account within the balance of payments, we should add its values to the values capturing the real rate of GDP growth. If we proceed from the basic framework, which is established in the magic square, we will find out that more than half (16) of the member countries reached negative values of the balance of the current account within the balance of payments in 2020 compared to the five-year average. We identified significantly the highest negative difference in the current account balance in Malta (-6.82% of GDP), Cyprus (-6.35% of GDP) and Greece (-4.83% of GDP). At this point, it is necessary to note that the negative difference in the current account balance within the balance of payments does not apply to all EU countries when comparing the five-year average with the year 2020. A total of eleven countries managed to increase their current account balance during 2020 compared to the five-year average. In this respect Lithuania is leading, as the current account balance within the balance of payments in 2020 showed an increase of 7.21% of GDP when compared to the five-year average.

The average HICP value during the years 2015-2019 in EU countries does not show significant deviations when compared to 2020. It has a relatively stable development without significant disparities. By comparison, we found a positive development trend (decline in HICP) in 2020 compared to the five-year average in almost $\frac{3}{4}$ of the EU countries. Only for the group of six former post-socialist countries, the year 2020 brought a slight increase in the HICP compared to the five-year average.

We found similar results when analysing and comparing the unemployment rate in 2020 against the five-year average. In the vast majority of EU countries (20), the unemployment rate decreased during 2020 compared to the 2015-2019 average. This is also evidenced by the data from the entire EU, where the unemployment rate decreased in 2020 compared to the five-year average by more than 1.1%. The maximum positive difference was registered in Greece, where the unemployment rate fell by more than 5%. On the other hand, there is a group of six EU member states where the unemployment rate increased in 2020 compared to the five-year average. However, this is not a significant increase, because compared to the

five-year average, the unemployment rate in 2020 increased only slightly (by a maximum of 1.44%).

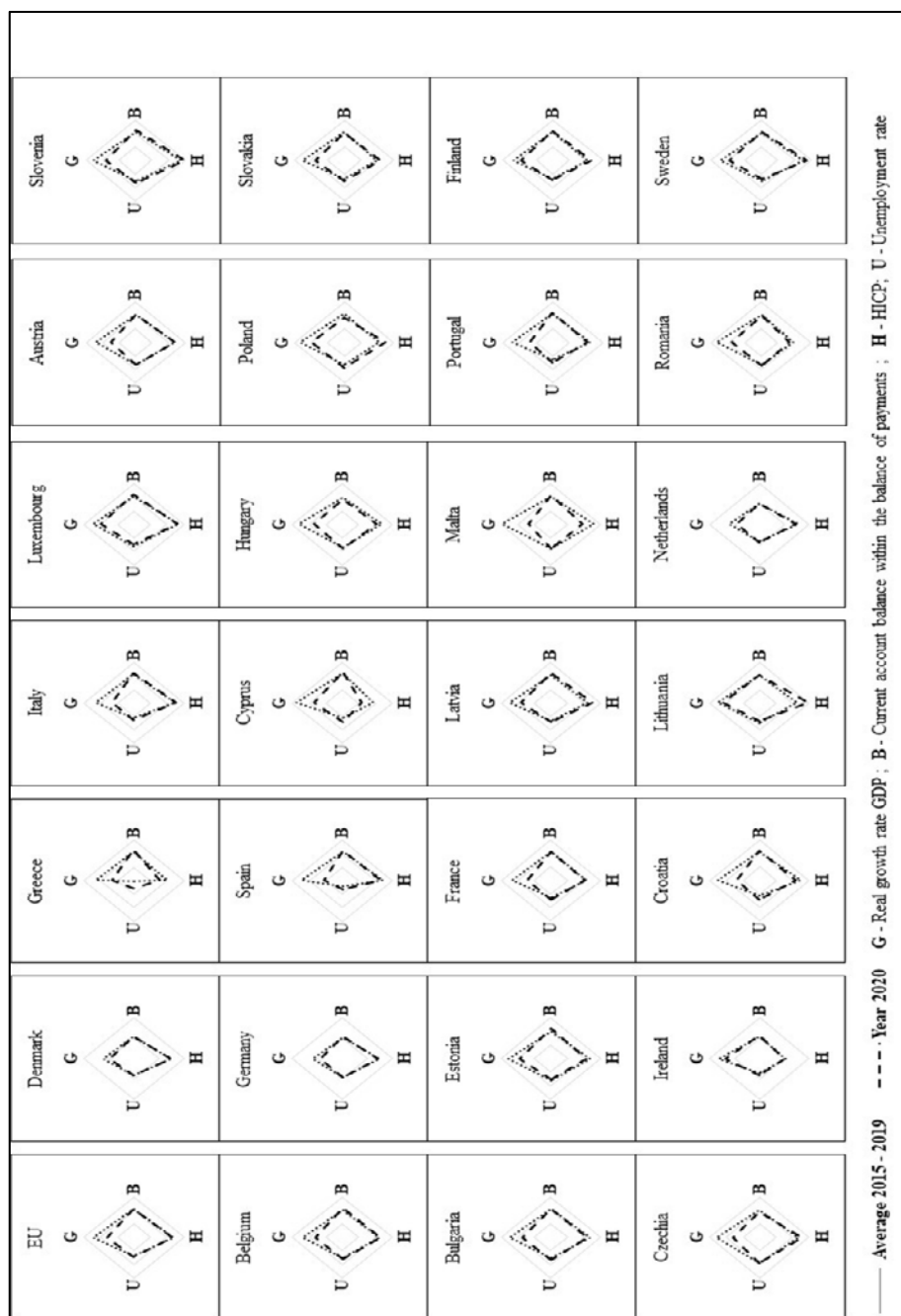
How our partial findings are reflected in the areas of the magic squares is graphically captured in the following image. It contains 28 magic squares - the entire EU and 27 member states, delimiting the five-year average area and the area in 2020.

The 2020 results indicate a slight to significant decrease in the area of the magic square in all EU member states, with one exception, compared to the five-year average. We found the most significant reduction in area in the case of Malta. Compared to the five-year average, the area of Malta's magic square shrank by more than 447 u in 2020, representing an area loss of over 40%. The results from Cyprus, Hungary, Spain, Romania, Croatia, Portugal and France also revealed a significant decrease in the average area of the magic square compared to 2020. In all mentioned countries, the area of the magic square decreased from -20.04% to -27.75%. On average the area of the magic square in the EU decreased by 132.44 u in 2020, which represents a reduction in area by approximately 15.68%. The given data indicate a general decline in the economies of 26 EU countries and foreshadow major challenges for national economies.

The only exception from the EU countries, where the area of the magic square did not decrease in 2020 compared to the five-year average, was Lithuania. This Baltic country achieved positive growth and an increase in the area of the magic square in 2020, contrary to the general EU-wide trend. From the point of view of absolute data, the area of the magic square increased by 73.75 u in Lithuania in 2020, which represents the expansion of the area of the magic square by 8.74% against the five-year average.

If we resorted to the generalization of our results, we could conclude that the year 2020 marked by the COVID-19 pandemic had a relatively negative impact on the economies of all EU member countries. In particular, a clear trend was the drop in the real GDP growth rate compared to the five-year average, which was not avoided by any EU country. Figure 1 also confirms this visually - it is clear that peak A (real GDP growth rate) always moved towards the intersection of the diagonals in 2020. The deficit balance of the current account within the balance of payments in 2020 also contributed to the reduction of the areas of the magic squares in the 15 member countries. The other two monitored economic indicators (HICP, unemployment rate) had the opposite impact on the area of the magic squares compared to the five-year average and 2020. Both the HICP and the unemployment rate, with minor exceptions, were lower in 2020 which automatically increased the areas of the magic squares of the EU countries. This (to a large extent) inertial effect from the passing progressive economic period could not balance the steep drop in real GDP. Thus, in 2020, the areas of the magic squares of countries across the entire EU are generally declining.

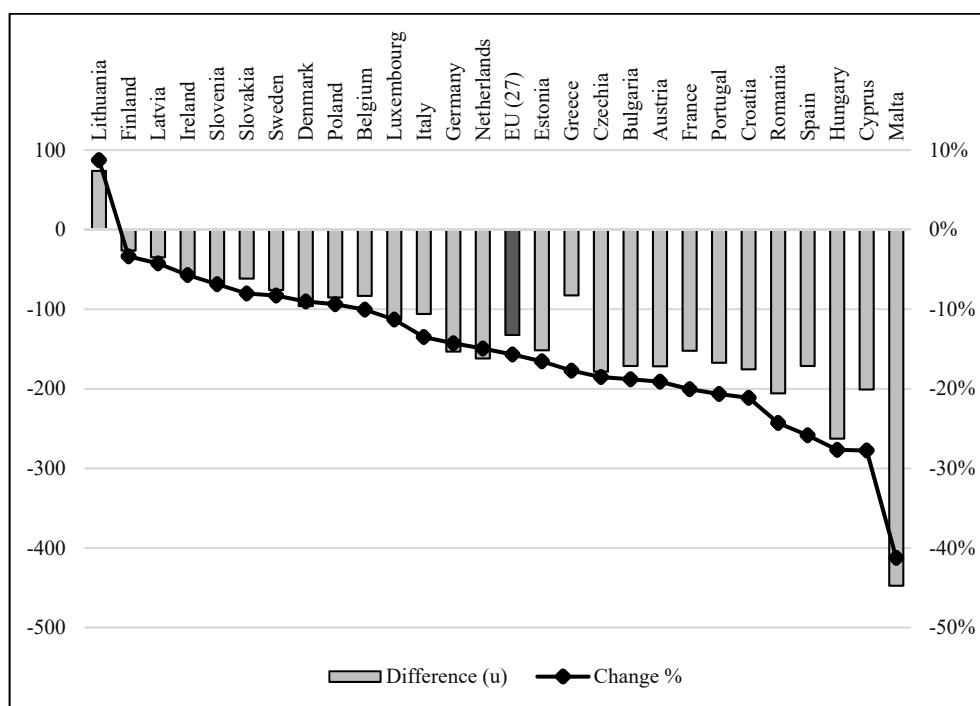
Figure 2. Magic squares in EU countries 2015-2020



Source: Own calculation

The only exception is Lithuania, which was the only country in the EU which increased the area of its magic square compared to the five-year average during the first year of the COVID-19 pandemic. The reason is the lowest drop in the real GDP growth rate in 2020 among all other EU member countries. In addition, the results in two other economic indicators (a positive balance of the current account within the balance of payments and a decline in the HICP) in 2020 made the area of Lithuania's magic square widen. The relatively lowest drop in real GDP, a highly positive current account balance within the balance of payments, a reduction in the HICP and only a minimal increase in the unemployment rate are a combination creating a unique situation of an increase in the area of the magic square in Lithuania. This is largely due to the inertia of development, especially the HICP, the unemployment rate, as well as the internal structure of the economy.

Figure 3. Change in the area of the magic square in EU countries in 2020 compared to the five-year average



Source: Own calculation.

In general, we could state that the most significant reduction in the areas of magic squares in EU countries during 2020 was found in the case of countries where tourism contributes significantly to the total GDP. This industry was hit very hard by the measures to mitigate the spread of the COVID-19 disease, and the tourist-attractive EU countries (Malta, Cyprus, Spain, Croatia, France or even Portugal) reported a significant drop in the real GDP growth rate in 2020 (Statista, 2022), which was automatically reflected in a significant reduction in

the areas of their magic squares. This factor is also underlined by the fact that EU countries with a lower share of tourism in their GDP (Lithuania, Finland, Latvia, Ireland, Slovakia) reported smaller changes in the area of their magic square.

Similarly, the very structure of the economies of the EU member countries had a significant impact on the slowdown of economic growth and the decrease in the areas of magic squares. It meant an increased risk of stagnation and recession in 2020 for the open and globalized economies of EU countries, as long as they were focused on the production of goods from oil, cars, equipment for mining and transport, or for the production of aircrafts and aircraft parts (OECD 2021).

In addition, many other determinants come into play as well, impacting one or more vertices of the magic square, thus increasing or decreasing its area in the case of all EU countries. For example, other factors include the quality of management and the quality of public government processes (WGI), the strictness of the anti-pandemic measures adopted (Sapir, 2020) and the role of the member states and the EU itself in dealing with the economic impacts of the COVID-19 disease through the public finance system.

Considering further economic development in the EU, it is very likely that the areas of the magic squares will continue to decrease. We observe economic recession and economic stagnation as the reasons (caused by two years of the COVID-19 pandemic and the war in Ukraine), while the positive short-term inertial effects of HICP stability from previous years will be minimized. These effects will affect the labour market as well, where the unemployment rate will increase. The negative economic outlook and shrinking area of the magic square will put public governments under severe pressure and will mean huge, possibly structural challenges for public finance systems.

6. Conclusions

The aim of our paper was to quantify the impacts of COVID-19 disease within the EU member countries in 2020 according to four basic aggregate economic indicators, which are set in Kaldor's magic square, and to identify changes in the area of the magic square compared to the five-year average. The drop in real GDP in 2020 which occurred across all EU countries compared to their five-year average is particularly significant, representing the most important negative factor in the decrease of the areas of magic squares in all EU countries. The deficit balance of the current account within the balance of payments had also contributed to the reduction of the areas of the magic squares in the 15 member countries in 2020. The other two monitored economic indicators (HICP and unemployment rate) mostly had the opposite impact on the areas of the magic squares when compared to their five-year averages.

The result of our paper is the finding that the area of the magic square has significantly decreased from the point of view of the entire EU in 2020 when compared to the five-year average. Hence, the area of the magic square for the entire EU has decreased by more than 15% in 2020. A total of 26 EU countries experienced a decrease in the area of the magic square ranging from -3.35% to -41.25%.

However, there is also one member country which was able to increase the area of the magic square even in 2020. This only exception is Lithuania, which is the single country in the EU increasing the area of its magic square by 8.74% during the first year of the COVID-19 pandemic, compared to the five-year average. The relatively lowest drop in real GDP, the highly positive balance of the current account within the balance of payments, the reduction in the HICP and only a minimal increase in unemployment were combined and together created a unique situation, where the area of the magic square increased. This is largely due to the inertia of development - especially the HICP, the unemployment rate, as well as the internal structure of the domestic economy.

The authors are aware that the secondary analysis of macroeconomic aggregate indicators presented in this text is limited by the utilized comparative procedures and the extent of this paper. At the same time, authors are aware of the limited selection of research methods. The performed analysis represents a generalized result, which is the result of the influence of multiple factors and variables, as well as specific conditions of the analysed countries.

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ECONOMIC GROWTH, INCOME DISPARITY AND GREENHOUSE GAS EMISSIONS: THE CASE OF BULGARIA³

The objective of this research is to perform an empirical analysis of the nexuses between real per capita output growth, income disparity and greenhouse gases in Bulgaria. To accomplish this goal, the original and the environmental Kuznets curves for Bulgaria were constructed. The results from the study indicate that in Bulgaria social resilience declines as economic sustainability increases. This demands tax and income policies for alleviating income disparity. It is advisable that progressive income taxation and tax-free minimum income be installed in order to diminish social instability in Bulgaria. Another inference from the empirical investigation is that Bulgaria ought to have a minimum real per capita output growth of 5.8% so that a decrease in carbon emissions is achieved.

Keywords: Sustainability; Kuznets curves; Bulgaria; income disparity; greenhouse gas emissions

JEL: F63; O20; Q01; Q56

1. Introduction

Sustainable development consists of three components: economic, social and environmental. Economic sustainability can be approximated by the real GDP per capita, social resilience may be measured by the Gini coefficient and environmental sustainability is indicated by greenhouse gas emissions per person.

The goal of this study is to estimate the nexuses between real per capita output growth, income disparity and green. The hypotheses of the existence of the OKC and EKC for Bulgaria were tested, the former being refuted and the latter being confirmed. The original and the environmental Kuznets curves for Bulgaria were produced. The original Kuznets curve (OKC) portrays the relationship between real economic growth per capita and income disparity, whereas the environmental Kuznets curve (EKC) depicts the nexus between economic growth and greenhouse gas emissions.

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The purpose of the research was achieved by the fulfilment of the following tasks:

- Make the reader familiar with the research problem;
- Systematize the theoretical fundamentals of sustainability and the empirical investigations on the Kuznets curves;
- Estimate the relationship between real per capita output growth and income disparity;
- Assess the nexus between real per capita output growth and greenhouse gas amounts in Bulgaria;
- Discuss the empirical results and recommend macroeconomic policies for achieving sustainability in Bulgaria.

The limitations of the investigation are related to data availability and short time series (the number of observations is below 30).

2. Literature Review

Brundtland (1987) defined sustainability as “development, which meets the needs of the present without compromising the ability of future generations to meet their own needs”. Sustainable development comprises two interdependent facets – sustainability and development. Sustainability has environmental and social aspects, while development concerns economic growth. Global trends in the modern world cover all the main spheres of public life - economic, social, science, education and ecology (Tsvetanova, 2022).

Kuznets (1955) claimed that in the long term economic growth results in a decline in income disparity. He described the economic growth-income disparity nexus via a U-shaped curve referred to as the original Kuznets curve. An alike curve portrays the relationship between output growth and carbon emissions. According to Grossman and Krueger (1995) in the beginning, accelerated economic growth causes a decline in carbon gases but this trend is reversed after a threshold level of per capita GDP is accomplished. The nexus between greenhouse gas emissions and economic welfare is expressed by an inverted curved line known as the environmental Kuznets curve. This term was coined by Panayotou (1993) and Seldon and Song (1994).

The nexuses between the aspects of sustainability, depicted by the two Kuznets curves, are a subject of incessant debate and argument by researchers, government officials, politicians, business circles and civil society.

The factors affecting the original Kuznets curve were examined by Rötheli (2011). They ascertained that with high-income disparity and low savings rates, economic growth does not always result in a more equitable income allocation. However, well-functioning capital markets may contribute to reducing income disparity.

Customarily, a well-developed financial sector favours accelerated economic growth and lower income disparity (Levine, 2005; Beck et al., 2007). However, in some cases, the

influence of the financial system on economic growth and social resilience may be controversial (Rousseau and Wachtel, 2011).

Okun (2015) asserted that the strife between income disparity and economic efficiency is inevitable. Increased equality discourages economic efficiency, but enhanced economic efficiency leads to higher disparity.

Piketty (2014) and Mavrov (2021) inferred that developed market economies tend to have higher return rates than economic growth rates, which stimulates wealth and income concentration. Ostry et al. (2014) and Stiglitz (2013) concluded that greater equality encourages economic efficiency.

Shahbaz and Sinha (2019) systematized the empirical research on the environmental Kuznets curve during 1991-2017. They found out, that study results and recommendations significantly differ because of great variations in research methodology, period and location. Shahbaz and Sinha (2019) advised that perfected and uniform methodology and data be employed in future investigations to raise the results' robustness and accuracy.

Howell et al. (2014) argued that most of the studies identified economic growth as a reason for the rise in greenhouse gas emissions (assumption one). The developments in green innovation and the environmental Kuznets curves (assumption two) showed that after a certain level of per-person income, greenhouse gas amounts drop. Boyce (1994) claimed that the general public may value more social resilience than economic prosperity (assumption three). Howell et al. (2014) verified the three assumptions for the USA and ascertained a positive correlation between carbon emissions and per capita output growth, confirming assumption 1. With other indicators used (poisonous gases), assumption two of the environmental Kuznets curve was supported. Assumption three regarding income disparity was also proved.

Singhania and Saini (2020) found proof in favour of the environmental Kuznets curve for different income-level countries. They discovered that output growth and energy production are the key drivers of the increase in carbon emissions.

Rajpurohit and Sharma (2021) verified the environmental Kuznets curve existence for Malaysia, India, Sri Lanka, Bangladesh and Pakistan during 1980-2014. They advised of greater output growth in spite of the rise in greenhouse gas amounts in the beginning. When economic growth occurs at a greater pace, air pollution will decline in the end.

Alshubiri and Elheddad (2020) checked the environmental Kuznets curve availability for thirty-two OECD states. At first, overseas investment, assets and remittances result in a significant increase in greenhouse gas amounts. However, after a certain threshold, investments, assets and remittances from abroad tend to reduce carbon dioxide amounts. Unlike foreign capital inflows, output growth initially generates more carbon gases but the trend is reversed when society becomes sufficiently well-off. A second turning point appears to make the nexus between output growth and greenhouse gases N-shaped.

Sajeev and Kaur (2020) confirmed the existence of the U-shaped EKC in the short run, but denied it in the long run for India in 1980–2012. They recommended that India introduce adequate environmental protection regulations and enforce their strict obedience.

Sen and Abedin (2021) confirmed the environmental Kuznets curve hypothesis for China and India during 1972–2017. They concluded that after a certain threshold output growth will decrease greenhouse gas amounts faster in India than in China.

Ahmed and Qazi (2014) confirmed the existence of short- and long-run EKC for Mongolia. As a result, adequate measures were taken to maintain an acceptable combination between the economic and ecological dimensions of sustainability.

Ansari et al. (2020) ascertained a long-run nexus between greenhouse gases, per capita output growth, foreign commerce and energy use in Australia, Canada, the United States, Saudi Arabia, Iran, Great Britain, France, Italy and Spain. The energy mix was found to be a crucial long-term factor of greenhouse gas amounts. The above-mentioned countries can decrease their energy use and greenhouse gases without impeding economic growth.

Bader and Ganguli (2019) validated the existence of a U-shaped EKC for Bahrain and Saudi Arabia. They recommended that the two countries rely less on fossil fuels as increased amounts of carbon emissions lower productivity and hamper GDP increase.

Borhan and Ahmed (2010) tested the EKC assumption for eight pollutants in Malaysia and found it valid for two pollutants only.

Cialani (2007) found no significant U-shaped nexus between greenhouse gas emissions and per-head output growth in Italy during 1861-2002.

Dar and Asif (2018) studied the long-term impact of financialization, energy consumption and per capita output growth on air pollution over 1960-2013. The amount of carbon emissions was found to be negatively correlated with financialization and positively correlated with energy consumption and GDP growth.

Hua and Boateng (2015) confirmed the existence of the EKC for a sample of 167 states during 1970-2007. The authors concluded that free trade and capital mobility contribute to reducing greenhouse gases on the global scale.

Lau et al. (2018) established an inverted nexus between per capita output growth and greenhouse gas amounts in developed states but refuted the EKC hypothesis for developing ones. In developing countries, corruption is a crucial determinant of carbon emissions whereas in developed states, institutional quality hinders the increase in greenhouse gas amounts.

Dimitrova (2019) tested the availability of the EKC for three small towns in Bulgaria – Krumovgrad, Breznik and Tran. No proof was discovered in favour of the EKC assumption in the three towns under investigation.

Kalchev (2016) studied the relationship between 5 air pollutants and per capita output growth in Bulgaria over 1970-2008 and proved the availability of an EKC for four out of five pollutants.

Tsiantikoudis et al. (2019) confirmed the validity of the N-shaped environmental Kuznets curve hypothesis for Bulgaria and recommended that landscaping and horticulture be adequately managed.

From the review of the literature, it may be concluded that a group of researchers (Levine, 2005; Beck et al., 2007; Rötheli, 2011; Stiglitz, 2013; Ostry, 2014) confirmed the validity of the OKC hypothesis, while other authors (Piketty, 2014; Okun, 2015) denied the OKC assumption. Our inferences are in agreement with the findings of Piketty (2014) and Okun (2015) and in contrast with the conclusions of Levine (2005), Beck et al. (2007), Rötheli (2011), Stiglitz (2013) and Ostry (2014).

The existence of the EKC was proved for many countries – the United States of America, Great Britain, Bahrain, Saudi Arabia and Mongolia. The environmental Kuznets curve assumption was found valid for Bangladesh, India, Malaysia, Pakistan and Sri Lanka provided that output grew at an increased rate. However, in some states (most of the Gulf Cooperation Council and Organization for Economic Cooperation and Development countries, Turkey, Italy, and China), no proof of an inverted nexus between per capita GDP increase and greenhouse gas emissions was ascertained. Our empirical findings confirmed the validity of the environmental Kuznets curve assumption in Bulgaria for the period 2001-2020.

It may be concluded that the empirical research on the OKC and EKC have ambiguous outcomes, which can be attributed to various methodologies, time intervals and geographical ranges.

3. Empirical Assessment of the Nexus Between Real per Capita Output Growth and Income Disparity

3.1. Methodology

The nexus between the growth of real GDP per capita and the Gini coefficient in Bulgaria is estimated by an ordinary least squares (OLS) regression, which involves the following variables:

Y_t – percentage change in real per capita output in Bulgaria in year **t** on year **t-1**;

G – percentage change of the Gini coefficient in Bulgaria in year **t** on year **t-1**.

The target variable is **G**, while the explanatory variable is **Y**. To correct for a possible non-linear nexus between the target and the explanatory variable, the square of **Y** participates in the regression too.

3.2. Data

Yearly Eurostat data for the interval 2007 – 2021 are employed in the research.

3.3. Results

The group stationarity tests indicate that jointly **Y** and **G** are integrated of order zero (see Table 1), which permits the implementation of the OLS methodology.

Table 1. Group Unit Root Tests on Y and G

Method	Statistic	Probability	Cross-sections	Observations
Null: Unit root (implies common non-stationarity)				
Levin, Lin and Chut*	-5.50	0.00	2	28
Null: Unit root (implies individual non-stationarity)				
Im, Pesaran and Shin W-statistic	-4.90	0.00	2	28
ADF-Fisher Chi-square	24.55	0.00	2	28
PP-Fisher Chi-square	38.60	0.00	2	28

Source: Authors' estimation

The nexus between **Y** and **G** is shown by Equation (1):

$$G = C(1) + C(2)*Y + C(3)*Y^2 + \Sigma \quad (1)$$

The results from the assessment of Equation (1) are displayed in Table 2. The absence of significant variables in Equation (1) means a lack of linear and non-linear impact of real growth per person on income disparity in Bulgaria.

Table 2. Econometric Assessment of Equation (1)

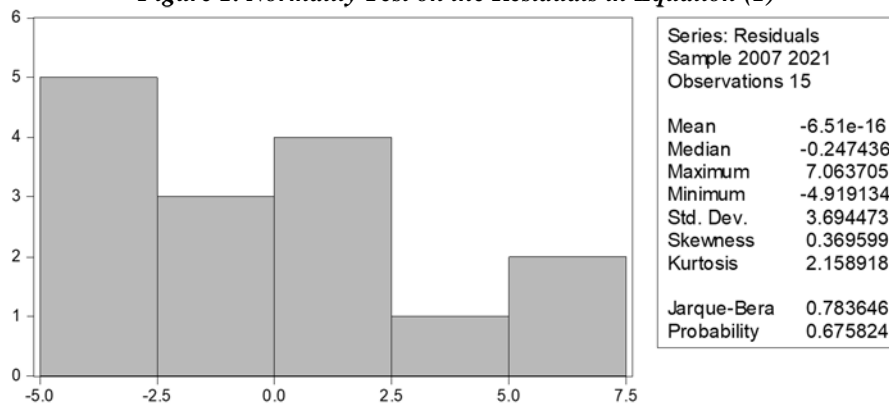
Variable	Coefficient	Standard Error	t-Statistic	Probability
C	-1.71	1.61	-1.07	0.31
Y	0.72	0.48	1.51	0.16
Y ²	0.09	0.11	0.87	0.41
R-squared	0.44	Mean of dependent variable		1.73
Adjusted R-squared	0.34	Standard deviation of dependent variable		4.91
S.E. of regression	4.00	Akaike info criterion		5.79
Sum squared residual	191.09	Schwarz criterion		5.93
Log likelihood	-40.37	Hannan-Quinn criterion		5.79
F-statistic	4.60	Durbin-Watson statistic		2.29
Probability of F-statistic	0.04			

Source: Authors' estimation

The determination coefficient value (0.44) suggests that 44% from the changes in **G** can be attributed to the variation in **Y**. The probability of the F-statistic of 0.032 means that Equation (1) properly expresses the nexus between **G** and **Y**.

The residuals in Equation (1) are characterized by normal distribution (see Figure 1), lack of serial correlation (see Table 3) and non-heteroscedasticity (see Table 4). The Regression Specification Error Test (RESET) indicates an absence of errors in the construction of Equation (1) (see Table 5). The CUSUM test (see Figure 2) displays that Equation (1) possesses dynamic stability.

Figure 1. Normality Test on the Residuals in Equation (1)



Source: Authors' estimation.

Table 3. Serial Correlation Test on the Residuals in Equation (1)

F-statistic	0.54	Probability F(2,10)	0.61
Observations R-squared	1.45	Probability Chi-Square(2)	0.49

Source: Authors' estimation.

Table 4. Test for Heteroskedasticity of the Residuals in Equation (1)

F-statistic	0.17	Probability F(2,12)	0.86
Observations R-squared	0.39	Probability Chi-Square(2)	0.82

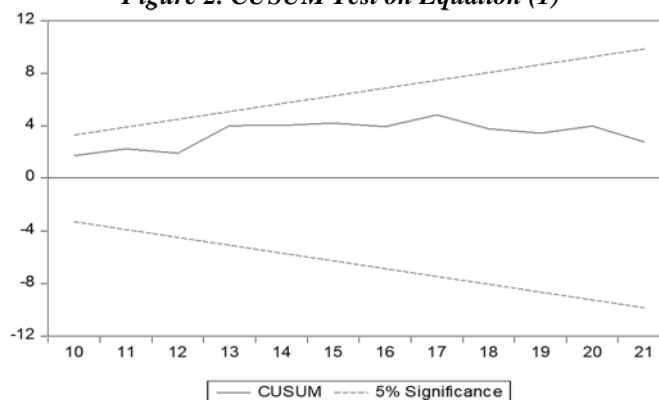
Source: Authors' estimation.

Table 5. RESET on Equation (1)

	Value	Degree of freedom	Probability
t-statistic	0.89	11	0.39
F-statistic	0.83	(1, 11)	0.39
Likelihood ratio	1.09	1	0.30

Source: Authors' estimation.

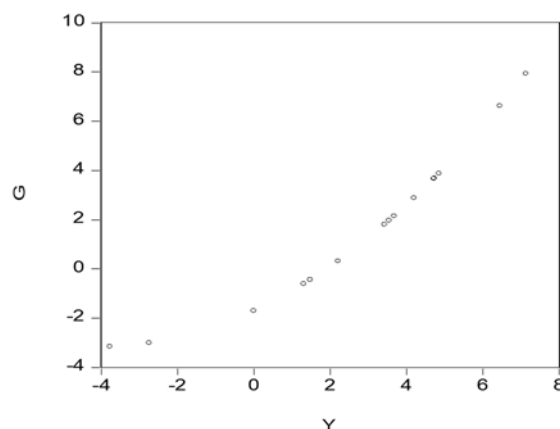
Figure 2. CUSUM Test on Equation (1)



Source: Authors' estimation.

The original Kuznets curve for Bulgaria during 2007-2021 (see Figure 3) is constructed using Equation (1). This curve displays that the acceleration of real per capita economic growth is combined with a rise in income disparity.

Figure 3. Nexus between real per capita output growth and income disparity in Bulgaria during 2007-2021



Source: Authors' estimation.

4. Empirical Estimation of the Nexus between Real per Capita Output Growth and Greenhouse Gas Amounts

4.1. Methodology

The nexus between real economic growth per person and carbon gases in Bulgaria is explored via an OLS model specification, which includes the variables mentioned below:

Y_t – percentage change in real per capita output in Bulgaria in year t on year $t-1$;

E – percentage change in greenhouse gas emissions per capita in Bulgaria in year t on year $t-1$.

The variable of interest is E , whereas the regressor is Y . To reflect a possible non-linearity between E and Y , the square of Y is also presented in the model specification.

4.2. Data

Yearly Eurostat data for the interval 2001 – 2020 are employed in the analysis.

4.3. Results

The group stationarity tests indicate that jointly Y and E are integrated of order zero (see Table 6), which permits the immediate implementation of the OLS methodology.

Table 6. Group Unit Root Tests on Y and E

Method	Statistic	Probability	Cross-sections	Observations
Null: Unit root (implies common non-stationarity)				
Levin, Lin and Chut*	-1.75	0.03	2	37
Null: Unit root (implies individual non-stationarity)				
Im, Pesaran and Shin W-statistic	-1.79	0.03	2	37
ADF-Fisher Chi-square	9.93	0.03	2	37
PP-Fisher Chi-square	12.3	0.02	2	38

Source: Authors' estimation.

The nexus between **Y** and **E** is described by Equation (2):

$$E = C(1) + C(2)*Y + C(3)*Y^2 + \Sigma \quad (2).$$

The results from the assessment of Equation (2) are displayed in Table 7. The availability of significant predictors in Equation (2) implies that **Y** has both linear and non-linear impact on **E** in Bulgaria.

Table 7. Econometric Assessment of Equation (2)

Variable	Coefficient	Standard Error	t-Statistic	Probability
Y^2	-0.23	0.10	-2.33	0.02
Y	2.58	0.60	4.35	0.01
C	-3.84	1.86	-2.08	0.04
R-squared	0.58	Mean of dependent variable		0.40
Adjusted R-squared	0.53	Standard deviation of dependent variable		7.25
Standard error of regression	4.97	Akaike info criterion		6.17
Sum squared residual	422.00	Schwarz criterion		6.32
Log likelihood	-58.88	Hannan-Quinn criterion		6.20
F-statistic	11.68	Durbin-Watson statistic		2.58
Probability of F-statistic	0.01			

Source: Authors' estimation.

The determination coefficient value (0.58) suggests that 58% from the changes in **E** can be attributed to the variation in **Y**. The probability of the F-statistic of 0.01 means that Equation (2) properly expresses the nexus between **E** and **Y**.

The residuals in Equation (2) are characterized by normal distribution (see Figure 4), lack of serial correlation (see Table 8) and non-heteroscedasticity (see Table 9). The Regression Specification Error Test (RESET) indicates an absence of errors in the construction of Equation (2) (see Table 10). The CUSUM test (see Figure 4) displays that Equation (2) possesses dynamic stability.

Figure 4. Normality Test on the Residuals in Equation (2)

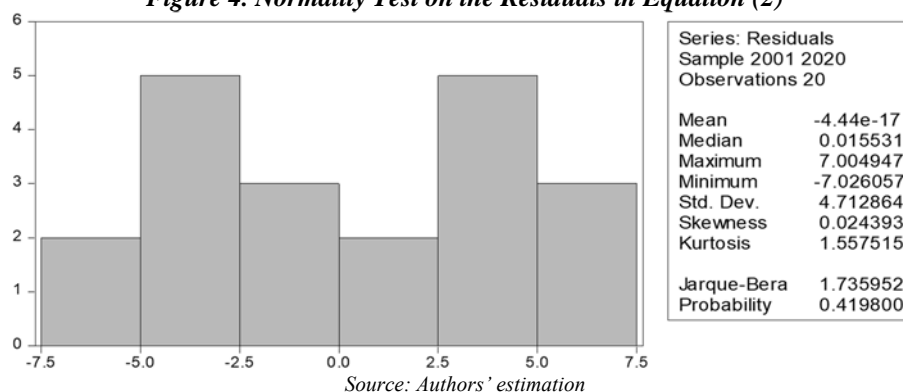


Table 8. Serial Correlation Test on the Residuals in Equation (2)

F-statistic	2.22	Probability F(1,16)	0.16
Observations R-squared	2.44	Probability Chi-Square(1)	0.12

Source: Authors' estimation

Table 9. Test for Heteroskedasticity of the Residuals in Equation (2)

F-statistic	0.02	Probability F(1,17)	0.91
Observations R-squared	0.02	Probability Chi-Square(1)	0.90

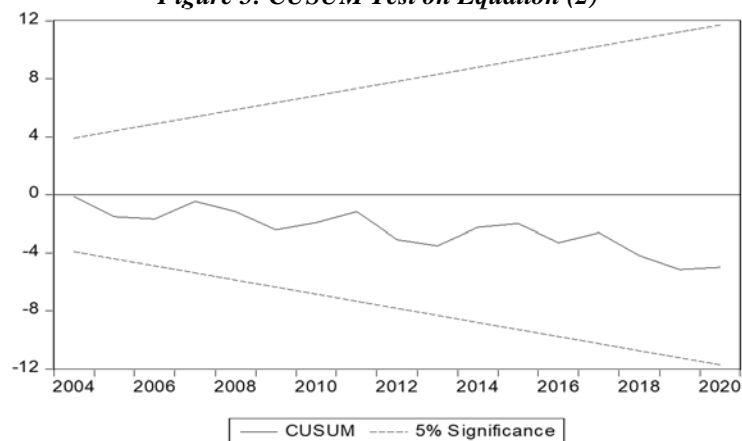
Source: Authors' estimation

Table 10. RESET on Equation (2)

	Value	Degree of freedom	Probability
t-statistic	0.24	16	0.82
F-statistic	0.06	(1,16)	0.82
Likelihood ratio	0.08	1	0.80

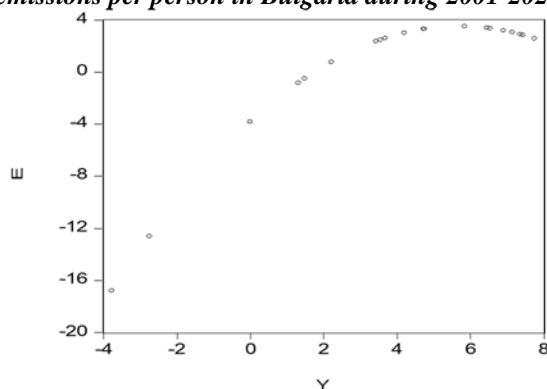
Source: Authors' estimation

Figure 5: CUSUM Test on Equation (2)



The ecological Kuznets curve for Bulgaria during 2001-2020 (see Figure 6) is constructed using Equation (2). This curve displays that the amount of carbon emissions in Bulgaria rises until the real per capita output growth rate reaches 5.8% per annum. After this threshold, the acceleration of real economic growth per person results in a decline in greenhouse gas amounts.

Figure 6: Relationship between real per capita output growth and greenhouse gas emissions per person in Bulgaria during 2001-2020



Source: Authors' estimation

Conclusion

The results from the study indicate that in Bulgaria in the period 2007 – 2021, the acceleration in real per capita output growth was coupled with a decline in social resilience. The results also show that in Bulgaria in the interval 2001 – 2020 the rise in real GDP per capita growth was paired with a rise in carbon emissions to the threshold of 5.8% after which the trend was reversed. When real economic growth exceeded 5.8%, a fall in greenhouse gas amounts occurred.

It can be concluded that in Bulgaria income disparity increases as economic growth accelerates. This requires tax and income policies to alleviate income disparity. It is advised that progressive income taxation and tax-free minimum income be implemented to enhance social stability in Bulgaria.

Another inference is that Bulgaria ought to reach a minimum real economic growth per head of 5.8% in order to achieve a decline in carbon emissions. Bulgarian policymakers ought to implement policies for moving the EKC to the right by making investments in sustainability and fostering green innovations for a smoother transition to net-zero greenhouse gas emissions by 2050.

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MACROECONOMIC FACTORS THAT GENERATE FISCAL RISK IN ROMANIA³

Fiscal risk, under the form of unforeseen increases in public expenditures, can be quantified by the (increasing) government debt level. This study aims to identify the interdependencies between government debt, the number of people active on the labour market (labour force), the level of the average salary in the economy, the harmonized index of consumer prices and the RON-EURO exchange rate. The main objective is thus to assess which ones of the last four variables influence in the short and long run the government debt and constitute a fiscal risk. The analysis is focused on Romania, using quarterly data starting from the 1st quarter of the year 2000 and up to the 2nd quarter of 2021, the applied methodology being VECM. The most important conclusions show that changes in the level of the average salary and active population are significant and influence the government debt both in the short and long run and they can constitute in this regard fiscal risk determinants, while HICP as an inflation indicator or HICP do not exert significant impact on government debt either on short term or long term. While the average salary constantly exerts a significant and positive influence on the government debt, the change in the active population leads to a change of the same sign in the government debt in the short term, but of the opposite sign in the long term. The main recommendation for the government that derives from the results of the study is to implement measures to increase the active population and increase the degree of employment, in order to decrease the pressure on the government debt and fiscal risks, both in the short term and long-term. This is in line with the results of numerous studies that show that the decrease in the active population, combined with the rise in retired people, lead to increasing indebtedness.

*Keywords: fiscal risk; government debt; demographic tendencies; average salary
JEL: H63; J01; H50*

1. Introduction

There are studies whose empirical results show that the evolution of government debt is influenced in the same way by the evolution of social assistance expenditures (Porumboiu & Brezeanu, 2022). Through this article we aim to identify if there is an interaction between the

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government debt (*debt*), the number of people active on the labour market (*activepop*), the level of the average salary in the economy (*sal*), the harmonized index of consumer prices (*HICP*) and the RON-EURO exchange rate (*exchange*). The reasoning for which we consider it appropriate to estimate a VECM (vector error correction model) has foundations of macroeconomic logic, explained in the following, but it is also suggested by the typology of the series included in the analysis. This econometric model allows, in turn, the analysis of the impact on each variable used, determined by changes in the other variables, and quantifies the interdependencies between each of them. However, the main objective is to identify if and how much the number of active people, the average salary in the economy, the HICP or the RON-EUR exchange rate can lead to increases in the public debt, given the fact that an increase in the public debt represents a risk fiscal, a potential threat to macroeconomic sustainability.

The macroeconomic system is composed of components that evolve depending on the measures that are taken with impact on themselves but also depending on the changes of the others. For example, the public debt can be a consequence of some government measures that do not find their financing in tax revenues, but then it can itself constitute a determinant of the level of taxes and fees established, since the credit must be repaid.

The increase in government debt and the payment of the related interest can translate into a reduced ability to cover social expenses and expenses with the salaries of the budget workers, a fact that is quickly reflected in the level of the average salary in the economy and can also influence the number of people active on the labour market. A government debt accompanied by a budget deficit is most often the cause of adjustments to public spending, for example through reforms with an impact on administration spending, which are felt in the incomes of people employed by the state and even in the structure of the active population.

In the field of the labour market, governments propose to match vacant jobs with the existing labour force (a complex process, which involves accompanying the individual in the long term through education and training, for the acquisition of skills and even professional reprofiling). In this way, the appropriate placement of the active population is ensured, workers will obtain their own income and the need for financial support from the public authorities will decrease (social assistance expenses). Placement of the labour force implies the reduction of the number of unemployed beneficiaries and the increase of the number of employed people. Of course, the situation will generate positive consequences on the average salary in the economy.

The intervention of the state in the labour market by establishing minimum levels of salary income should be carried out with caution, always taking into account the ability of employers in the private sector to comply with the regulations without reducing the number of employees. Setting a higher level of the economy's minimum salary is a welcome measure for people employed on such a salary, but governments must ensure that this does not backfire on the state by increasing unemployment and social spending. We appreciate that the main objective of public policies on the labour market is to support the development of commercial companies that offer new jobs, to facilitate the access of the active population to vacant positions, to have a high level of employment and thus reduce the pressure on expenses public with social assistance.

The changes regarding the active population are in turn the effect of several factors, among which the demographic one deserves to be remembered as a priority. The low birth rate and the increasing life expectancy are the phenomena that determine the working population (people having the working age – from 15 to 64 years) in the long term and which also affect the active population (employed and unemployed population). If we also take into account the growing phenomenon of migration, we can say that the active population is fundamentally determined by three major demographic phenomena: “reducing mortality, reducing birth rates and external migration” (Rangelova & Bilyanski, 2019). The decrease in the number of employed people, against the background of the increase in the number of retired and jobless people, can lead to greater pressure on the component of social contributions of people who earn income. Net salaries are negatively influenced, so there will also be changes in the average salary in the economy. The decrease in the active population, against the background of the two mentioned demographic phenomena, will require the addition of social expenses from the governments, financing that could sometimes only be done through loans.

Part of the products and services that are sold, and even part of the salaries in Romania have as a reference point the EUR value at a given moment, the price being represented by the counter value in RON, paid in the national currency, but in fact also determined by the evolution the exchange rate. Also, the structure of Romania's government debt shows a well-defined component represented by loans in EUR currency. A possible change in the exchange rate translates into lower/higher interest costs for loans in EUR.

The specialized literature abounds in studies that quantify the impact of demographic changes on government debt, ex-ante analyses whose primary objective is to raise an alarm signal to public authorities that the situation can only be partially resolved through reforms and additional revenues (Afflatet, 2018). We therefore observe that there is a dynamic of the variables: the government debt, the active population, the average salary in the economy, and the complexity of the system is undoubtedly greater, given the correlations with other macroeconomic variables. The use of a VECM model is justified.

2. Literature Review

Among the variables included in the analysis, the specialized literature most often concludes that demographic factors are the ones that constitute fiscal risk and represent a vulnerability of long-term fiscal sustainability.

In 2009, amid the economic crisis, the International Monetary Fund stated that, in the conditions of increasing government debt and contingent liabilities, the main threat to fiscal solvency is the ageing population trend. Although the countries of reference at that time were advanced economies, as expected, this demographic problem extended to developing economies as well. The estimated solution to prevent a government debt boom was to reduce the level of government debt, spending and maintaining the level of taxes, in order to subsequently have available fiscal space.

Increasing life expectancy does not only mean that people are living longer, but that they can survive longer from diseases (Birg, 2015), and this reality of life entails increasing costs for

the healthcare system that has to treat them (Lee & Tuljapurkar, 1998). Yared (2019) shows that government debt fulfils three functions, as follows: it allows for lower taxation, it represents an asset of safe value and determines the efficient use of capital over time. The author raises the following fundamental question: does the fact that the use of the growing government debt is done in order to increase the social benefits of the population compensate for the risk it entails?

The way demographic phenomena affect the government debt of OECD countries has attracted the attention of authors since the end of the last century, against the background of the increase in life expectancy and the decrease in the birth rate. The fact that the working population is declining, while the number of elderly people is high, has been flagged as a challenge to the sustainability of public finances since 1995. Authors Jensen and Søren opined that, for intergenerational equity to exist, in periods when there is a significant labour force governments must focus on reducing the government debt so that, in times when the ageing population requires financial support, there is not a large burden on workers contributing to the social insurance fund. The two authors carry out an analysis regarding the sustainability of public finances and the possibilities of adjusting the tax rate, starting from the study of Blanchard, Chouraqui, Hagemann and Sartor (1990), in which the current tax rate is compared with the permanent one (calculated in such a way as to ensure the sustainability of public finances, the government debt to tend to 0, or at least at the time of projection to be lower than the current one). Under normal circumstances, a current tax rate that exceeds the permanent tax rate allows tax reduction, and vice versa. But Jensen and Søren show that the ageing population makes the decision to cut tax levels unsustainable and will actually lead to a more costly deferment of government debt service.

Other authors (Jensen & Søren, 1996; Balassone et al., 2009; Cecchetti et al., 2010) raised the issue of the burden that the ageing population can constitute on the government debt and sought to propose alternatives, but as observed relevant in repeated articles (Preston, 1984; Sinn & Silke, 2002; Auerbach, 2009), possible fiscal consolidation reforms with an impact on the elderly are all the more difficult to implement the larger their number, and implicitly, and their political decision-making power is more significant. Although the private pension system already operates in many countries, where the state only has the obligation to provide a minimum level of pension (more like subsistence), pensions are still a concern for industrial economies (Klyvienė, 2004).

The connection between the government debt and the active population is an obvious one: the interest payment is based on the tax revenues collected by the public authorities, where an essential place is occupied by labour taxation. People need a job, hence the rigidity of labour as a factor of production. According to Menguy (2020), from a fiscal point of view, this translates into greater efficiency in raising tax revenues by increasing labour taxation than by raising other types of taxes. The same author develops an econometric model applied to the euro states which confirms that states with a low level of labour taxation are those with a lower debt ratio. Because of the need to finance interest, states with high government debt have higher labour tax rates to meet their tax revenue targets. For employees, this means a lower net salary.

However, an unjustified level of taxes on labour can also generate undesirable consequences, such as increasing the unemployment rate and illegal work, that is, forms of tax evasion that reduce the level of budget receipts (Genschel, 2001). The same idea emerges from the recommendations made by Dieppe et al. (2015): to ensure economic growth in the medium term in countries with high government debt and an ageing population, fiscal consolidation requires prudent implementation, so as not to generate undesirable effects of decreasing labour supply.

The fact that demographic phenomena affect government debt derives from the following reasoning: starting from the last century, most European countries have used a system called PAYG (pay-as-you-go) to obtain pension funds, a system that is based on social contributions, determined by the number and salaries of active people. A larger pensionable population and a decline in the working population are driving governments to identify new sources of funding – even possibly borrowing. Precisely for this reason, the ageing of the population is a challenge for the sustainability of finances and a matter of inter-generational equity (Sánchez-Romero et al, 2019).

Empirical research with panel data models carried out on the Member States of the European Union proved that there is a correlation between the active population represented by young people who do not hold a job and macroeconomic conditions, in the sense that high government debt, low GDP growth and poor development of the construction sector are associated with a higher vacancy rate (Tomić, 2018). Hansson (2010) also explains with reference to the EU that against the background of increased mobility of capital and people, and in the context of an ageing population (he uses the example of Sweden), the use of the PAYG system proves to be inefficient and cannot be corrected by increasing the level of taxation of the work, but a possible source of financing the expenses with the elderly could be the increase in property taxation. The objective of identifying sustainable sources to cover these expenses results from the idea of not resorting to government debt to compensate for this imbalance between the active population and the population benefiting from social support. Bengtsson and Scott (2011) warn that it is unlikely that the problem of population ageing will be solved only by increasing taxation since employees have (well-founded) expectations that the evolution of labour productivity will be felt in the level of income and living conditions. Bongaarts (2004) even expects a reduction in pension 'generosity' to be inevitable.

Demmel and Keuschnigg (2000) opine that the alternative to the PAYG pension system and the accumulation of excessive government debt is the development of the private pension system, which would have a positive impact on the employment rate and capital accumulation.

Moreover, there are studies that show not only that government debt negatively influences the level of net income of the population, but even contributes to an unequal distribution of wealth (Chatzouz, 2020). Topal et al. (2018) show that the government debt Granger causes the unemployment rate, leads to an increase in the number of unemployed, as the unemployment rate also leads to an increase in the government debt. Farmer and Kuplen (2018) also confirm that higher government debt favours higher unemployment and slows the growth rate of GDP and the interest rate.

Regarding the studies carried out on this topic and the methodology used, we note the analysis by Afflatet (2018) which uses panel data for 18 European countries to identify whether demographic factors (number of unemployed, age structure of the population) have influenced the evolution of government debt. The regression results demonstrate that until 2015 the changes produced in the debt level were not mainly due to demographic factors, but this does not exclude the future influence they will exert, a study that also confirms empirical results previously obtained by Razin et al. in 2001, or Chen in 2004.

The study of Tanchev & Mose (2023) confirms the fact that government initiatives on the labour market to develop human capital, although they involve additional expenses, have measurable effects of increasing productivity and contribute to economic growth. However, the recommendation is that these increases in expenses should be done at a reasonable cost, since debt financing can translate into pressure on the economy and the private sector (in order to obtain tax revenues intended for reimbursement) and, in the long term, in a delay of economic development.

3. Methodology

Quarterly government debt (abbreviated *debt*) is, according to the European System of Accounts ESA 2010, the “total gross debt at nominal value outstanding at the end of each quarter for the general government sector”. The variable is expressed in million units of national currency, RON. The active population (*activepop*) concerns both employed and unemployed people, aged from 15 to 64 years, and it is synonymous to the labour force, in accordance with the definition provided by the International Labour Organization. The active population is expressed in thousands of persons. The average salary in the economy (*sal*) refers to the average quarterly amounts paid by employers to their employees, and it is expressed in the national currency, RON. The Harmonised Index of Consumer Prices (abbreviated *HICP*) is an “economic indicator that measures the change over time of the prices of consumer goods and services acquired by households” (definition provided by Eurostat) and constitutes an indicator for inflation. The variable is expressed as an index, for which the reference moment is represented by the first quarter of the year 2005. Finally, the exchange rate between RON and EUR (*exchange*) represents the rate at which one currency (RON) will be exchanged for another currency (EUR).

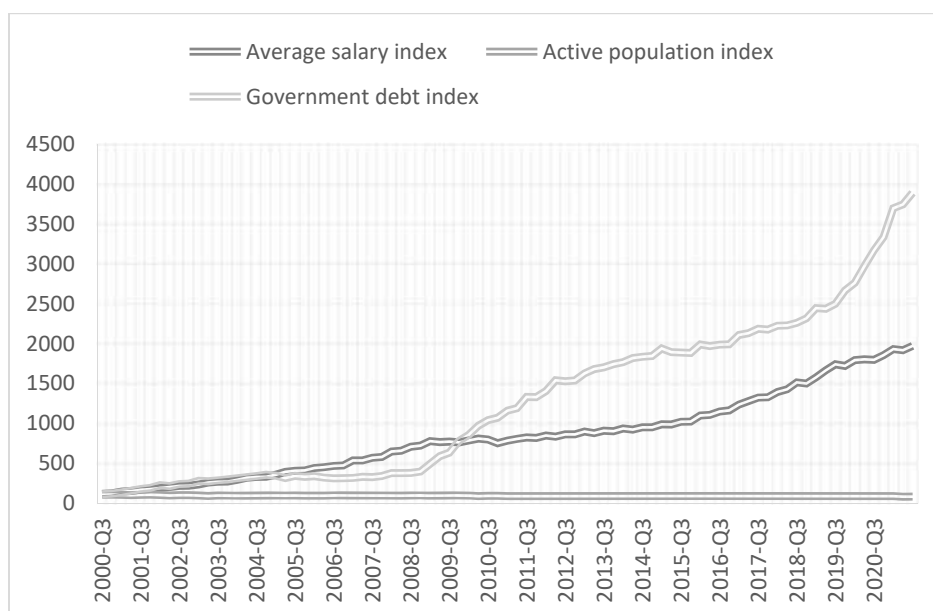
To proceed with the estimates for Romania, we used quarterly data starting from the 1st quarter of 2000 and up to the 2nd quarter of 2021, the data being mostly provided by the Eurostat database (for government debt, active population, HICP, exchange) and by the website of the Ministry of Labour (only the evolution of the average salary in the economy). We used log transformation for data, except for the exchange rate and the HICP.

Compared to the first quarter of 2000, the second quarter of 2021 shows very different values for the analysed variables, as follows: the active population is 19 percentage points lower, in absolute terms it is about 1.9 million people less for the workforce represented by employees and the unemployed. The average salary in the economy experienced gradual increases, reaching in 2021 a value 19 times higher than in 2000. The government debt increased gradually, reaching in 2003 a value three times that of 2000, and this value was somewhat

maintained at a similar level until 2008. Then, given the context of the financial crisis, the government debt increased, and the COVID-19 pandemic period caused that during 6 quarters (2020Q1 – 2021Q2) accumulate a surplus of government debt, equivalent to 9 times the value of the entire government debt from the year 2000.

The HICP had a gradual evolution, reaching in 2021 to have 4.66 times the value of the year 2000, which shows that inflation had a slower growth, there were no periods of inflationary boom. As for the RON-EUR exchange rate, it increased the least among all the other variables included in the study, compared to its own value from the year 2000. With an increase of 2.66 times compared to the year 2000, we can say that the exchange rate had a controlled flotation and therefore, even at first glance, it does not seem to constitute a fiscal risk.

Figure 1. The evolution of the analysed variables compared to their value from the year 2000, quarter I



Source: own representation using Eurostat and Romanian Ministry of Labour data.

4. Modelling and Findings

To check if there are links between the five variables that are included in the analysis, we started with the following hypotheses:

- H1: $l_debt = F(\text{exchange}, \text{HICP}, l_debt, l_activepop, l_sal)$
- H2: $l_sal = F(\text{exchange}, \text{HICP}, l_debt, l_activepop, l_sal)$
- H3: $l_activepop = F(\text{exchange}, \text{HICP}, l_debt, l_activepop, l_sal)$
- H4: $\text{HICP} = F(\text{exchange}, \text{HICP}, l_debt, l_activepop, l_sal)$
- H5: $\text{exchange} = F(\text{exchange}, \text{HICP}, l_debt, l_activepop, l_sal)$

Table 1 includes the main statistical parameters of the variables included in the analysis:

Table 1. Descriptive statistics

	EXCHANGE	HICP	L_DEBT	L_ACTIVEPOP	L_SAL
Mean	3.994993	125.1977	11.60796	9.123588	7.073937
Median	4.257000	137.9650	11.92217	9.111310	7.269255
Maximum	4.924000	175.9800	13.17346	9.278064	8.169336
Minimum	1.850600	37.76000	9.511326	8.993986	5.187386
Std. Dev.	0.734462	37.38058	1.026696	0.057982	0.761393
Observations	86	86	86	86	86

Source: own results obtained through Eviews software

The correlation coefficients are presented in Table 2 and illustrate a strong correlation between the variables under analysis.

Table 2. Correlation matrix

	EXCHANGE	HICP	L_DEBT	L_ACTIVEPOP	L_SAL
EXCHANGE	1.000000	0.934750	0.925912	-0.888426	0.920761
HICP	0.934750	1.000000	0.970304	-0.881426	0.986515
L_DEBT	0.925912	0.970304	1.000000	-0.885611	0.945281
L_ACTIVEPOP	-0.888426	-0.881426	-0.885611	1.000000	-0.855317
L_SAL	0.920761	0.986515	0.945281	-0.855317	1.000000

Source: own results obtained through Eviews software.

To verify the stationarity of the series, we applied unit root tests. In order to determine whether the series are integrated of order 0, we used two unit root tests, both the Augmented Dickey-Fuller test and the Phillips-Perron test in Eviews.

The ADF test gave us a probability of 65% for government debt, 43% for the labour force, and 70% for the average salary (greater than 5%), which means that we will not reject the null hypothesis, so these series are non-stationary. As for the exchange rate and the HICP, the probabilities indicated by the test are less than 5%, so we will accept the null hypothesis that there is a unit root and the series are stationary. Similar results are also indicated by the PP test, except for the series corresponding to the average salary in the economy, which is suggested to be a stationary series (obtained probability of 0%).

Table 3. ADF-level stationarity test for the studied variables

Variable	exchange	l debt	HICP	l activepop	l sal
Test critical values	t-statistic	t-statistic	t-statistic	t-statistic	t-statistic
ADF test statistic	-3.105720	-1.243046	-6.990468	-1.691584	-1.128088
1%	-3.510259	-3.511262	-3.509281	-3.513344	-3.513344
5%	-2.896346	-2.896779	-2.895924	-2.897678	-2.897678
10%	-2.585396	-2.585626	-2.585172	-2.586103	-2.586103
Interpretation	Stationary series	Non-stationary series	Stationary series	Non-stationary series	Non-stationary series

Source: own results obtained through Eviews software

Table 4. PP-level stationarity test for the studied variables

Variable	exchange	l debt	HICP	l activepop	l sal
Test critical values	t-statistic	t-statistic	t-statistic	t-statistic	t-statistic
PP test statistic	-4.613771	-1.609957	-11.65858	-2.171072	-5.233594
1%	-3.509281	-3.509281	-3.509281	-3.509281	-3.509281
5%	-2.895924	-2.895924	-2.895924	-2.895924	-2.895924
10%	-2.585172	-2.585172	-2.585172	-2.585172	-2.585172
Interpretation	Stationary series	Non-stationary series	Stationary series	Non-stationary series	Stationary series

Source: own results obtained through Eviews software

Since the ADF test indicates three of the variables as non-stationary, we applied the first-order difference for them. We have obtained stationary series for all the variables in question, which are now integrated in the first order. Consequently, we expect the relationships between the variables under analysis to manifest themselves in the long run.

Table 5. ADF stationarity test - differences of the first order for the studied variables

Variable	exchange	l debt	HICP	l activepop	l sal
Test critical values	t-statistic	t-statistic	t-statistic	t-statistic	t-statistic
ADF test statistic	-6.560735	-3.585188	-5.372754	-17.60305	-3.249879
1%	-3.510259	-3.511262	-3.510259	-3.511262	-3.513344
5%	-2.896346	-2.896779	-2.896346	-2.896779	-2.897678
10%	-2.585396	-2.585626	-2.585396	-2.585626	-2.586103
Interpretation	Stationary series	Stationary series	Stationary series	Stationary series	Stationary series

Source: own results obtained through Eviews software

Table 6. Stationarity test PP- differences of the first order for the studied variables

Variable	exchange	l debt	HICP	l activepop	l sal
Test critical values	t-statistic	t-statistic	t-statistic	t-statistic	t-statistic
PP test statistic	-6.549692	-7.569184	-5.204739	-12.76910	-9.470411
1%	-3.510259	-3.510259	-3.510259	-3.510259	-3.510259
5%	-2.896346	-2.896346	-2.896346	-2.896346	-2.896346
10%	-2.585396	-2.585396	-2.585396	-2.585396	-2.585396
Interpretation	Stationary series	Stationary series	Stationary series	Stationary series	Stationary series

Source: own results obtained through Eviews software

Given the expert recommendation to use the Schwartz criterion for quarterly series that have more than 20 observations, we will take this into account to determine the number of lags of the model. According to this criterion, the optimal number of lags is 3.

Table 7. Criteria for determining the number of lags

Lag	LogL	LR (sequential modified LR test statistic)	FPE (Final prediction error)	AIC (Akaike information criterion)	SC (Schwarz information criterion)	HQ (Hannan-Quinn information criterion)
0	88.03907	NA	2.27e-05	-2.180489	-2.089846	-2.144203
1	472.3199	729.1483	1.50e-09	-11.80308	-11.44050	-11.65793
2	502.2979	54.57530	8.78e-10	-12.34097	-11.70647	-12.08697
3	529.8995	48.12578	5.47e-10	-12.81793	-11.91151*	-12.45508
4	541.1222	18.70448	5.19e-10	-12.87493	-11.69657	-12.40321
5	565.3879	38.57627	3.54e-10	-13.26636	-11.81607	-12.68578
6	576.1907	16.34269	3.42e-10	-13.31258	-11.59037	-12.62315
7	593.1593	24.36520*	2.84e-10*	-13.51690*	-11.52277	-12.71861*
8	601.4855	11.31506	2.95e-10	-13.49963	-11.23356	-12.59248

* indicates lag order selected by the criterion

Source: own results obtained through Eviews software

However, it must be taken into account that the macroeconomic variables are both stationary and non-stationary, which also implies checking the cointegration of the time series, in order to determine which estimate can be accepted.

Table 8. Cointegration test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.365652	84.77993	69.81889	0.0020
At most 1	0.289998	47.00181	47.85613	0.0600
At most 2	0.104009	18.57533	29.79707	0.5238
At most 3	0.088938	9.459821	15.49471	0.3246
At most 4	0.020614	1.728802	3.841466	0.1886

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values

Source: own results obtained through Eviews software

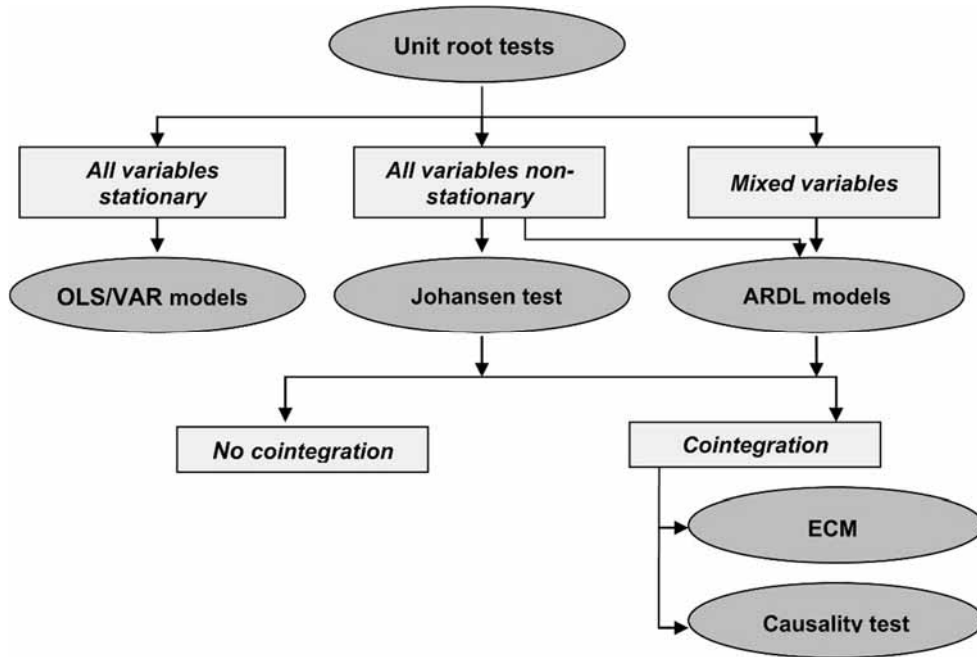
Table 9. The coefficients of the cointegration equation

1 Cointegrating Equation(s):		Log-likelihood		541.4410	
Normalized cointegrating coefficients (standard error in parentheses)					
L_DEBT	L_SAL	L_ACTIVEPOP	EXCHANGE	HICP	
1.000000	1.993308	-6.072202	-0.875232	-0.076134	
	(0.49530)	(4.76459)	(0.29863)	(0.01263)	

Source: own results obtained through Eviews software

The fact that there is cointegration between the variables under analysis, and there are both stationary and non-stationary series, denotes that the VECM model can be estimated, as indicated by Shrestha, M.B & Bhatta, G.R. (2018).

Figure 2. Determination of the right model according to the specifics of the analysed series



Source: Shrestha, M.B & Bhatta, G.R. (2018)

The cointegration equation of the ECT considering debt as the interest variable, as announced in the objectives of the paper, and the long-term model obtained by running the VECM in Eviews is as follows:

$$ECT_{t-1} = 1.000L_{DEBT(t-1)} + 2.234L_{WAGE(t-1)} - 5.580L_{ACTIVEPOP(t-1)} - 0.952EXCHANGE_{t-1} - 0.079HCPI_{t-1} + 37.331 \quad (1)$$

Therefore, in the long term, we note that the value of the average salary in the economy exerts a significant influence in the same direction on the government debt, while the active population exerts an influence in the opposite direction, but with a larger value impact. The economic foundation that explains these relationships is the following: the increase in the average salary in the economy also includes the salary level of budget workers, therefore, the increase in the average level would mean an increase in public expenses for the payment of employees employed by public institutions, hence an increased need to obtain income public, even by the instrumentality of indebtedness. On the other hand, the opposite relationship between the active population and long-term government debt confirms the fact that a growing labour force can generate additional sources of tax revenues and social contributions for the government, thus new public revenues that would decrease the need to obtain credits.

Compared to the other variables, the HICP and the exchange rate exert a less important influence on the public debt in the long run.

If we consider the *debt* as the target variable, we can say that in the short term, estimates show that the deviations of previous quarters from the long-term equilibrium are corrected in the current period at a speed of 0,8%. If we refer to *sal* as the main variable, the previous period deviations from the long run equilibrium are corrected in the current period at an adjustment speed of 4,9%, while for *activepop* the speed is of 1,4%, for *exchange* is of 5%, and for *HICP* it is of 138%.

In conditions of caeteris paribus, as the coefficients estimated in Table 10 reveal, among the variables under analysis, the change in the average salary and the change in the active population are more able to produce effects on the government debt. 1% shocks in the level of the exchange rate or the prices of consumer goods are not likely to generate an impact on the government debt. Thus, considering the number of lags and the error correction estimates presented in table 10, we will present the main consequences in the short run between the variables in the following: 1% change in *sal* is associated to a 0.33% decrease in *debt*, on average caeteris paribus, in the short run; in the same time, a 1% modification of *activepop* leads to a 0.55% decrease in *debt*; 1% change of exchange would lead to 0.06% increase in debt, while 1% modification of HICP conduces to only 0.01% increase of debt.

If we focus on the government debt as a possible indicator of fiscal risk, we observe that if the number of active persons and the average salary increase, this will diminish the value of the government debt, which confirms the economic principles which show that these positive changes on the labour market mean an increase in public revenues, thus a greater capacity to finance public expenses, to the detriment of the government debt.

Table 10. VECM estimates for the variables under analysis

Vector Error Correction Estimates	
Sample (adjusted): 2001Q1 2021Q2	
Included observations: 82 after adjustments	
Standard errors in () & t-statistics in []	
Cointegrating Eq:	CointEq1
L_DEBT(-1)	1.000000
L_SAL(-1)	2.234770 (0.37584) [5.94610]
L_ACTIVEPOP(-1)	-5.580016 (4.01443) [-1.38999]
EXCHANGE (-1)	-0.952348 (0.24455) [-3.89436]
HICP(-1)	-0.079593 (0.00981) [-8.11309]

C	37.33150				
Error Correction:	D(L_DEBT)	D(L_SAL)	D(L_ACTIVEPOP)	D(EXCHANGE)	D(HICP)
CointEq1	-0.008460 (0.01969) [-0.42954]	0.049314 (0.00895) [5.50942]	-0.014786 (0.00718) [-2.05829]	0.050870 (0.03992) [1.27430]	1.389985 (0.40359) [3.44408]
D(L_DEBT(-1))	0.165748 (0.12571) [1.31854]	-0.186429 (0.05713) [-3.26320]	-0.087998 (0.04585) [-1.91917]	0.422005 (0.25480) [1.65622]	-1.542798 (2.57600) [-0.59891]
D(L_DEBT(-2))	0.437101 (0.12714) [3.43806]	-0.078100 (0.05778) [-1.35167]	0.002745 (0.04637) [0.05919]	-0.021710 (0.25770) [-0.08425]	2.797173 (2.60531) [1.07364]
D(L_DEBT(-3))	0.085575 (0.13825) [0.61899]	-0.103780 (0.06283) [-1.65171]	-0.020775 (0.05043) [-0.41196]	-0.164704 (0.28023) [-0.58775]	-1.432176 (2.83308) [-0.50552]
D(L_SAL(-1))	0.461707 (0.25530) [1.80849]	-0.513574 (0.11603) [-4.42628]	0.058346 (0.09312) [0.62655]	0.220677 (0.51748) [0.42645]	-8.134823 (5.23167) [-1.55492]
D(L_SAL(-2))	0.364534 (0.25197) [1.44676]	-0.043958 (0.11451) [-0.38387]	0.132890 (0.09191) [1.44592]	-0.316072 (0.51072) [-0.61887]	-5.985569 (5.16336) [-1.15924]
D(L_SAL(-3))	-0.330139 (0.22231) [-1.48506]	-0.254706 (0.10103) [-2.52099]	0.120570 (0.08109) [1.48690]	0.191603 (0.45061) [0.42521]	-4.929696 (4.55559) [-1.08212]
D(L_ACTIVEPOP(-1))	-0.242940 (0.36239) [-0.67039]	0.354343 (0.16470) [2.15147]	-0.289748 (0.13218) [-2.19200]	-1.122037 (0.73454) [-1.52753]	0.273715 (7.42616) [0.03686]
D(L_ACTIVEPOP(-2))	0.440340 (0.25258) [1.74333]	0.580881 (0.11479) [5.06016]	-0.745456 (0.09213) [-8.09112]	0.326987 (0.51198) [0.63867]	12.22438 (5.17606) [2.36172]
D(L_ACTIVEPOP(-3))	-0.555423 (0.34915) [-1.59080]	0.598075 (0.15868) [3.76906]	-0.113337 (0.12735) [-0.88994]	-1.415589 (0.70770) [-2.00025]	7.292355 (7.15483) [1.01922]
D(EXCHANGE (-1))	-0.047531 (0.06116) [-0.77710]	0.016170 (0.02780) [0.58168]	-0.004308 (0.02231) [-0.19312]	0.232696 (0.12398) [1.87692]	1.290988 (1.25340) [1.02999]
D(EXCHANGE (-2))	0.015183 (0.06327) [0.23998]	0.042301 (0.02875) [1.47118]	0.023696 (0.02308) [1.02683]	-0.177239 (0.12824) [-1.38213]	-1.098480 (1.29645) [-0.84730]
D(EXCHANGE (-3))	0.063231 (0.06013) [1.05163]	0.022750 (0.02733) [0.83254]	0.014235 (0.02193) [0.64905]	0.201903 (0.12187) [1.65665]	0.318334 (1.23214) [0.25836]

D(HICP(-1))	-0.005994 (0.00569) [-1.05349]	0.001841 (0.00259) [0.71181]	-0.001623 (0.00208) [-0.78181]	-0.008450 (0.01153) [-0.73269]	0.180321 (0.11660) [1.54651]
D(HICP(-2))	-0.002156 (0.00569) [-0.37874]	0.003045 (0.00259) [1.17714]	0.004444 (0.00208) [2.14063]	0.003388 (0.01154) [0.29363]	0.074334 (0.11663) [0.63733]
D(HICP(-3))	0.008979 (0.00559) [1.60559]	-0.000359 (0.00254) [-0.14143]	-0.003206 (0.00204) [-1.57183]	-0.005100 (0.01134) [-0.44993]	0.156379 (0.11460) [1.36459]
C	-0.008053 (0.02344) [-0.34356]	0.068733 (0.01065) [6.45234]	-0.012700 (0.00855) [-1.48549]	0.021928 (0.04751) [0.46154]	1.580580 (0.48032) [3.29071]
R-squared	0.423411	0.679892	0.715836	0.355649	0.579748
Adj. R-squared	0.281482	0.601097	0.645888	0.197040	0.476301
Sum sq. resids	0.149954	0.030973	0.019951	0.616094	62.97116
S.E. equation	0.048031	0.021829	0.017520	0.097357	0.984270
F-statistic	2.983248	8.628548	10.23384	2.242295	5.604317
Log likelihood	142.1170	206.7822	224.8155	84.18112	-105.5272
Akaike AIC	-3.051633	-4.628833	-5.068670	-1.638564	2.988469
Schwarz SC	-2.552679	-4.129879	-4.569716	-1.139610	3.487423
Mean dependent	0.041037	0.031907	-0.002841	0.033524	1.552683
S.D. dependent	0.056664	0.034562	0.029441	0.108647	1.360108
Determinant resid covariance (dof adj.)		2.29E-12			
Determinant resid covariance		7.16E-13			
Log likelihood		564.7770			
Akaike information criterion		-11.57993			
Schwarz criterion		-8.938407			
Number of coefficients		90			

Source: own results obtained through Eviews software

In addition to estimating the VECM model, it is important to determine whether there are indeed interdependencies between the variables under analysis. We will apply the Granger causality test (Appendix 1). It studies pairs of variables (X and Y) and identifies whether the evolution of one variable (Y) produces a change in the other analysed variable (X). The null hypothesis of the causality test shows that the evolution of one variable does not produce results on the other variable, and vice versa. When the probability of the F-Statistic estimated by the test has a value lower than 0.05 (5%), then the null hypothesis is rejected, in which case there is a Granger causality between the analysed variables. This means that a change in one variable will also influence the evolution of the other variable. The existence of cointegration also confirms the validity of the Granger causality test. According to the authors Sims et al. (1990), if the variables are non-stationary and the cointegration condition would not have been met, the results provided by the Granger test could not be accepted. The results of the Granger causality test can be found in Appendix 1 and show that:

- Government debt Granger causes the active population;
- Government debt Granger causes the exchange rate;
- The active population Granger causes the average salary;
- The exchange rate Granger causes the active population;
- The average salary Granger causes the HICP;
- There is bidirectional Granger causality between the HICP and the labour force.

Therefore, the VECM model is representative to explain the interdependencies that are created between the government debt variables, the level of the average salary in the economy, the active population, the HICP and the RON-EURO exchange rate and above all, to quantify the evolution of the government debt in case of possible changes to the level of the studied variables. The impulse responses that evaluate the shock on each variable of interest to a change in the reference variable are shown in Figure 3. Some of the estimates that can be formulated starting from the graphical representation would be the following:

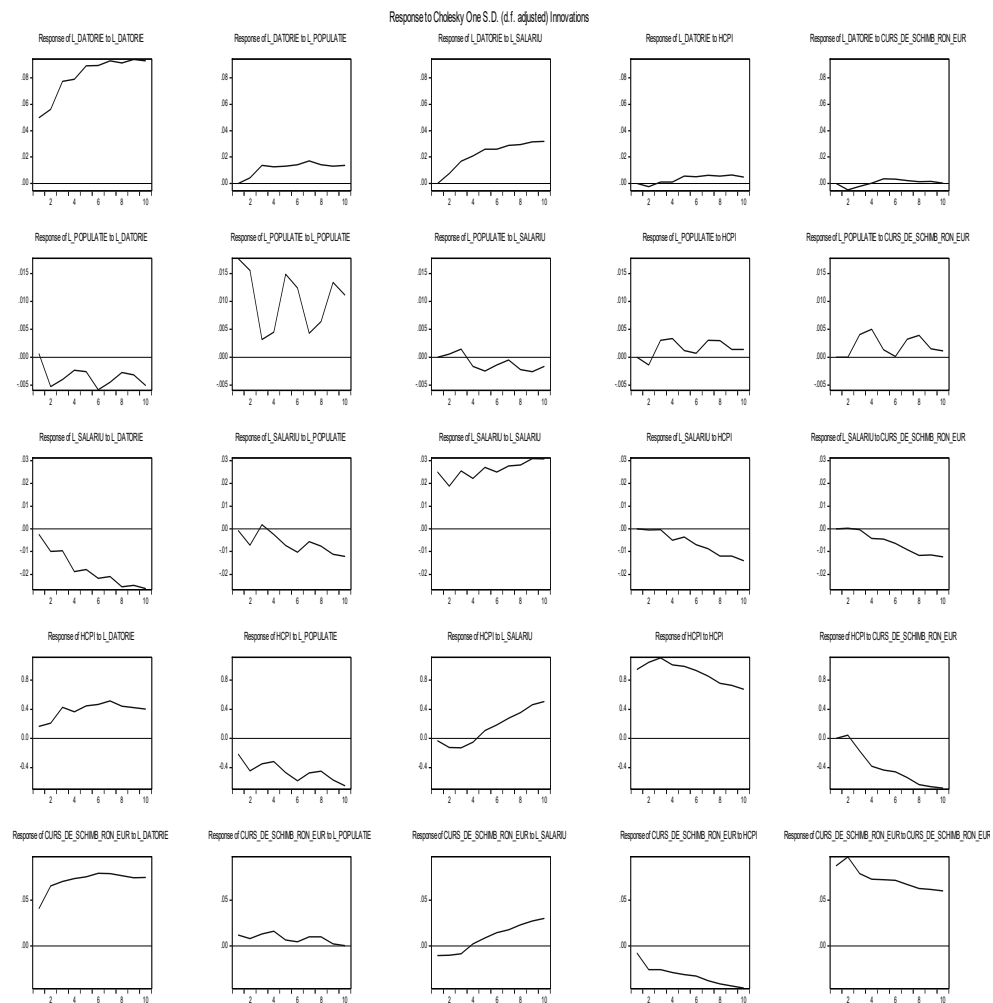
- A 1% shock to the average salary in the economy is quickly reflected in the government debt, which experiences considerable growth in the medium term. The government debt also responds to the shock produced by an evolution of the active population, but the response is more moderate than in the case of the evolution of the average salary. This practically confirms the economic theory since the determination of the price on the labour market is not a simple result of the meeting between the demand and the supply of labour, and the salary expenses are one of the key components of public expenses, less flexible expenses due to their social characteristics;
- Broadly speaking, a 1% shock on the RON-EURO exchange rate does not generate significant changes on the government debt. The interdependence between the exchange rate and the government debt deserves to be studied separately, as several other factors must be considered: the structure of the government debt portfolio in currencies, payment terms, the history of the country regarding the payment of foreign interests, etc.
- The impulse response of the average salary level on the active population and vice versa suggests, as expected, that a change in the average salary causes an increase in the active population in the short term, but the trend is not maintained in the medium term, given the fact that the labour market knows numerous imperfections, and the employee status is the result of several demographic, social, cultural conditions in a context that exceeds the country's borders.

Appendix 2 captures the variance decomposition of the forecast error. The evolution of the government debt is weakly influenced during the next 10 quarters by the evolution of the other analysed variables, the only variable that exerts an influence greater than 2% is the average salary in the economy. Therefore, government debt is a strongly endogenous variable, or whose change is generated by other variables than those included in the present study.

The variables labour force, HICP and exchange rate are explained to a proportion of 50% or more by their own evolution, although there is also an important influence on them from the other variables.

During the evaluation period, we observe that the average salary is the variable least affected by its own evolution. Although it was expected that the salary level would be correlated with the evolution of the exchange rate and with the HICP for example, the estimate denotes the fact that it is more strongly influenced by the evolution of the government debt even than by its own change.

Figure 3. Impulse response estimates



Source: own results obtained through Eviews software

5. Conclusions

This article aims to identify the interdependencies between the government debt, the number of people active on the labour market, the level of the average salary in the economy, the harmonized index of consumer prices and the RON-EURO exchange rate, for Romania during the period starting from the 1st quarter of the year 2000 and up to the 2nd quarter of the year 2021. Given the specificity of the series under analysis, the economic model used for estimations is VECM.

The focus of the analysis is still related to fiscal risks, which can be measured by government debt. Thus, the main objective of the study is to identify which of the other variables used exert a greater impact on the government debt: the size of the average salary and the number of employed people that can bring increases in public revenues (or, on the contrary, increases in social assistance expenses and budget employees' salary expenses), HICP which is a form of measuring inflation (inflation is a known means of reducing of the value of the government debt), or the RON-EUR exchange rate that can influence the government debt depending on the predominant currency of the loans and the evolution of the national currency?

In the long term, the average salary exerts a significant impact in the same direction on the government debt, whilst the labour force (active population) exerts an influence in the opposite direction, but with a larger value impact. Two very important conclusions emerge from this. The first is that an increase in the average salary that does not have a corresponding increase in productivity only increases the government's indebtedness and fiscal pressure for the next generations. The salary increases of budget officers require prudence in order not to become a risk for fiscal sustainability in the long term. The second conclusion is that government measures to increase the active population prove to be beneficial in the long term and make the public debt decrease faster than the number of active people increases.

Thus, it is recommended that the government implement measures to increase the labour force by: discouraging the phenomenon of early retirement, better visibility of existing jobs, attracting foreign investors to open workplaces in Romania, encouraging local businesses, the implementation of professional training and conversion programs (including the fruition of human capital development opportunities through projects financed by the European Union).

We note that HICP and RON-EUR exchange rate don't have as much influence on the evolution of government debt as the other two variables mentioned before, from which it follows that there were generally neither large fluctuations in prices, nor major changes in the exchange rate that would require the refinancing of the public debt at high costs.

Instead, in the short term, the modifications in the average salary and in active population are more able to produce effects on the government debt: 1% change in *sal* is associated to a 0.33% decrease in *debt*, on average caeteris paribus, in the short run; in the same time, a 1% modification of *activepop* leads to a 0.55% decrease in *debt*; while 1% change in HICP or in exchange rate conduct to less than 0.10% change in government debt.

Not least, according to the variance decomposition of the forecast error, the most important conclusions show that the government debt is influenced, among the variables included in

the study, by changes in the average salary in the economy. The increase in the average salary implies (and derives from) also increases in expenses with the salaries of budget workers. The latter is a rigid public expenditure, that needs financing funds, obtained even through borrowing. Fluctuations in the number of active persons do not have a medium-term impact on the government debt, just as the change in the average salary does not have the ability to maintain in the medium and long term an evolution in the same direction of the active population. As for the ability of the RON-EUR exchange rate to influence the government debt, the estimates do not prove a sensitivity of the latter determined by the euro currency, which denotes, at least at first glance, a prudent structure of the government debt portfolio.

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Appendix 1

Granger causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
L_ACTIVEPOP does not Granger Cause L_DEBT	83	2.44671	0.0702
L_DEBT does not Granger Cause L_ACTIVEPOP		7.15844	0.0003
L_SAL does not Granger Cause L_DEBT	83	1.48340	0.2258
L_DEBT does not Granger Cause L_SAL		1.39540	0.2507
HICP does not Granger Cause L_DEBT	83	1.19855	0.3161
L_DEBT does not Granger Cause HICP		1.82251	0.1502
EXCHANGE does not Granger Cause L_DEBT	83	1.08992	0.3586
L_DEBT does not Granger Cause EXCHANGE		3.35675	0.0231
L_SAL does not Granger Cause L_ACTIVEPOP	83	2.06470	0.1119
L_ACTIVEPOP does not Granger Cause L_SAL		11.7493	2.E-06
HICP does not Granger Cause L_ACTIVEPOP	83	3.74250	0.0145
L_ACTIVEPOP does not Granger Cause HICP		5.66151	0.0015
EXCHANGE does not Granger Cause L_ACTIVEPOP	83	4.02693	0.0103
L_ACTIVEPOP does not Granger Cause EXCHANGE		2.68983	0.0522
HICP does not Granger Cause L_SAL	83	1.29596	0.2820
L_SAL does not Granger Cause HICP		2.92603	0.0391
EXCHANGE does not Granger Cause L_SAL	83	0.66056	0.5789
L_SAL does not Granger Cause EXCHANGE		1.48654	0.2249
EXCHANGE does not Granger Cause HICP	83	0.98309	0.4053
HICP does not Granger Cause EXCHANGE		1.26722	0.2917

Source: own results obtained through Eviews software

Appendix 2

Decomposition of forecast error variance

Variance Decomposition of L DEBT:						
Period	S.E.	L_DEBT	L_SAL	L_ACTIVEPOP	EXCHANGE	HICP
1	0.048031	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.071697	97.06874	2.091219	0.145329	0.197629	0.497081
3	0.102940	94.50962	3.672110	0.770145	0.212689	0.835438
4	0.129501	95.55705	3.181306	0.511160	0.166162	0.584322
5	0.159034	96.02821	2.947297	0.340292	0.296745	0.387452
6	0.186213	96.49320	2.612465	0.248735	0.336586	0.309016
7	0.213345	96.69091	2.552267	0.191250	0.311748	0.253824
8	0.238281	96.86589	2.446594	0.161430	0.303961	0.222124
9	0.263491	96.89309	2.466633	0.148255	0.289585	0.202437
10	0.287002	96.96159	2.440336	0.129872	0.259773	0.208434

Variance Decomposition of L SAL:						
Period	S.E.	L_DEBT	L_SAL	L_ACTIVEPOP	EXCHANGE	HICP
1	0.021829	1.189430	98.81057	0.000000	0.000000	0.000000
2	0.027543	12.34495	85.92132	0.327328	0.889564	0.516840
3	0.034752	15.12480	78.80928	4.773992	0.861504	0.430425
4	0.041987	28.44087	62.28280	6.807582	0.978428	1.490316
5	0.049716	33.30501	58.07903	4.877168	1.679675	2.059117
6	0.058551	40.33927	49.79460	3.567126	2.839019	3.459981
7	0.068842	40.46952	45.93426	3.157552	4.538871	5.899802
8	0.079905	43.19655	39.77462	3.078150	6.332991	7.617696
9	0.090397	44.30046	37.59241	2.501413	7.314248	8.291471
10	0.100665	45.89219	34.93076	2.024022	8.004720	9.148311

Variance Decomposition of L ACTIVEPOP:						
Period	S.E.	L_DEBT	L_SAL	L_ACTIVEPOP	EXCHANGE	HICP
1	0.017520	1.465850	0.310026	98.22412	0.000000	0.000000
2	0.022605	2.606718	0.544643	96.66057	0.152974	0.035090
3	0.023836	3.170772	0.565670	88.06258	3.172622	5.028357
4	0.025176	3.391752	0.580837	82.32175	8.179525	5.526132
5	0.029330	2.965058	0.443631	85.66082	6.749332	4.181163
6	0.032461	5.335667	0.374519	84.78302	5.937477	3.569321
7	0.033754	7.372661	0.360304	79.74551	7.991042	4.530480
8	0.034847	8.139082	0.338887	77.04927	9.865719	4.607038
9	0.037682	8.329344	0.291694	78.49993	8.935112	3.943921
10	0.040294	10.01171	0.263643	77.91921	8.279349	3.526087

Variance Decomposition of EXCHANGE						
Period	S.E.	L_DEBT	L_SAL	L_ACTIVEPOP	EXCHANGE	HICP
1	0.097357	17.97981	0.146384	0.159123	81.71468	0.000000
2	0.159174	24.02357	0.099340	1.322598	73.99798	0.556515
3	0.194940	28.91296	0.118503	1.557413	68.18984	1.221281
4	0.228593	29.69810	0.601428	1.654309	64.96015	3.086010

Porumboiu, A. E., Brezeanu, P. (2023). Macroeconomic Factors that Generate Fiscal Risk in Romania.

5	0.262869	30.88257	0.764920	2.153226	61.98742	4.211865
6	0.293384	32.26979	1.049924	2.428865	59.06119	5.190226
7	0.320131	33.21993	1.403103	2.354517	56.26570	6.756750
8	0.344985	33.88148	1.819987	2.431621	53.78860	8.078309
9	0.368760	34.29200	2.213809	2.667903	51.64911	9.177180
10	0.391548	34.68398	2.656722	2.742265	49.47846	10.43857
Variance Decomposition of HICP:						
Period	S.E.	L_DEBT	L_SAL	L_ACTIVEPOP	EXCHANGE	HICP
1	0.984270	1.739118	2.355293	2.443715	0.299583	93.16229
2	1.478220	1.500530	4.577816	5.056199	0.300388	88.56507
3	1.866653	3.710542	5.343116	4.452801	2.216124	84.27742
4	2.202938	3.786926	5.650759	3.628472	5.595714	81.33813
5	2.509342	4.334810	4.852778	4.160208	8.583813	78.06839
6	2.810398	4.858230	4.228982	5.517831	11.45524	73.93972
7	3.060681	5.754609	3.611752	5.329459	15.34158	69.96260
8	3.288317	6.108548	3.154579	4.886057	19.95577	65.89504
9	3.522318	6.336670	2.755468	5.013423	23.78140	62.11304
10	3.746673	6.501581	2.461009	5.513684	27.13522	58.38850
Cholesky Ordering: L_DEBT L_WAGE L_ACTIVEPOP EXCHANGE HICP						

Source: own results obtained through Eviews software

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THE IMPACT OF HUMAN RESOURCE PERFORMANCE MANAGEMENT PROCESS ON THE SUCCESS OF THE ORGANIZATION: CASE STUDY – KOSOVO⁴

It is already known that performance management represents a set of processes and practices of human resource management, i.e. activities that aim to achieve the goals of the organization in the best possible way. In fact, there are numerous studies which are dedicated to the performance management process, showing that this process is now not only applicable in various organizations, but is also the object of analysis to improve it ongoing. Moreover, in organizations in Kosovo, there has been a lack of studies about this process over the years. Previous research has proven that the human factor is one of the key components of a successful organization. As a result, good human resource management with special emphasis on performance management practices and processes can be considered as a successful way to achieve the objectives that the organization aims. Therefore, the main objective of this paper focuses on performance management which is measured through human resource management practices and processes, defining the success or failure of the organizations in Kosovo. Thus, for the realization of this paper, we conducted a survey through a questionnaire that we distributed to employees and managers of organizations throughout the territory of Kosovo. The findings have shown that recruitment and selection, performance appraisal, training, reward system and career development are important factors in the performance of the enterprise. Considering these factors and their importance, the study provides recommendations and suggestions for improving these processes and human resource management practices for the researched organizations and broader.

Keywords: Performance management; human resources; processes; practices; development

JEL: O15; J53

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1. Introduction

Performance management is a factor by which the best results are obtained from organizations, teams and individuals by understanding and managing performance within an agreed framework of planned goals, standards and attributes/competencies and requirements, according to Armstrong (1994). This means not only meeting the objectives of the individual, but also to guide and assist employees to work effectively and efficiently in accordance with the requirements of the organization according to Walters (1995). Although a number of government organizations and entities have shown great interest in performance management, there is a growing perception, but this process seems to have large gaps in the implementation of Employee Performance Management in both the private and public sectors according to McKinsey and Company (2011). Therefore, based on the above explanations on the need for performance management, the focus of this study is to investigate whether the implementation of HRM in Kosovo organizations will affect their success.

Specifically, the focus of this study is on the manager-subordinate relationship in the organization, in particular on: "The impact of the HR performance management process on the success of the organization." Also, this paper aims to answer some research questions which are related to HR performance management and the success of organizations in Kosovo. Special attention has been paid to the good formulation of the strategy, since "Well-formulated performance management is a strategy which seeks to build a distinctive competence in some key activities and then using it to create a competitive advantage in the market versus other enterprises". This best shows how important it is to formulate a good strategy and then work out detailed plans for its best and easiest implementation in practice.

This study is based on basic assumptions:

1. performance management in the context of the organization affects the successful realization of the objectives of the organization;
2. that the performance management components are characterized by differences in terms of their influence and outcome on the success of the organization with some components being more influential and productive and with some other components being less influential and productive;
3. performance appraisal, done according to standards can strongly affect the high performance of employees; and
4. successful employees who bring success to the organization, especially when these are standardized according to the goals, missions and strategies of the organization.

Our findings show that in Kosovo enterprises general knowledge related to human resource management and their performance is lacking. One of the main requirements of enterprises today is to have qualified employees to fill the gaps and shortcomings of organizations and to be successful in the increasingly global market.

The aim of the study is to explore the relationships between variables such as: recruitment, training and development, motivation, career management, and performance appraisal as

independent variables with dependent variables that are individual performance and organizational performance.

Thus, the study analyzes the relationships between dependent and independent variables and the impact they have on individual and organizational performance. As such, the aim of the study is to research the factors that affect the increase of individual performance in Kosovo organizations and to highlight the effect of these factors on the performance of organizations.

Primary and secondary data of enterprises in Kosovo will be made available to the final results giving the appropriate recommendations for the surveyed enterprises and all those who will be interested in these results. Human resources within organizations are and will remain a fundamental factor in achieving the goals of organizations.

Initially, our study aims to gather information from primary sources; study of organizations in Kosovo about the analysis of practices and processes which influence the performance of employees and how this performance affects the success of organizations.

And secondly, using scientific theories and previous studies similar to our study, the factors that influence the performance of HR and that of the organization have been identified.

The basic purpose of this paper is to show how a well-built process of human resource performance management will affect the success of the organization. The whole axis of the study is based on the confirmation of the hypotheses raised in response to the research questions below:

1. Research question 1: Is organizational performance affected by individual performance?
2. Research Question 2: Does a well-consolidated performance management process affect the success of the organization?
3. Research question 3: Does the training process differ from the educational level of the employees of the organizations?

Based on the research questions we have raised this hypothesis from which 4 sub-hypotheses are derived:

- **Hypothesis 1:** Implementing the human resource performance management process affects the growth of the organization's success.
- **Hypothesis 1a:** Organizational performance in organizations is influenced by motivated employees.
- **Hypothesis 1b:** Organizational performance in organizations is influenced by an ongoing process of employee training.
- **Hypothesis 1c:** The individual performance of employees of organizations is closely related to the well-studied reward process.
- **Hypothesis 1d:** The individual performance of employees of organizations is also related to the ongoing training process.

Therefore, the realization of this research is based on scientific literature and empirical research. Empirical research is field research, research which has the analysis of two questionnaires where one is dedicated to employees and one to managers and interviews for managers. The sample consists of 395 employees of various organizations and 155 managers of 11 different organizations operating in the territory of Kosovo in different sectors of the economy.

2. Literature Review

The potential success of a business depends on organizational performance, which means the ability of the business to effectively implement strategies to achieve institutional objectives according to Kasim Randaree, Hind Al Youha, (2009). This means that organizational performance cannot be successful if its employees are not proficient in performing certain tasks. This means that individual performance is directly related to organizational performance. Researchers and practice managers widely accept that human resource management is a basic organizational function, which makes an important contribution to achieving objectives not only in the field of business, but also in other areas of human activity. We can say that the performance of any organization depends to a large extent on the level of skills that its leaders have when it comes to implementing strategies. Given that there are always obstacles to achieving organizational goals, it is important that the techniques used by managers are flexible enough to accommodate change. The performance of an organization also depends on its employees, who are a key part of the organization and form the team that works towards achieving the goals of the organization according to Almatrooshi, Kumar Singh, and Farouk, (2016).

There are potentially many reasons why organizations evaluate individual HR performance. Some of them include Edmonstone (1996):

- improving communication between the boss and subordinates through the use of feedback between them;
- identifying space for performance improvement and the means to achieve this;
- identifying individual training and development needs;
- identifying individuals' potential for future promotion, promotion or dismissal;
- as a basis for reward, based on performance;
- as a powerful tool of managerial control, through setting hierarchically objectives and a review of success or failure in achieving them.

Performance management is an ongoing process of identifying, measuring, and developing the performance of individuals, groups, and adapting performance to the strategic goals of the organization Aguinis (2009). Human Resource Performance Management aims to improve performance by focusing on key areas of activity responsibilities, which are identified through strategic planning processes. It seeks to provide guidance and establish

clear links between institutional development, the provision of quality services and the personal and professional development of employees at work.

According to Greiling, (2006), proponents of performance measurement are convinced that performance measurement can greatly contribute to increasing efficiency and increasing productivity in public services, further identified four areas in an organization that contribute to success and efficiency, namely, (1) competencies of how employees go about their work, (2) attitude over how employees prepare to work, (3) skills on what the employee can do and knowledge of what the employee knows (4) Institutions tend to not link the performance development plan as an annual activity and implement it every year.

Therefore, Fletcher (2008) thought that there is no clear objective and no direction in most organizations and there are some managers who fail to set objectives from the beginning of the process. Moreover, emphasized that corporate strategies and objectives, performance agreements and plans, ongoing performance management throughout the year, formal performance reviews and development planning are aspects of the key role of the conceptual framework for performance management.

Aguinis (2013) States that performance management has become effective since 1970 in Mexico. He adds that performance management is a process used to link employee activities to the goals and objectives of institutions. Furthermore, performance management is an endless process to identify measure and develop employees in terms of aligning performance with the strategic goals and objectives of the organization.

This is supported by Huprich (2008) who states that the Performance Management Process has been applicable for almost two millennia. She states that performance management is created to help organizations in order to achieve organizational goals and objectives through continuous evaluation. Furthermore, performance management will help organizations align themselves with setting goals that will identify areas of progress, strengths and weaknesses in each employee. She further explains that employees and supervisors are confusing both processes, performance management and performance appraisal. According to Armstrong and Taylor (2014), performance management is an instrument directed at employee performance, their engagement, and skills improvement. Furthermore, it will help to improve productivity and quality levels of customer service, increase growth and productivity. Thus, the organization will be able to achieve its goals and objectives. It is argued by Aguinis (2013) that a well-designed performance management system can be a useful tool in many ways in terms of employee self-esteem and increases motivation that will help improve performance. Thus, it will improve the performance and productivity of the organization. The same further commented that performance management aims to measure what an employee does, the results and outcomes of employee behavior. Therefore, behavioral outcomes can be assessed as neutral, negative, or positive; affecting the effectiveness of the individual and the organization.

3. Research Methodology

One of the research instruments, among others, is the analysis through questionnaire observation, which provides an analysis with concrete data from the field, enables us through data analysis to argue the connection or correlation of variables between them in time and certain fields. Our sample has the analysis of 395 employees of 11 different organizations as well as the interviews of 155 of their managers. These two questionnaires were completed in different organizations operating in the territory of Kosovo in different sectors of the economy.

Our sample contains the analysis of 395 employees as well as the structured interviews of their 155 managers. Referring to the information of the Kosovo Institute of Statistics regarding the total number of organizations operating in the country which registers 2251 enterprises and with an error margin of 4.5% we have that the sample size of our sample would be 392. On the other hand, by calculating SS according to the following formula we have that for $z=1.96$, $p=0.7$, $1-p=0.3$ and $c=4.5\%$ we have that $SS=395$

$$SS = Z^2 * (p) * (1-p) / c^2 \text{ (almost the same as our champion)}$$

The primary research instruments of this study are: the questionnaire of the employees of the organizations as well as the structured interview of the managers who lead these organizations.

So, both levels have been studied precisely, both the executive level (employees) and the managerial level (management) to face their opinions and evaluations on each concrete issue.

This analysis includes information from 155 managers of different levels in medium and large organizations and belonging to different sectors as well. This is due to having a more comprehensive representation and a more complete and realistic analysis.

Data collection through questionnaires, respectively the questionnaire of company employees but also managers was realized mainly through direct contacts with them, but also through completing and sending them by e-mail where it was mostly used by company managers.

This survey with questionnaires was conducted in the time frame of 6-7 weeks not only for their completion but also for the preparation of the database by working simultaneously with their completion and dumping. Their realization according to the selected organizations was realized through a well-thought-out calendar.

The analysis of the data obtained from the completion of both questionnaires was performed through specific computer programs for these analyses such as SPSS 25.0 and Excel. This analysis contains not only descriptive analysis presented with specific tables or graphs but also through analyses such as Chi Square Independence Test, ANOVA Analysis, and Crosstabs etc.

4. Statistical Analysis

The whole axis of the study is based on the confirmation of the hypotheses raised in response to the research questions below:

Hypothesis 1: Does implementing the human resource performance management process affect the increase of organizational success?

- Hypothesis 1a: Organizational performance in organizations is influenced by motivated employees.
- Hypothesis 1b: Organizational performance in organizations is influenced by an ongoing process of employee training.
- Hypothesis 1c: The individual performance of employees of organizations is closely related to the well-studied reward process.
- Hypothesis 1d: The individual performance of employees of organizations is also related to the ongoing training process.

Research Question 1: Is organizational performance affected by individual performance?

Research Question 2: Does a well-consolidated performance management process affect the success of the organization?

Research question 3: Does the training process differ from the educational level of the employees of the organizations?

The independent variables are:

- Recruitment/selection (which is measured by 7 questions);
- Training (which is measured by 5 questions);
- Motivation (which is measured by 18 questions);
- Reward process (which is measured by 7 questions);
- Career development (which is measured by 7 questions).

While the dependent variables are:

- Organizational performance (which is measured by 7 questions);
- Individual performance (which is measured by 14 questions).

We first look at the factor weights and Alpha reliability coefficients for each of them which refer to the Principal Component Analysis method. The data in the table below show that the factor weights of all queries measuring this variable are greater than their threshold value of 0.4; hence they are all kept in their further analysis. Even their Cronbach Alpha coefficient or in other words the reliability coefficient has a value of 0.675 a relatively high value (Table 1).

Table 1. Factor weights of the independent variable Recruitment / selection

Alternatives	Factor weight
What has been the way of recruiting you to the organization where you currently work?	0,658
Did you win the employment contract immediately or were you initially on probation?	0,584
What was the number of competitors for the position where you currently work?	0,657
The selection systems for employment in our organization are very scientific and rigorous.	0,659
In our organization, line managers and human resource managers participate in the selection.	0,702
Valid and standardized tests are used in our organization when needed in the selection process.	0,678
The selection process in our organization selects those candidates who have the right knowledge as well as skills and attitudes.	0,664

Extraction Method: Principal Component Analysis

Source: Authors' calculations in the SPSS program

We also see the factor weights and the Alpha coefficient for the other independent variable, training. From the following data, it is noticed that except for the third question all the other questions have a factor weight greater than 0.4 therefore only these questions continue the further analysis, while the value of the reliability coefficient for the other questions is 0.778 (Table 2).

Table 2. Factor weights of the independent training variable

Alternatives	Factor weight
Our organization develops extensive training programs for its employees in all aspects of quality.	0,443
Workers in any job will normally go through training programs each year.	0,460
Training needs have been identified through a formal performance appraisal mechanism.	0,334
New knowledge and skills are passed on and passed on to employees periodically to work in teams.	0,547
Training needs are realistically identified, useful and based on the organization's business strategy.	0,555

Extraction Method: Principal Component Analysis

Source: Authors' calculations in the SPSS program

We already refer to the other independent variable motivation which is measured by 18 questions but according to the data of the analysis for factor weights the third, tenth question and the last question do not have the necessary weights to continue the analysis and therefore in the analysis continue to be the other questions for which the Alpha value is 0.862 (Table 3).

Regarding the other instrument which is also an independent variable, the data in the table below show that all the questions that measure this variable have weights greater than 0.4, while their reliability coefficient has a value of 0.698 (Table 4).

Regarding the career development variable, the following analysis shows that except for the first question which has a factor weight of less than 0.4, all other questions are kept in the analysis estimating that their Alpha has a value of 0.833 (Table 5).

Table 3. Factor weights of the independent variable Motivation

Alternatives	Factor weight
I like the work I do because I am given the opportunity to express my creativity.	0,568
The work I do I am allowed to do in my own way.	0,483
I can take on responsibilities related to my work because there is no interference.	0,380
I can discuss issues related to my work with my superiors.	0,649
Supervisors, my managers, listen to and follow my recommendations related to my work	0,446
I work here because the payments are considerable.	0,618
The work I do is rewarded with modest pay to cover expenses.	0,569
If I continue to work well, I will not lose my job.	0,628
If I cannot fulfil the job planning, then I can be fired.	0,591
I work better when I have job security and work security.	0,236
In any case, I can get a job promotion at any time, as a result of fulfilling work plans and performance.	0,635
I am asked to expand my knowledge, my skills to have a higher performance.	0,562
I believe I have considerable knowledge, skills and abilities to successfully accomplish the job.	0,490
I have the special skills needed to successfully perform the tasks associated with my job.	0,595
There is always a career development opportunity in the organization.	0,487
My current job gives me constant satisfaction, and I am respected as a result of my work.	0,559
I would recommend employment in this organization to all friends, if there were vacancies.	0,609
Even if my income were cut I would continue to work here.	0,339

Extraction Method: Principal Component Analysis.

Source: Authors' calculations in the SPSS program

Table 4. Factor weights of the independent variable Reward

Alternatives	Factor weight
The payroll process in our organization is motivating.	0,900
The payroll process is in line with country rules and legislation.	0,739
The salary of each employee of the organization is related to the performance of their work	0,520
The employees of the organization are generally satisfied with their salaries	0,558
The payment process of our organization is competitive compared to other organizations.	0,630
In our business, the principle of internal justice of salaries and financial assistance is respected (that is, the same salary is given for work of equal value)	0,539
Organizations distribute differentiated bonuses to motivate its employees.	0,605

Extraction Method: Principal Component Analysis

Source: Authors' calculations in the SPSS program

Table 5. Factor weights of the independent variable career development

Alternatives	Factor weight
Employees in the enterprise have a clear path to their career development.	0,297
The employee's career aspirations within the organization are recognized by Management.	0,492
Employees in our organization have more than one potential position for promotion.	0,599
The company supports employee career and development plans.	0,612
The company prefers an in-house employee whenever there is a vacancy.	0,530
Every employee is aware of his / her career path in the organization.	0,466
These promotion opportunities as well as the integration of performance appraisal components affect the behavior of qualified and competent employees	0,609

Extraction Method: Principal Component Analysis

Source: Authors' calculations in the SPSS program

We do the same with the analysis for the questions that measure individual performance, where it is noticed that all the questions have a factor weight greater than 0.4 and are therefore kept in the further analysis. Their Alpha has a value of 0.759 (Table 6).

Table 6. Factor weights of the individual performance independent variable

Alternatives	Factor weight
In your opinion, how well the components of the performance management process are integrated with each other (performance planning and evaluation; career development and planning, Feedback, Coaching, training, development, and rewards)	0,588
How important is your job analysis during the job process?	0,680
How often is job evaluation/analysis performed in your organization?	0,605
Performance planning/goal setting	0,676
Performance appraisal	0,593
Development planning	0,531
360-degree feedback (full)	0,664
Informal feedback	0,542
Coaching and/or Mentoring	0,764
Training	0,454
Leadership development	0,481
Rewards	0,721
Discipline at work	0,611
The performance management process as a whole	0,606

*Extraction Method: Principal Component Analysis
Source: Authors' calculations in the SPSS program*

While in terms of organizational performance also the questions that measure this variable have weights all greater than 0.4 and a reliability coefficient of 0.872 (Table 7).

Table 7. Factor weights of the independent variable organizational performance

Alternatives	Factor weight
Employee performance is measured based on computable objective results.	0,622
The evaluation process in our organization is growth and development-oriented.	0,580
Employees of our company are given performance-based comments and advice.	0,590
Employees trust the performance appraisal process.	0,786
The evaluation process has a strong impact on individual and team behaviour.	0,715
Evaluation data is used to make decisions such as job rotation, training and compensation.	0,773
The objectives of the evaluation process are clear to all employees.	0,567

In summary, the following table presents all the Cronbach Alpha coefficients of the independent and dependent variables as well.

Table 8. Cronbach Alpha coefficients

Independent variables	Cronbach's Alpha	Number of questions
Recruitment / selection	0.765	7
Trainings	0.778	4
Motivation	0.862	15
Rewards	0.698	7
Career development	0.833	6
Dependent variables		
Individual performance	0.759	14
Organizational performance	0.872	7

5. Results

Hypothesis 1: Does implementing the human resource performance management process affect the increase of organizational success?

Hypothesis 1.a: Organizational performance in organizations is influenced by motivated employees.

To analyze this hypothesis, we refer to the Chi-Square independence test which measures the correlation or not of variables. Referring to the data of Pearson coefficient, Asymptotic Significance (2-sided) it is noticed that this value is 0.030 < 0.05, which allows us to say that these two variables are dependent, so organizational performance is affected by the process of motivating its employees regardless of the type of this motivation (Table 9).

Table 9. Independence test for organizational performance and motivation

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.412 ^a	2	0.030
Likelihood Ratio	2.996	2	0.224
Linear-by-Linear Association	0.407	1	0.524
N of Valid Cases	395		

Hypothesis 1.b: Organizational performance in organizations is affected by the ongoing process of employee training.

Again we refer to the analysis of this correlation through the Chi-square test which in this case as expected and has been analyzed in special literature, the value of Asymptotic Significance (2-sided) = 0.017 again less than $p = 0.05$ shows that the continuous training of employees of organizations whether they are at the senior management level or at the executive level undoubtedly increase not only their performance in results but also of the organization as a whole, as and consequently this training process directly affects the overall performance of the organization (Table 10).

Table 10. Independence test for organizational performance and training

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.881 ^a	4	0.017
Likelihood Ratio	7.645	4	0.105
Linear-by-Linear Association	0.987	1	0.321
N of Valid Cases	395		

So far, we have analyzed the elements of the management process one by one for their direct impact on organizational performance. But referring to the fact that these processes go hand in hand and complement each other, we already analyze these elements taken together as well as the practical process of organizations through the following hypothesis in which other factors such as recruitment and career are equally important.

Hypothesis 1: Implementing the human resource performance management process affects the increase of organizational success?

To analyze this hypothesis, we need to construct the equation of multiple linear regression which has the general form as follows.

$$Y_i = b_0 + b_1X_1 + b_2X_2 + \dots + b_nX_n + \varepsilon_i$$

An important element which is realized along the construction of multiple linear regression is the analysis of the interaction between independent variables which is otherwise known as "multicollinearity". Multicollinearity occurs when an independent variable has a high correlation with a set of other independent variables. The presence of multicollinearity can lead us to incompletely fair and accurate conclusions about which of the independent variables is statistically significant (Bronwyn Lind, Don Weatherburn, Shuling Chen, Marian Shanahan, Emily Lancsar, Marion Haas, Richard De Abreu Lourenco, 2002). Therefore, this connection between them is analyzed first, which should be between the interval -0.7; 0.7 [Referring to the data in the table below, it is noticed that the correlation values of the independent variables between them are within the allowed limits and therefore we have no problem in the conclusions of the analysis of this hypothesis. Variance Inflation Factor values vary from 1.039 to 1.055 and that limit should be VIF = 5, or Tolerance Values are all > 0.2 (Table 11).

Table 11. Co linearity values

Co linearity Statistics	
Tolerance	VIF
0.961	1.040
0.948	1.055
0.962	1.039
0.952	1.051
0.962	1.039

Table 12. Correlation between independent variables

	Recruitment	Training	Motivation	Reward	Career
Recruitment	1				
Training	.566**	1			
Motivation	.611**	.635**	1		
Reward	.492**	.558**	.508**	1	
Career	.491**	.451**	.478**	.483**	1

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

Based on these data we can already construct this equation of multiple linear regression starting with the analysis of variance ANOVA, from which it is observed that for df (5,389) and F = 4.782 we have that the value of Sig. = 0.000 < 0.05, which will that is, it is statistically significant for the correlation between the independent variables and the dependent variable that is organizational performance (Table 13).

Table 13. ANOVA analysis

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	2.003	5	0.401	4.782	.000b
Residual	32.579	389	0.084		
Total	34.582	394			

a. Dependent Variable: Organizational Performance

b. Predictors: (Constant), Career, Recruitment, Reward, Motivation, Training

From the following data, it is noticed that, of all the independent variables whose fulfilment or maximization of their values leads to the benefit of the success of the organization only two factors (variables) have more impact on the organizational performance of organizations. They are training and motivation. The other factors are not that important but in this case, their impact is less significant in relation to the other two variables. The linear multiple regression equation takes the form:

$$(Organizational\ performance) = 4.163 + 0.118 (Training) + 0.161 (Motivation).$$

Table 14. Multiple regressions between organizational performance dependent variable and independent variables

Model	R2	R2 regulated	T	Sig.
Constant	0.058	0.046	9.042	0.000
Recruitment			-1.654	0.099
Training			-2.729	0.007
Motivation			2.386	0.018
Reward			-1.618	0.107
Career			0.675	0.500

From the equation, it is observed that motivation has a higher impact than training referring to the coefficient $\beta = 0.161$. So, the more motivated the employees of the organizations, the higher the organizational performance of the organizations themselves and its impact is even greater in relation to the increase of the level of their training. As for the other factors (other

independent variables), their influence in which case was very low but not insignificant, said this because some of them were high-level employees and perhaps the impact of remuneration, recruitment or career development does not have that significant impact on organizational performance as it is thought that all these elements run parallel to organizational performance or the other fact that it is precisely the management of organizations that assesses the need for training, career development assessment other employees or even reward as well.

We are already analyzing the other dependent variables with independent variables such as reward and training as two processes and at the same time as two factors namely that are directly related to the employees of organizations and their performance through the following hypotheses.

Hypothesis 1.c: *The individual performance of employees of organizations is closely related to the well-thought-out reward process.*

Independence test analysis in this case also shows the relationship of dependence between the dependent variable individual performance and the reward process showing their direct relationship, confirmed by the value of the Pearson coefficient via Asymptotic Significance (2-sided) = 0.027 < 0.05 (Table 15). So, this correlation is not only significant but also important in the whole process of human resource management and performance as a whole.

Table 15. Individual performance independence test and reward

	Value	df	Chi-Square Tests
			Asymptotic Significance (2-sided)
Pearson Chi-Square	2.582 ^a	2	0.027
Likelihood Ratio	2.338	2	0.311
Linear-by-Linear Association	2.129	1	0.144
N of Valid Cases	395		

Hypothesis 1.d: *The individual performance of employees of organizations is also related to the ongoing training process.*

The analysis shows that the value of Asymptotic Significance (2-sided) = 0.010 < 0.05 (Table 16), which shows that the training process of employees of organizations is necessary mainly in updating knowledge in economic, legal, technical, etc. which are consequence of the evolution of socio-economic life but also valuable and visible in the indicators of their individual performance.

Table 16. Individual performance and training independence test

	Value	df	Chi-Square Tests
			Asymptotic Significance (2-sided)
Pearson Chi-Square	1.346 ^a	2	0.010
Likelihood Ratio	1.505	2	0.471
Linear-by-Linear Association	1.223	1	0.269
N of Valid Cases	395		

If we analyze the elements together which in this case also act simultaneously in the organizational environment, we refer to the following analysis.

To further analyze these sub-hypotheses, we again refer to the construction of the multiple linear regression equation from where we first analyze ANOVA. The data of this analysis show that for $df(5,389)$ and $F = 4,588$ we have that the value of $Sig. = 0.00 < 0.05$, which shows that there is really a statistically significant relationship between these variables. This allows us to proceed with further analysis.

Table 17. ANOVA analysis

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	0.734	5	0.147	4.588	.000 ^b
Residual	12.451	389	0.032		
Total	13.185	394			

a. Dependent Variable: Individual Performance

b. Predictors: (Constant), Career, Recruitment, Reward, Motivation, Training

So, referring to the linear regression data we have the dependent variable, individual performance depends largely on training and reward, two factors really important and expected to be important in this relationship, as their SIG values. are 0.001 and 0.025, respectively, both smaller than 0.05. Therefore, the shape of the multiple linear regression equation is:

$$(Individual\ performance) = 4.057 + 0.087 (Training) + 0.059 (Reward)$$

The equation states that both variables have positive coefficients and respectively the coefficients β are 0.087 and 0.059 from which it is observed that training has a higher value of the coefficient β indicating that its impact is higher in relation to the reward related to the evaluation of individual performance of them. Of course, these two factors were expected to have an impact on individual performance, and even other factors such as recruitment, motivation and career are certainly very significant elements, but in our case study, their impact has been lower (Table 13).

Table 18. Multiple regression analysis between independent variables and individual performance dependent variable

Model	R2	R2 regulated	t	Sig.
Constant	0.056	0.044	14.253	0.000
Recruitment			-0.755	0.451
Trainings			3.269	0.001
Motivation			-1.695	0.091
Reward			2.253	0.025
Career			-0.057	0.955

A very important element for this study is the analysis of the interaction of factors between them through research questions which is considered as an additional and complementary analysis. On the other hand, it was shown that the training process is a key factor not only as

an indicator of individual performance but also in the organizational one therefore, in order to emphasize the importance of this process, even at the hierarchical level related to the educational level of employees within organizations, the research question arises as follows:

Research Question 1: *Is organizational performance affected by individual performance?*

To analyze this research question, we refer to the analysis through the Chi-Square independence test. The data of this test show that the value of Sig. = 0.021 < 0.05. This allows us to express that there are statistically significant relationships between these variables. So, in other words, organizational performance depends on the individual performance of employees (Table 19).

Table 19. Group averages for educational level

Homogeneous Subsets		
Training		
Tukey HSD _{a,b}		
What is your educational level?	N	Subset for alpha = 0.05
Secondary education	170	1
Primary school	53	3.97
High education	172	4.00
Sig.		4.03
Means for groups in homogeneous subsets are displayed.		
a. Uses Harmonic Mean Sample Size = 98.154.		
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.		

Research Question 2: *Does a well-consolidated performance management process affect the success of the organization?*

Analysis through the independence test shows that the success of the organization through performance indicators and the achievement of its goals and objectives is closely linked to a consolidated process of managing human resources along with other factors such as strategies and so on. Statistically, the value of Asymptotic Significance (2-sided) = 0.008 < 0.05 (Table 20) confirms this fact.

Table 20. Independence test of the success of the organization and the managerial process as a whole

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.248a	2	0.883
Likelihood Ratio	0.476	2	0.788
Linear-by-Linear Association	0.001	1	0.975
N of Valid Cases	395		

So, we can say that the correct functioning of all the links of the performance management process at the same time undoubtedly leads to important results and towards the indisputable success of the organization.

Research question 3: Does the training process differ from the educational level of the employees of the organizations?

To analyze the first part of this research question we refer to the ANOVA analysis which is used to show whether or not there are differences between more than two different groupings of a variable, as in our case the levels of education.

Table 21. Independence test for organizational performance and training

Chi-Square Tests			
	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.881 ^a	4	0.017
Likelihood Ratio	7.645	4	0.105
Linear-by-Linear Association	0.987	1	0.321
N of Valid Cases	395		

Thus, referring to this analysis presented in Table 21, where it is observed that the Pearson Chi-Square value measured via Asymptotic Significance (2-sided) = 0.028 < 0.05. This proves that there is a dependence between education and training.

Table 22. Chi-Square between training and educational level of employees of organizations

Chi-Square Tests			
	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.852 ^a	4	0.028
Likelihood Ratio	11.916	4	0.018
Linear-by-Linear Association	1.276	1	0.259
N of Valid Cases	395		

But let's see if there are differences between each level. The analysis of the comparison of means by ANOVA (Table 22), shows that for df (2,392) and F = 1.317 we have that the value of Sig. = 0.269 > 0.05. So, we can say that there is indeed a dependency between the training and the educational level of the employees, but there are no statistically significant differences between them.

Table 23. Analysis of comparison of means through ANOVA

ANOVA					
Training					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0.354	2	0.177	1.317	0.269
Within Groups	52.644	392	0.134		
Total	52.997	394			

This is also confirmed by the analysis of the Post Hoc test according to the Tukey procedure where it is noticed that the value of Sig. (Significance value) in the comparison between each group, two by two is significantly greater than 0.05 (Table 23).

Table 24. Post Hoc Tests

Multiple Comparisons						
Dependent Variable:	Training					
Tukey HSD						
(I) What is your educational level?		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Primary education	Secondary education	0.029	0.058	0.866	-0.11	0.17
	High education	-0.035	0.058	0.817	-0.17	0.10
Secondary education	Primary education	-0.029	0.058	0.866	-0.17	0.11
	High education	-0.064	0.040	0.237	-0.16	0.03
High education	Primary education	0.035	0.058	0.817	-0.10	0.17
	Secondary education	0.064	0.040	0.237	-0.03	0.16

On the other hand, the averages calculated for each comparison between groups are almost the same, again showing that there is no difference between these groups (Table 24).

So, we can say that the correct functioning of all the links of the performance management process at the same time definitely leads to important results and leads to indisputable success of the organization.

6. Conclusions

The organization today is paying more attention to employee performance and productivity than ever before; in an effort to not only remain competitive but to survive (Jamal Abu-Doleh, David Weir, 2007). The employee's role in performance management must take an active role in achieving performance excellence. The role of the employee should initiate challenging but realistic objectives, which support the strategies of the organizations and the goals of the departments, in order to be able to create action plans and follow through to achieve the objective and let the managers know when they need information, help or advice to meet their objectives. By monitoring their performance is actively seeking feedback from others on year-round performance and initiating suggestions for improvement. This should be informed of progress towards achieving their objectives and demonstrating competencies. Critical success factors for the human resource performance management process to be effective in organizations must respect many things; all actors must understand and support the vision, mission and strategy of the organization. This research on the human resource performance process made it clear that the biggest challenges are not related to the development of adequate models of the human resource performance management process in organizations. However, these systems cannot work or cannot have high performance without motivated and dedicated employees.

The solution requires a system that will inspire and motivate the person, because organizational performance ultimately depends on motivated employees. The solution requires one that is holistic and able to create synergy between different organizational processes, systems and subsystems.

However, motivated employees can generate high performance, regardless of any performance management system. The simple logic is that motivated people make high-performance organizations. Ultimately, the role of leadership is to inspire human resources and create commitment to the vision of the organization and create an organizational culture based on the foundation of a strong work ethic and responsibility. Another leadership role is to harmonize and channel individual, team, and organizational energies.

The results suggest that the majority of respondents are satisfied with the overall quality of the current performance management process, it is argued that high-performance organizations should strive for excellence rather than mediocrity in terms of the performance management systems that they use. However, the results show that respondents have identified a number of areas that require significant improvements.

Improving a performance management process requires better design, higher commitment to implementation, enhanced skills and knowledge, skilled leadership, regular monitoring and evaluations. Performance management is not an event – it is an ongoing process, which requires continuous learning and improvement. There is no performance management recipe or magic formula for success. To create a successful performance management system, organizations need to take a multidimensional approach to address performance issues.

Organizations need to align their performance management process with organizational strategy, structure, processes, culture, and capacity. There should be balance and emphasis on the technical and human aspects of performance management. Organizations need to harmonize individual, team, and organizational objectives, needs, and aspirations. By approaching performance management from an integrated and holistic perspective, organizations will have a better chance of building a successful and sustainable performance management system- a system that will be able to harness human potential and keep people motivated and committed to the department's mission. Performance management, as a cross-cutting management methodology, integrated with similar methodologies such as strategic planning, human resource management, financial management and quality management, should be considered as a critical tool for improving the performance of individuals, teams and organizations in general.

The new Performance Management process proposed in this study is informed by the key performance management challenges identified in the research. The model addresses these challenges systematically and provides sustainable solutions. Solutions to these challenges are supported by strong theoretical foundations informed by a review of the literature in the field of performance management. Implementation of a new performance management process and the subsequent change management process accompany its implementation. And it is not a battle to be won and to be declared victory. It is an ongoing learning process.

In an increasingly global and competitive operating market, improving performance is a major challenge, especially for city departments operating within bureaucratic constraints,

rules and different parties. However, high performance is the only way to achieve the lasting success of any individual, organization or society.

In conclusion, although the results suggest that the majority of respondents are satisfied with the overall quality of the current performance management process, it is argued that high-performing organizations should strive for excellence rather than mediocrity in relation to their performance management systems. that they use. However, the results show that respondents have identified a number of areas that require significant improvement.

Improving a performance management process requires better design, higher commitment to implementation, enhanced skills and knowledge, capable leadership, regular monitoring and assessments. Performance management is not an event – it is an ongoing process, which requires continuous learning and improvement. There is no performance management recipe or magic formula for success. To create a successful performance management system, organizations must take a multidimensional approach to addressing performance problems.

Organizations must align their performance management process with organizational strategy, structure, processes, culture and capacity. There should be balance and emphasis on the technical and human aspects of performance management. Organizations must harmonize individual, team and organizational objectives, needs and aspirations. By approaching performance management from an integrated and holistic perspective, organizations will have a better chance of building a successful and sustainable performance management system – one that will be able to exploit the potential human resources and keep people motivated and committed to the department's mission.

Performance management, as an interdisciplinary management methodology, integrated with similar methodologies, such as strategic planning, human resource management, financial management and quality management, should be considered as a critical tool for improving the performance of individuals, teams and organizations in general.

We hope that the findings and knowledge developed in this study will help organizations to improve the performance of their human resources and achieve the highest possible success.

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MACROECONOMIC STABILITY AND ECONOMIC GROWTH: AN EMPIRICAL ESTIMATION FOR NORTH MACEDONIA³

The main aim of the paper is to investigate the effect of macroeconomic stability on economic growth in North Macedonia by applying ARDL econometric model and by using quarterly data for the period from the first quarter of 2007 to the fourth quarter of 2022. We divide the concept of macroeconomic stability into four sub-concepts – output stability, price stability, fiscal stability and financial stability – and find suitable proxies for each of them. In addition, we add a few growth drivers as control variables. The estimated results indicate that higher GDP volatility has a negative effect on economic growth at one level, but weaker and positive effects at one lag; inflation volatility and budget balance volatility have no effect on GDP growth; and capital adequacy ratio negatively impacts GDP growth. Furthermore, we find that the levels of financial intermediation and indebtedness negatively impact the growth of the Macedonian economy.

Keywords: macroeconomic stability; economic growth; ARDL model

JEL: E31; E32; E44; O40

1. Introduction

There is a general consensus that sound and prudent macroeconomic policies promote higher economic growth by providing a stable financial and economic environment. Historically, macroeconomic policies improved in a majority of developing countries in the 1990s, but the expected growth benefits failed to meet high expectations by policymakers. In addition, a series of financial crises severely deteriorated growth and worsened economic conditions (Serven, Montiel, 2004). Any shock to the economic system is likely to be reflected in macroeconomic statistics (Bleaney, 1996).

Based on long-term data and historical patterns for 30 countries up to 2006, Barro & Ursúa (2009) revealed 232 stock-market crashes (multi-year real returns of -25% or less) and 100 depressions (multi-year macroeconomic declines of 10% or more). Easterly (2001) very remarkably stressed that crises are more likely symptoms of the growth slowdown than its

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cause. These developments turn out one important question: what is the relationship between macroeconomic instability and economic growth? In other words, we are interested in finding out how stability affects growth performances in the case of the Macedonian economy. What is behind this relationship? Is volatility a source or a symptom? Through what transmission mechanisms does volatility affect economic growth?

There are many reasons to believe that growth and economic volatility may be linked, either positively or negatively. For instance, if there are irreversibilities in investment and incomplete financial markets under imperfect market structures, then increased volatility can lead to lower investment. Further, if there is a precautionary motive for savings (Mirman, 1971; Aizenman, Marion, 1999), then higher volatility should lead to a higher savings rate, and hence a higher growth performance (Ramey, Ramey, 1995). However, generally speaking, economic instability has a negative impact on output growth and thus on future consumption. Volatility has this negative effect through its links with various forms of uncertainty and with the tightening of binding investment constraints (Loayza et al., 2007).

In addition, the level of inflation is strongly associated with the volatility of relative prices. For these reasons and because high levels of inflation are likely to be viewed as unsustainable, inflation itself is commonly taken as a summary indicator of price instability (Serven, Montiel, 2004). Higher inflation is associated with lower growth because lower real balances reduce the efficiency of factors of production, and because there may be a link between government purchases and the use of the inflation tax (Fischer, 1983). Moreover, price stability is of particular interest for understanding of growth-finance relationship and the mechanisms of transmission. If one country is stable, then there is a relative investment prospect and savers can decide about what investment forms there should be with respect to the expected returns. In stable countries, it is simple to transform savings into investments with the help of banks or markets. In this case, we can indirectly explain why rich countries demonstrate this link, not only because they are rich but because they are stable (Rousseau, Wachtel, 2002; Perri, 2014).

On another subject, what about the possible link between financial instability and growth? Financial stability plays a dominant role in the modern financial theory. Moreover, financial stability is a commonly employed word in the financial literature. Once upon a time, the German Minister of Finance emphasised that stability is not everything, but without stability everything becomes nothing. The mission of De Nederlandsche Bank (DNB) can best summarised as follows: stability to us is worth its weight in gold. However, financial stability evaluation has become more challenging (Simonovska et al., 2015). Also, to the best of his understanding, Blejer (2005) stressed that there is no important empirical paper dealing with and pertaining to the financial stability-growth relationship. As a consequence, we consider this as a very good room for substantial academic improvements which will fill the existing literature gap.

In sum, macroeconomic stability, both a source and a reflection of growth and development, is a fundamental concern for developing countries. In other words, in the last decades, at least the 40 most volatile countries in the world are developing economies (Hnatkovska, Loayza 2005). We have witnessed a spectacular divergence of growth levels amongst developing countries (Bleaney, 1996). Among the most volatile are not just small economies such as Dominican Republic and Togo, but also large ones such as China and Argentina. More

precisely, not only are the effects of volatility larger in developing countries but these countries also face more macroeconomic volatility than do industrial countries. Their high aggregate instability results from a combination of large external shocks, a volatile macroeconomic environment, microeconomic rigidities and weak economic and political institutions (Loayza et al., 2007). Basically, the effect of business cycles on growth is much larger for poor countries or countries with a lower degree of financial development (Fatás, 2002). Since the external environment is more or less similar for all developing countries this divergence of performance has concentrated attention on the internal determinants of growth and has sharpened the debate about specific economic determinants in the developing world.

Therefore, our intention is to revisit the relationship between macroeconomic stability and economic growth by using advanced econometric methodology. More specifically, we are interested in determining the effects of macroeconomic and financial volatility on the growth rate in North Macedonia as an excellent example of a developing country. A convincing result largely depends on providing reliable proxies for this issue. The number of variables which may be considered as potential candidates in a model is very large, even if we confine ourselves to those which have been found to be empirically significant in valuable empirical research (Bleaney, 1996). In order to examine the link between volatility and economic growth in North Macedonia, we are focused on the level of macroeconomic outcome variables as well as on our original financial stability indicator.

The rest of this paper is structured as follows. In section 2, we briefly review existing literature and describe various methodological approaches towards macroeconomic instability and economic growth relationship. The main empirical results then appear in Section 3. Finally, Section 4 presents our concluding remarks based on the empirical analysis.

2. Brief Literature Overview

The problem of economic growth and macroeconomic stability becomes particularly relevant and topical in moments of recession, economic crises and post-crisis periods, as nowadays. The beginning of the new millennium, namely, brought another recession to the world economy and put the question of economic growth again at the top of the economic agenda (Šokčević, Štokovac, 2011). A growing body of research suggests that higher volatility is causally associated with lower growth (Wolf, 2005). Moreover, macroeconomic stability is regarded and acknowledged as a growth prerequisite (Sanchez-Robles, 1998).

Conceptually, macroeconomic instability refers to phenomena that make the macroeconomic environment less predictable, and it is of concern because unpredictability hampers resource allocation decisions, investment and growth. Macroeconomic instability can take the form of volatility of leading macroeconomic variables or of unsustainability in their behavior which predicts future volatility. Nevertheless, a long time ago, business-cycle theory and growth theory have traditionally been treated as unrelated areas of the macroeconomic arena. Specifically, little attention has been paid to the effect of macroeconomic volatility on growth prospects. Furthermore, bunch of literature has remained silent on the subject of volatility (Lucas, 1987). Still, the picture is far from rosy despite some substantial and major improvements. The negative volatility-growth nexus was notably documented by Ramey and

Ramey (1995). They have conducted an empirical analysis that demonstrates a strong negative link between volatility and growth. By using a panel of 92 countries, they concluded that countries with higher volatility have lower mean growth, even after controlling for other country-specific growth correlates.

Also, based on extensive cross-country data, Kormendi and Meguire (1985) have shown that countries with higher volatility in terms of output growth tend to experience higher mean growth rates. Further, Bleaney (1996) has found that macroeconomic instability has an important negative influence on investment and growth in developing countries. Concretely, volatility appears to be associated with low growth for a given rate of investment, and possibly also with a lower rate of investment. There is some evidence that macroeconomic instability affects growth principally by reducing the effectiveness of fixed capital investment, but the main problem of this study could be the small sample. Therefore, we cannot draw definite and comprehensive conclusions. Additionally, in contrast to the many studies (e.g. De Gregorio, 1992; Fischer, 1993; Barro, 1995; Fischer et al., 1996; Andres, Hernando, 1997; Bruno, Easterly, 1998; Ghosh, Philips, 1998; Gillman et al., 2002; Efendic et al., 2008; Šokčević, Štokovac, 2011), this paper does not suggest any negative influence of inflation on growth. However, it should be noted that there is no clear and strong evidence that disinflation necessarily incurs significant output costs, even at moderate inflation rates. Basically, losses only appear to arise when moderate inflation is stabilized in the presence of exchange rate pegs. Even in this context, however, the losses seem likely to be due to undervalued pegs, rather than pegs per se (Christoffersen, Doyle, 1998).

Importantly, Hnatkovska and Loayza (2005) empirically discussed the relationship between macroeconomic volatility and long-run economic growth. They found that indeed macroeconomic volatility and long-run economic growth are negatively related. This negative link is exacerbated in countries that are poor, institutionally underdeveloped, undergoing intermediate stages of financial development, or unable to conduct countercyclical fiscal policies. They provided evidence that this negative relationship over the 1960-2000 period actually reflects the harmful effect of volatility on growth.

Moreover, they suggested that the negative effect of volatility on growth has become considerably larger in the last decades and that it is mostly due to large recessions rather than normal cyclical fluctuations. Consistent with previous work on this topic, Imbs (2002) further confirmed that growth and volatility are negatively related across countries, but show that the relation reverses itself across sectors. Famously, he claimed and argued that the relationship between volatility and growth may be positive or negative depending on the impact of various transmission mechanisms. Interestingly, Kroft and Lloyd-Ellis (2002) have documented a significant negative correlation between growth and medium-term business cycle fluctuations, and a significant positive correlation between growth and short-term, year-to-year fluctuations.

Recently, by using the original index for measuring macroeconomic stability, Sirimaneetham and Temple (2009) suggested that growth is found to be positively associated with macroeconomic stability in a sample of 70 developing countries. Le Fort, Guillermo – Gallardo and Bustamante (2020) investigate the relationships between GDP growth and macroeconomic volatility by applying fixed-effect panel regressions for the period 1980-2015 debunks certain myths, such as those that maintain that more inflation generates more

growth, that stabilization carries real costs, or that large inflows of foreign capital stimulate growth.

Finally, the countries in Eastern Europe have undergone a long and difficult process of transformation from centrally planned to market economies. All macroeconomists, and especially those interested in growth, may draw insights and lessons from the attentive consideration of these processes. These facts have implied a particular pattern of growth in the last decades, with their own features. In terms of Eastern Europe, Martínez and Sanchez-Robles (2009) have examined the link between macroeconomic stability and growth. More precisely, they carried over a panel data analysis of 13 countries over the period 1992-2008. They found that macroeconomic stability, captured by low levels of inflation and public deficits, has been beneficial and plays a substantial role in growth according to their estimations. Additionally, Pera (2016) explores the evaluation of the Macroeconomic Stability of Central and Eastern European Countries in the integration process toward EU membership by using multidimensional risk analysis. Vasylieva, Lyeonov, Lyulyov and Kyrychenko (2018) investigate the impact force of macroeconomic stability on economic growth in Ukraine for the period from 2000 to 2016 by applying a modified Cobb-Douglas production function. They found a positive and statistically significant relationship between macroeconomic stability and economic growth. On the other hand, Tanchev and Mose (2023) investigated the influence of fiscal performance on economic growth in EU countries by using the panel ordinary least squares (POLS) technique and found that higher rates of public debt lead to a decrease in economic growth.

Overall, existing theoretical and empirical work has given some indefinite responses to questions about the dichotomy of volatility and growth. Most of the studies confirmed the negative relationship between macroeconomic instability and economic growth, but they are facing many methodological problems. Although macroeconomic stability could be important for growth, the strength of the empirical relationship remains uncertain. A possible argument and explanation is that the observed correlation between stability and growth is mainly due to a small number of countries with the very worst macroeconomic outcomes (Sirimaneetham, Temple, 2009). Therefore, keeping all this in mind, the paper explores some alternative methods. Strictly speaking, our objective in this paper is to determine empirically the extent to which instability matters to economic growth in North Macedonia.

The paper represents an updated contribution in this direction. It assesses the impact of various measures of macroeconomic instability on growth. Our approach differs in some ways from those of the authors just cited here, but the general conclusions correspond to the literature about macroeconomic management.

3. Empirical Analysis of Macroeconomic Stability and Economic Growth

The empirical analysis investigates the relationship between the macroeconomic stability and economic growth of the Macedonian economy using quarterly data in the period from Q1 2007 to Q4 2022. The length of the period was deliberately chosen to capture three periods of various developments in the economy with its constituent sectors: 1) period of high activity of the financial sector and strong economic performance before the events of the global

economic crisis, 2) period of macroeconomic fragility with multiple critical signals and sharp drop in economic performance during the events of the global economic crisis and 3) period of restore of the macroeconomic stability at the time of external vulnerabilities after the events of the global economic crisis. Macroeconomic stability refers to the economy as a whole and thus its measurement requires examination of various constituent sectors of the economy. For the purpose of our analysis, we break down the concept into three different kinds of stability, namely: 1) output stability, 2) price stability, 3) fiscal stability and 4) financial stability.

Output stability refers to the state of the economy at which the output is fairly constant and free of the influence of any factors that may cause large fluctuations. Higher economic stability implies lower uncertainty, resistance to excessive shocks and higher predictability of the future growth path. Though economic stability stems from the developments within the real sector, it is strongly dependent on the developments in the other macroeconomic sectors, but most notably on the stability of the financial system. As the less volatile movement of the output has a central role in ensuring economic stability and the gross domestic product (GDP) is a usual measure for the output of an economy, we employ the volatility of the real GDP growth rate as a measure for economic stability.

Price stability implies low and stable inflation. The concept can be linked to economic stability in the sense that low and stable inflation is an important pre-condition for achieving economic stability. Since inflation is targeted through the monetary policy and the level of the monetary aggregates have high interconnectedness with the inflation rate, the level of price stability may also be affected by the developments in the financial system and financial stability in general. As a proxy for price stability in our analysis, we use the volatility of the inflation rate. According to Tsvetkov and Georgieva (2022), there is a two-way causal relationship between inflation and inflation instability in the case of Bulgaria indicating that the inflation rate proves the inflation instability and vice versa.

Fiscal stability denotes a state in which the government can finance its main activities by ensuring contained and stable levels of budget deficits, which do not have the tendency to accelerate the levels of government debt. In essence, the role of the government is to make sure that its spending targets of those sectors in the economy that could promote the highest economic growth through the fiscal multiplier. These may include items both on the side of investment, such as capital expenditures, and on the side of consumption, such as transfers and purchases of goods. As a proxy for fiscal stability in the economy, we employ the budget balance volatility.

Financial stability denotes a state in which the financial system is functioning with low risks of default, low uncertainties on the financial markets and stable growth of the monetary aggregates. The functioning of the financial system is vital for the economy, because it may have implications on different macroeconomic sectors. Because of the structural complexity of the financial system and its relation to the macroeconomic sectors, in particular the monetary sector, the proper measurement of financial stability requires using a wide variety of measures. For that purpose, we use the credit growth, the capital adequacy ratio, the NPL ratio and the liquidity ratio as measures of financial stability.

In the end, it is important to note that there may be other macroeconomic measures that can be used as control variables to complete the model. They are usually measures that control for other macroeconomic areas that are not covered by the aforementioned stability concepts. In this regard, we take the export growth as a measure of the external sector, the investment growth rate as a growth driver and the employment rate as a measure of the labour market.

A detailed overview of the variables in the empirical model is presented in Table 1.

Table 1. Definition of variables in the empirical model

Dependent variables	Notes
GDP growth rate	
Independent variables	
GDP growth rate volatility	a measure of output stability
Consumption growth rate volatility	
Investment growth rate volatility	
Gross value-added growth rate volatility	
Inflation volatility	measure of price stability
Budget balance volatility	
Budget balance to GDP	
Government expenditure to GDP	measure of fiscal stability
Interest payments to GDP	
Government debt to GDP	
Credit growth rate	
Capital adequacy ratio	measure of financial stability
NPL ratio	
Consumption growth rate	
Investment growth rate	control variable
Gross value-added growth rate	

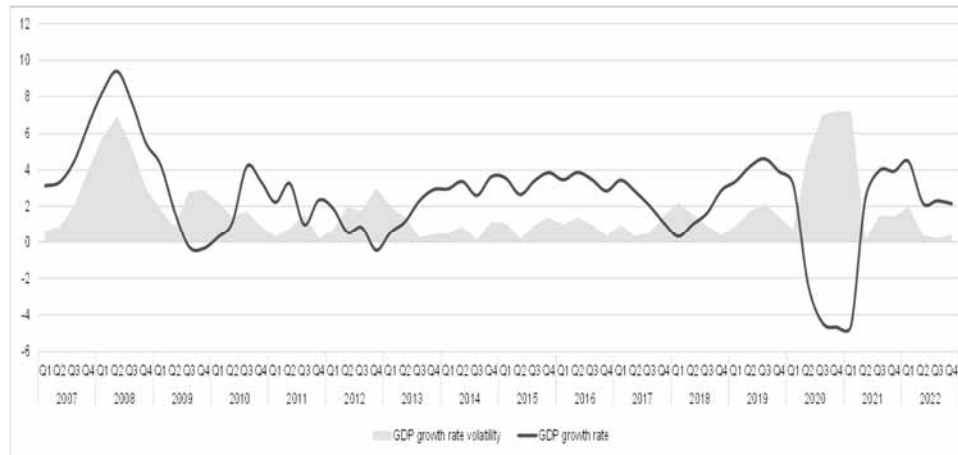
The empirical analysis is organised in two sub-sections. The first one gives a historical perspective of the development of the main macroeconomic variables in the empirical analysis during the analysed period. The second one elaborates on the empirical model with its prerequisites and discusses the results from the analysis.

3.1 Macroeconomic trends in the Macedonian economy

In this section, we study the macroeconomic trends in the Macedonian economy during the analysed period in order to get more insights about its stability and the sources of its vulnerabilities.

We begin with an analysis of the growth path throughout the analysed period (see Figure 1). The growth was relatively high and stable amid the global economic expansion during the 2000s with average values of 6.0 per cent in the period from Q1 2007 to Q4 2008. However, the adverse effects of the Global financial crisis caused the growth to shrink significantly, which marked the start of a substantially volatile period full of external vulnerabilities lasting from 2009 to 2012. As the economy recovered and released from the effects of the vulnerabilities, the growth started to pick up from 2013 to 2019, which also reduced the volatility.

Figure 1. The growth path of North Macedonia from Q1 2007 to Q4 2022 (in %)



Source: Authors' calculation.

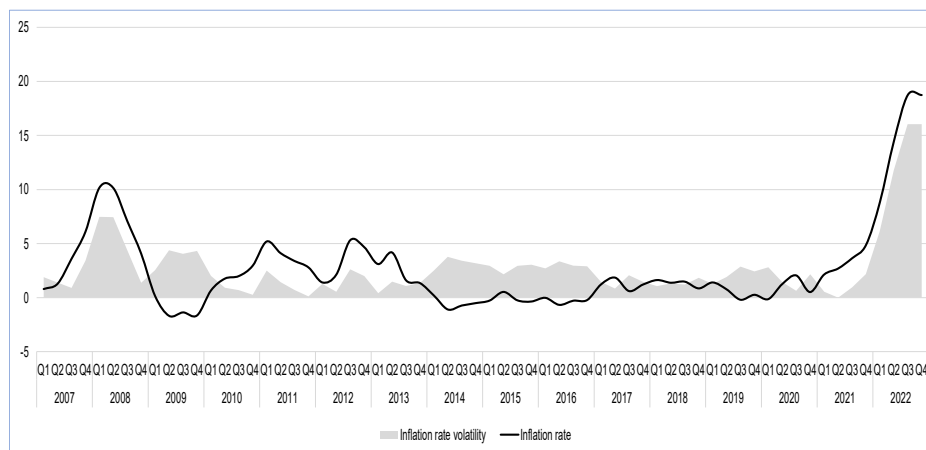
Another increase in volatility was recorded during the COVID-19 recession when there was a large drop in GDP growth. The period of recovery from 2021 on experienced modest growth rates with reduced volatility. Two main conclusions can be drawn regarding the growth path. Firstly, it exhibits higher volatility in times of modest growth. Secondly, the volatility fell amid stabilising growth rates.

Next, we move on to analysing the development of inflation as a measure of price stability in the analysed period. The inflation was at normal levels with moderate volatility in the mid-2000s, but started a galloping behaviour during the peak of the economic expansion in 2008 when price growth of nearly 10 per cent was recorded. Following the economic slump, the inflation turned into deflation in 2009 and then stabilised to its pre-crisis normal levels for 2010-2013. A period of near-zero inflation with frequent deflation periods followed from 2014 to 2016 before it returned to positive values but was still below the benchmark level of around 2.0 per cent.

A large increase of the inflation volatility was recorded during the inflation surge in 2022. Two main conclusions can be inferred regarding the inflation path. Firstly, higher inflation raised volatility amid economic expansion. Secondly, the price volatility was stable in times of low inflation.

Finally, we analyse the path the budget balance path as a measure of financial stability. The highest volatility occurred during the economic expansion of the late 2000s when the budget balance was positive, i.e. there was a budget surplus, whereas it started to stabilise in the period to come with some pick-ups in 2013 and 2014.

Figure 2. The inflation path of North Macedonia in the period from Q1 2007 to Q4 2022 (in %)

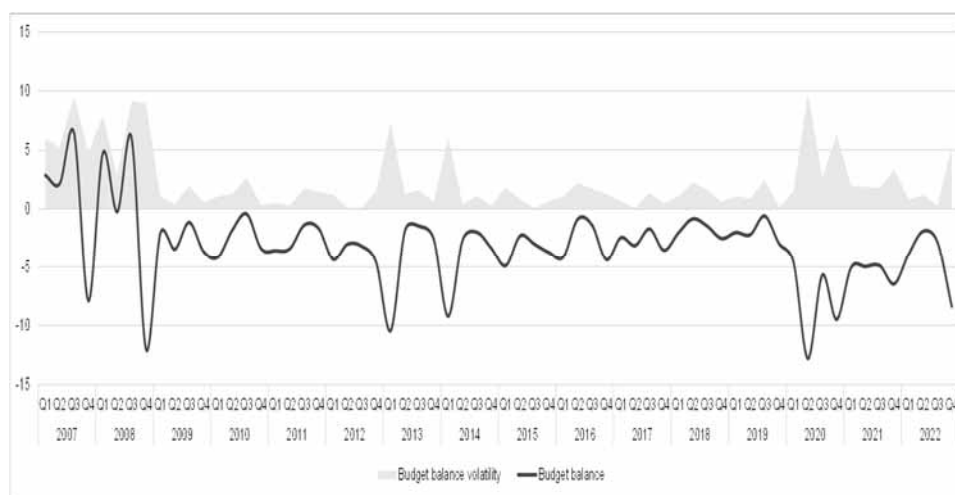


Source: Authors' calculation.

In general, the recovery period from the crisis was marked by relatively stable budget deficits. A rise in volatility was recorded during the COVID-19 pandemic, which came as a result of the increased budget deficits to support the economy during that period.

The two main conclusions regarding this measure are as follows. Firstly, rising volatility appeared in times of economic expansion when there was a budget surplus. Secondly, low volatility was typical for times of crisis with stable budget deficits.

Figure 3. The budget balance path of the Macedonian economy in the period from Q1 2007 to Q4 2022 (in %)



Source: Authors' calculations.

3.2 Empirical results and discussion

In this sub-section, we develop an autoregressive model with distributed lags to study the macroeconomic stability and economic growth in the Macedonian economy. The model is of the form:

$$g_t = \alpha + \sum_{i=1}^p \beta_i g_{i,t-1} + \sum_{j=1}^q \delta_j s_{j,t} + \sum_{j=1}^q \sigma_j \mathbf{X}_{j,t} + \varepsilon_t \quad (1)$$

where, g_t denotes growth rate, p and q denote the number of lags, $s_{j,t}$ is a measure of stability and $\mathbf{X}_{j,t}$ is a vector of control variables. Considering that we want to study the impact of three kinds of stability, we run the model in (1) four times, that is, for output stability, price stability, fiscal stability and financial stability.

The problem of long-run structural modelling has been addressed elsewhere (Johansen, 1991; Phillips, 1991; Pesaran, Shin 2002). We estimate the regression coefficients using the autoregressive distributed lag (ARDL) approach developed by Pesaran and Shin (1999) and further extended by Pesaran et al. (2001).

The ARDL approach allows large flexibility and has multiple advantages over the cointegration techniques and the other models used to study the linear long-run relationship in a model. Some of the advantages that we reckon as important are the usefulness in employing both stationary and non-stationary as well as fractionally co-integrated time series (Pesaran and Pesaran 1997) and the ability to distinguish between dependent and explanatory variables that make the estimation possible even when the explanatory variables are endogenous (Pesaran and Shin 1999). In addition, this methodology takes advantage of reverse causality and addresses spurious correlation.

Finally, the ARDL approach has the additional advantage of yielding consistent estimates of the long-run coefficients that are asymptotically normal irrespective of whether the underlying regressors are of order $I(1)$ or $I(0)$ (Pesaran, Pesaran 1997).

Another important pre-requisite before moving on to estimate the model is to define the concept of volatility. In our analysis, volatility is calculated for growth rate, inflation and budget balance as an absolute variation using the formula:

$$Vol = |x_t - \bar{x}| \quad (2)$$

where x_t is the observed variable and \bar{x} is the mean. This definition of volatility is used in the estimates of the baseline model.

In order to test for the robustness of the volatility measure, we also use an alternative formula for its calculation, which is given as

$$Vol^* = |x_t - x_{med}| \quad (3)$$

where the median value of the observed variable x_{med} is taken to replace the mean \bar{x} . These estimates are used in the model testing for robustness.

The number of lags in the regression equations of the baseline model is selected using the Akaike information criterion (AIC). The selection results are presented in Table 2.

Table 2. Number of lags in the regression equations

Variable	Number of lags
GDP growth rate	3
GDP growth rate volatility	2
Inflation volatility	2
Interest payments to GDP	4
Government debt to GDP	4
Credit to GDP	4
Credit growth rate	3
Capital adequacy ratio	1
ROAA	4
ROAE	4
NPL ratio	1

Source: Authors calculations.

The estimated results from the ARDL model for output stability are presented in Table 3.

Table 3. Estimation results from the model for output stability

Variable	Estimates with robust standard errors			
	(1)	(2)	(3)	(4)
GDP growth (one lag)	1.114*** (0.132)	1.020*** (0.135)	0.731*** (0.138)	0.740*** (0.144)
GDP growth (two lags)	-0.237 (0.188)	-0.111 (0.193)	-0.083 (0.167)	0.012 (0.177)
GDP growth (three lags)	-0.176 (0.122)	-0.328 (0.130)	-0.249 (0.110)	-0.310** (0.119)
GDP growth volatility	-0.395*** (0.137)	-0.348** (0.161)	-0.208* (0.111)	-0.259* (0.146)
GDP growth volatility (one lag)	0.485** (0.188)	0.357* (0.184)	0.304** (0.150)	0.265* (0.152)
GDP growth volatility (two lags)	-0.105 (0.147)	-0.068 (0.146)	-0.008 (0.116)	-0.027 (0.120)
Credit to GDP		-0.468* (0.254)		-0.402 (0.226)
Credit to GDP (one lag)		0.541* (0.317)		0.082 (0.295)
Credit to GDP (two lags)		0.063 (0.321)		0.248 (0.271)
Credit to GDP (three lags)		-0.326 (0.305)		-0.114 (0.266)
Credit to GDP (four lags)		0.084 (0.230)		-0.053 (0.0199)
Government debt to GDP			-0.317*** (0.068)	-0.189** (0.080)
Government debt to GDP (one lag)			0.151 (0.092)	0.185* (0.092)
Government debt to GDP (two lags)			-0.125 (0.092)	-0.128 (0.096)
Government debt to GDP (three lags)			0.078 (0.096)	0.042 (0.105)
Government debt to GDP (four lags)			0.194** (0.079)	0.168* (0.086)
Adjusted R^2	0.742	0.776	0.846	0.856

Notes: Symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively. Robust standard errors are reported in parentheses. Constants are not reported.

Source: Authors' calculations.

The results reveal that GDP volatility has a negative overall effect, which is statistically significant at the level and one lag with the opposite sign. At this level, the estimated coefficient is negative in the range from -0.208 to -0.395, which indicates that increased volatility by one percentage point would slow down GDP growth by 0.2 to 0.4 percentage points. At first lag, the estimated coefficient alternates its sign and becomes positive in the range from 0.265 to 0.485. This means that the positive effect of GDP volatility is pronounced with a lag of two quarters. However, it is important to link these results to the estimated coefficients of the lagged values of the GDP growth itself.

Table 4. Estimation results from the model for price stability

Variable	Estimates with robust standard errors			
	(1)	(2)	(3)	(4)
GDP growth (one lag)	1.029*** (0.126)	0.921*** (0.128)	0.667*** (0.140)	0.689*** (0.151)
GDP growth (two lags)	-0.133 (0.181)	-0.011 (0.184)	-0.038 (0.169)	0.059 (0.183)
GDP growth (three lags)	-0.299** (0.129)	-0.463*** (0.132)	-0.313** (0.121)	-0.378*** (0.130)
Inflation volatility	0.184 (0.126)	0.210* (0.120)	-0.049 (0.114)	-0.089 (0.117)
Inflation volatility (one lag)	-0.317 (0.206)	-0.201 (0.194)	0.017 (0.171)	0.102 (0.170)
Inflation volatility (two lags)	0.294* (0.175)	0.190 (0.169)	0.126 (0.142)	0.037 (0.146)
Credit to GDP		-0.610** (0.230)		-0.524** (0.226)
Credit to GDP (one lag)		0.584* (0.325)		0.192 (0.308)
Credit to GDP (two lags)		0.031 (0.317)		0.341 (0.277)
Credit to GDP (three lags)		-0.299 (0.317)		-0.155 (0.283)
Credit to GDP (four lags)		0.141 (0.203)		-0.071 (0.188)
Government debt to GDP			-0.347*** (0.073)	-0.231*** (0.084)
Government debt to GDP (one lag)			0.172* (0.100)	0.202** (0.098)
Government debt to GDP (two lags)			-0.139 (0.097)	-0.168* (0.099)
Government debt to GDP (three lags)			0.089 (0.101)	0.071 (0.109)
Government debt to GDP (four lags)			0.203** (0.089)	0.195* (0.097)
Adjusted R^2	0.751	0.770	0.829	0.844

Notes: Symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively. Robust standard errors are reported in parentheses. Constants are not reported.

Source: Authors' calculations.

Namely, they show that the GDP growth from the previous period positively and statistically significantly affects the current GDP growth rate with a magnitude from 0.731 to 1.140, implying that GDP growth at one lag is primarily driven by its value in the previous period

and the volatility is only a constraining factor. At two lags, the effect of the lagged values of GDP growth disappears and the impact of GDP volatility becomes more pronounced. With regards to the level of financial development as measured by the credit-to-GDP ratio, the estimated coefficients point out a negative impact, which means that the increased financial development already reflects the increased crediting in the economy and squeezes out the possibility for further growth driven by excess crediting.

Finally, the level of indebtedness as measured by the government do debt ratio negatively impacts GDP growth, which is a logical conclusion given that high debt ratios generally contain investment as a driving growth factor.

The estimated results from the ARDL model for price stability are presented in Table 4.

Table 5. Estimation results from the model for fiscal stability

Variable	Estimates with robust standard errors			
	(1)	(2)	(3)	(4)
GDP growth (one lag)	1.007*** (0.126)	0.982*** (0.128)	0.703*** (0.135)	0.750*** (0.146)
GDP growth (two lags)	-0.084 (0.182)	0.010 (0.189)	-0.046 (0.165)	0.043 (0.183)
GDP growth (three lags)	-0.307** (0.125)	-0.426*** (0.131)	-0.300** (0.113)	-0.366*** (0.125)
Budget balance volatility	-0.079 (0.075)	-0.096 (0.082)	-0.011 (0.060)	-0.059 (0.074)
Budget balance volatility (one lag)	0.072 (0.076)	0.084 (0.081)	0.024 (0.062)	-0.014 (0.076)
Budget balance volatility (two lags)	0.147* (0.077)	0.100 (0.076)	0.099 (0.062)	0.057 (0.067)
Credit to GDP		-0.705*** (0.226)		-0.550** (0.218)
Credit to GDP (one lag)		0.698** (0.318)		0.238 (0.298)
Credit to GDP (two lags)		0.156 (0.321)		0.361 (0.278)
Credit to GDP (three lags)		-0.436 (0.315)		-0.200 (0.280)
Credit to GDP (four lags)		0.185 (0.223)		-0.066 (0.201)
Government debt to GDP			-0.323*** (0.071)	-0.194** (0.087)
Government debt to GDP (one lag)			0.198** (0.097)	0.212** (0.100)
Government debt to GDP (two lags)			-0.176* (0.098)	-0.196* (0.098)
Government debt to GDP (three lags)			0.116 (0.101)	0.094 (0.109)
Government debt to GDP (four lags)			0.167** (0.083)	0.152* (0.089)
Adjusted R^2	0.724	0.766	0.834	0.843

Notes: Symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively. Robust standard errors are reported in parentheses. Constants are not reported.

Source: Authors' calculations.

The regression coefficients show that price stability has no statistically significant impact on GDP growth. These results are supported by the alternating signs of the estimated coefficients across equations, with only two of them showing a positive statistically significant effect at 10%. The positive coefficient contradicts the majority of the economic literature for other countries, but it is mostly caused by the low inflation change during the extended period of vulnerabilities in the 2010s. The impact of the lagged values of GDP growth in this specification are very similar to those for measuring output stability where the main difference are the weaker negative and statistically significant coefficients at three lags. The negative effects of financial intermediation and indebtedness are statistically significant with a similar magnitude as in the analysis of the output volatility.

The estimated results from the ARDL model for fiscal stability are presented in Table 5.

Table 6. Estimation results from the model for financial stability

Variable	Estimates with robust standard errors			
	(1)	(2)	(3)	(4)
GDP growth (one lag)	0.944*** (0.127)	0.999*** (0.126)	0.972*** (0.132)	0.979*** (0.132)
GDP growth (two lags)	-0.052 (0.179)	-0.103 (0.182)	-0.076 (0.188)	-0.078 (0.189)
GDP growth (three lags)	-0.288** (0.124)	-0.252* (0.127)	-0.290** (0.133)	-0.283** (0.133)
Capital adequacy ratio	-0.832* (0.464)			
Capital adequacy ratio (one lag)	0.618 (0.440)			
NPL ratio		-0.208 (0.492)		
NPL ratio (one lag)		0.197 (0.459)		
ROAA			-0.176 (0.522)	
ROAA (one lag)			0.403 (0.596)	
ROAA (two lags)			0.194 (0.579)	
ROAA (three lags)			0.110 (0.577)	
ROAA (four lags)			-0.156 (0.510)	
ROAE				-0.012 (0.058)
ROAE (one lag)				0.046 (0.067)
ROAE (two lags)				0.021 (0.066)
ROAE (three lags)				-0.029 (0.057)
Adjusted R^2	0.707	0.692	0.703	0.702

Notes: Symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively. Robust standard errors are reported in parentheses. Constants are not reported.

Source: Authors' calculations.

In a similar fashion to price stability, no impact has been found for fiscal stability either. Budget balance volatility has a sluggish negative impact on GDP growth at level, whereas the impact is positive with one and two lags, but the coefficients are statistically insignificant. The other results in the estimated equations confirm the previously obtained results. In that regard, the lagged GDP growth rates have a positive and statistically significant impact at one and three lags, while financial development and indebtedness negatively affect GDP growth.

The estimated results from the ARDL model for financial stability are presented in Table 6.

In the final specification regarding financial stability, we obtain negative and statistically significant coefficients only for the capital adequacy ratio at level, which amounts to -0.832 and indicates that every increase of the total capital to risk-weighted assets by one percentage point would slow down GDP growth by 0.832 percentage points. This means that the increased prudence by banks, reflected through the larger capital held, tends to restrict crediting and hamper GDP growth. As for the effect of the other financial variables, we establish a negative overall effect of the NPL ratio, ROAA and ROAE, but the estimated coefficients are all statistically insignificant. Finally, the results of the Granger causality and Wald tests indicate the causal relationship between output stability, financial stability and economic growth in the case of North Macedonia.

4. Conclusion

Macroeconomic stability is an important pre-condition for robust economic growth and positive future growth prospects. The investigation of the relationship between the two categories in the case of the Macedonian economy has resulted in several useful conclusions and policy recommendations.

Firstly, output volatility adversely affects GDP growth. This is largely due to the effect of the higher external vulnerabilities in the 2010s and it has led to an abrupt increase in volatility as GDP growth shrank reflected through low volatility amid episodes of suboptimal growth. Hence, the policy-makers in the country should create growth and development policies that will promote sustainable and long-run growth instead of focusing on delivering economic growth in the short run. Moreover, the results and conclusions about the negative relationship between growth volatility and economic growth indicate that the policymakers in the country should put more efforts during the economic crisis and stimulate the national economy by using fiscal policy.

Secondly, price volatility has no impact on GDP growth. This confirms the ambivalent relationship between inflation and economic growth. Moreover, it reflects the sharp changes in the inflation trajectory at the beginning and the end of the analyzed period at times with differing GDP growth rates. As a consequence of these results, it stands to reason to consider integrating price stability through different measures or investigating a potential non-linear relationship on economic growth, that is, estimating impact in one direction up to some saddle point and impact in an alternating direction above that point.

Thirdly, fiscal volatility has no effect on GDP growth. This result clearly shows that changes in fiscal policy fail to support economic activity, which, in the case of the Macedonian economy, is due to the increased government spending on current expenditures instead of boosting capital expenditures that have a higher fiscal multiplier. In fact, the lack of fiscal volatility indicates that the fiscal impulse in the Macedonian economy does not work because of the bad internal composition of the government revenues and expenditures that produce the budget balance.

Fourthly, the impact of financial stability on economic growth reveals that the overly prudent behaviour by banks hampers GDP growth. The prudence results from the effects of the global financial crisis and the subsequent regulatory changes that resulted afterwards. The larger capital adequacy ratio of banks restricts the crediting activities of banks, which in turn fails to support economic growth.

Our future research would probably include the use of a different methodological framework to capture the COVID-19 recession and the period of high inflation surge following Russia's invasion of Ukraine. This will include testing of different hypotheses, identification of other variables and testing of non-linear relationships. It is also challenging to develop a composite macroeconomic stability measure that will be related to economic growth.

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DRIVERS OF SHADOW BANKING SYSTEM: A PANEL EMPIRICAL APPROACH FOR DEVELOPED COUNTRIES³

In the current paper, we aim to examine the Shadow Banking System (SBS) in a number of developed countries, more precisely nine countries from Europe and the United States for the period 2002-2018. The goal is to define which are the key determinants that drive the SB processes. To this end, we run simple robust panel estimations. As a result of this analysis, we have reached a number of conclusions: 1/ the roles of banks, insurance companies and pension funds are important, 2/ changes in banking variables, such as the capital ratios, lead to an increase in shadow banking activity, 3/ there is a negative relation between banking interest margins and shadow banks, and 4/ developments on the stock market affect shadow banking positively. However, given the limitations in terms of data size and evolving definitions, our findings are not generalizable. Our main recommendation is to develop a more granular and reliable approach to improve the quality of empirical research and reduce the literature gap.

Keywords: Shadow Banking System; Robust panel estimations; macro-prudential policy.

JEL: C1; E5; G2

Introduction

At the G20 Summit 2011, the Financial Stability Board (FSB) was assigned to study a potential Shadow Banking regulation. It was charged with defining and monitoring risks that could threaten financial stability in order to avert systemic risks. The FSB therefore proposed a definition of Shadow Banks. However, since some countries were not satisfied with the initial definition, which was considered too general and therefore misleading, the FSB introduced new definitions: a broad one and a narrow one. These definitions are being regularly improved in order to more accurately measure the extent of non-banking funding. It is worth noting that throughout the years, there have been changes in Shadow Banking terminology. In fact, in 2019 the FSB completely ceased using the term “Shadow Banks” due

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to its negative connotation, replacing it with “non-bank financial intermediation” or “other financial intermediation”.

From a statistical point of view, SB is expanding, despite an initial decline following the subprime turmoil. From 2002 to 2020, total financial bank sector assets increased by 213%, while Other Financial Intermediaries (OFIs) increased by 967%. Such a trend is a subject of concern, since OFIs are not all regulated.

According to the FSB Report 2020, the Monitoring Universe of Non-Bank Financial Intermediation (MUNFI) rose to \$184.3 trillion in 2017. This was a 7% increase over 2016, which is rather insignificant. For OFIs, the growth rate has been the same. It reached \$116.6 trillion for the benchmark period.

These trends show that a transition is taking place between bank intermediation and non-bank intermediation. To ensure an optimal transition and avoid financial turbulence, the non-bank system must first of all become transparent. In addition, a good understanding of the SBS and its interlinkages with the monetary, banking and production spheres is absolutely necessary.

The scope definition of the SBS is at the heart of any study that hopes to analyze the development of non-bank intermediation. Several reports produced by the FSB have attempted to define the Shadow Banking (SB) notion and the risks related to this unregulated financing.

The FSB provides a harmonized database making comparisons between several countries possible. Note that the definition of the FSB is not universal and has continuously been upgraded. Therefore, the database may have been modified because of definition changes. To illustrate this, in 2013 the FSB tried to narrow the broad definition by removing entities without credit intermediation tasks or those that had already been consolidated into banks. Moreover, the recorded database shows several limitations. One of the most important limitations is the lack of available data and the extended time lapse between data points. Only annual data have been published on the website. These data run for the period 2002-2018 and only for some countries.

At present, two definitions of SB, the broad and the narrow one, are in use. The first one is a general definition based on this simple rule: Shadow Banks are all financial entities that act like banks but are less regulated than banks. The name used by the FSB to qualify these entities is “Other Financial Intermediaries (OFIs)”. OFIs comprise all financial institutions that are not classified as banks, insurance corporations, pension funds, public financial institutions, central banks, or financial auxiliaries. It can be considered as a conservative proxy or broad measure of shadow banking” (FSB, 2015). This definition does not really capture what the SBS is. Following discussions with several competent national authorities, the FSB introduced a narrow definition based on the occurrence of systemic risk and tied to the size of entities. Thus the narrow definition covers all non-bank entities assumed to be presenting a systemic risk for financial stability, as well as entities considered to be

systemically risky, i.e. according to the narrow definition shadow banking is the non-banking, per se banking activity, done by large, systemically important institutions only⁴.

Finally, to be exhaustive, the FSB reports also mention the Monitoring Universe of Non-Bank Financial Intermediation. This “is a measure of all non-bank financial intermediation, which is comprised of OFIs, insurance corporations and pension funds. It provides the starting point for authorities’ assessment of their non-bank financial entity types’ involvement in shadow banking” (FSB reports 2015-2022, Table A1, Appendices).

It is worth emphasizing the importance of accurately defining and measuring the SBS in order to correctly evaluate its size, its trend, and its perspectives. For this study, both definitions are used. However, for the empirical estimations, only the broad definition is taken into account (OFIs) because of the data availability for them from 2002 to 2018.

Applying this approach to the use of definitions, we go on to discuss the determinants of the SBS.

Several variables contribute to the growth of the SBS. Regulatory variables play an important role as supply-side drivers. Some macroeconomic variables affect the evolution of non-bank financial intermediation.

The academic literature dealing with SB drivers is not abundant despite their crucial importance.

Empirical studies are scarce for at least two reasons. Before the global financial crisis (GFC) of 2007-2008, the literature had little or no interest in SB activities. These activities were viewed as simply representing an alternative means of funding for investors. Today, the SBS has captured policymakers’ attention because developments showed that regulation of this alternative funding is insufficient. The second reason for the lack of sufficient studies is the scarcity of data. Despite the efforts of the FSB to produce a harmonized database, the lack of data remains a problem. The available data published by the FSB is annual and is still extremely recent, which could invalidate the results of empirical estimations. Robustness limits can appear and most of the time it may not be suitable to extrapolate general policies from the empirical estimations. To tackle the issue of limited data, panel analysis is an alternative to increasing the number of observations. After some preliminary tests, we have selected a number of key variables to be incorporated in the robust panel models. We chose a robust estimation model because of outliers.

Given the situation outlined above, this study raises the following thorny question: what are the drivers of the Shadow Banking System despite the complexity to assess this phenomenon?

The paper is structured as follows. Section 1 presents the definition of the SBS and its limits. Section 2 supplies a theoretical explanation of the drivers of the Shadow Banking System. Section 3 lays out empirical models related to the drivers of non-bank financing intermediaries for the panel sample. It also discusses the main results. Section 4 presents robustness tests. The last section concludes and suggests policy implications.

⁴ For more details, cf. <https://www.fsb.org/2017/05/global-shadow-banking-monitoring-report-2016>.

1. The Non-Banking System: Definitions, Risks, and Limitations

This section provides an overview of the Shadow Banking System. Broadly speaking, the SBS is a set of specialized financial entities that carry out liquidity credit transformations without public safety nets. The fact that they do not have government backstops makes them unstable and risky. Most SB activities have ties to regulated institutions such as banks and insurance companies. This interconnectedness with regulated companies can impact the real economy and provoke a systemic crisis. Here we attempt to capture the rapid evolution of the SBS in terms of both definitions and statistics. We then analyze the transmission channels between the regulated system and the “less” regulated (or completely unregulated) system. Finally, we show the limits of the SBS and recommend some guidelines for the future.

Since 2008, interest in the SBS has grown in worldwide financial institutions. There have been several attempts to define and measure the SBS but there is currently no consensus. The great challenge for the prudential authorities is to develop analytical instruments to measure and accurately define the SBS; it is not an easy one. Indeed, the most important task is to establish a harmonized and sufficiently flexible definition, yet one that is applicable to all countries. Of course, this is not simple because of the variety of business models for each SBS entity.

There are different ways to define the SBS. The most common way is to assume that SBS activities can be deduced exclusively from regulated activities. This kind of approach is based on binary reasoning. Intermediation activities are shadow banking, if they go beyond the scope of traditional banking activities. For instance, Pozar, Adrian, Ashcraft, and Boesky (2010) emphasize the idea of a systemic risk since SB activities are “inherently fragile” due to their lack of safety nets in case of financial turbulence. In addition, banks are tied to non-banking activities which can be part of shadow banking.

Over time, two different definitions for the SBS have emerged: the broad and the narrow approaches. The first one is older and deals with shadow banking activity as a residual concept. The paragraphs below present this definition. Later, we will explain the more limited definition. After 2009, the Financial Stability Board (FSB) began serious studies of SBS phenomena. Today the FSB is the main contributor to Shadow Banking studies.

1.1. OFIs and Shadow Banking: The broad definition

The Financial Stability Board was created to replace the Financial Stability Forum (FSF) in 2009. The FSB is based in Basel and its first Chair was Mario Draghi. The main purpose of the FSB is to build bridges between the work of national financial authorities and international standard-setting bodies (SSBs) at the international level in order to boost and promote the implementation of effective regulatory, supervisory, and other financial sector policies. The FSB is made up of the national bodies responsible for financial stability (24 countries) and jurisdictions (including the members of the G20). These bodies include international financial institutions, sector-specific international groupings of regulators and supervisors, and committees of central bank experts.

The aim of this nonprofit association under Swiss law is also to provide accurate information about the shadow banking system. Through workshops and discussions between all regulating actors, the FSB annually produces reports to explain the definitions, the size, and the scope of the SBS.

The broad definition is built on several national accounts according to ESA2010⁵ (the European System of Accounts). The national accounts have been used to evaluate the size of the shadow banking system. Table S123 analyzes all transactions related to Money Market Funds (MMFs). Financial institutions and governments use them to finance short-term operations⁶. Table S124 deals with operations in non-MMF investment funds. Table S125 reports the transactions of non-monetary financial intermediaries other than insurance corporations and pension funds (OFIs). Finally, table S127 covers captive financial institutions and moneylenders, excluding public units (which have been reported in Tables S125 and S127). Note that the equity investment funds are not considered SB since they do not participate primarily in the credit intermediation process. Moreover, most equity funds are held by banks and are therefore not considered to be sources of systemic risk. Banks use their central bank collateral in case of financial turbulence. This means that there is no transfer of risk outside the regulated system but it does not exclude the anti-selection risk.

This point coincides with the view of the ESRB (European Systemic Risk Board) joint ATC-ASC Expert Group on Shadow Banking (JEGS). That expert group emphasized the limits of the broad definition because of its lack of indicators for each entity. Analysis of off-balance sheets seems to be the cornerstone of a good approach to the SBS since it provides information on mitigation risks, for example.

These ESA tables are valid only for the European area. For the US area, a different accounting system is used. Several tables measure the SBS. From the Federal Reserve Flow of Funds, it is possible to extract tables L107 and L212 and to obtain a good view of SB activities (Adrian and Ashcraft, 2012; Adrian, Ashcraft, and Cetorelli, 2013).

The FSB provides some statistics on OFIs and other actors that participate in financing the economy. We use them to analyze the trend and the composition of the SBS in the Euro area and the US.

The first step is to rank the actors of financial intermediation. The following chart provides some interesting results. In terms of assets, banks and OFIs are the most important actors in the financial intermediary landscape.

Banks make up more than 40% and OFIs less than 30% of financial intermediaries.

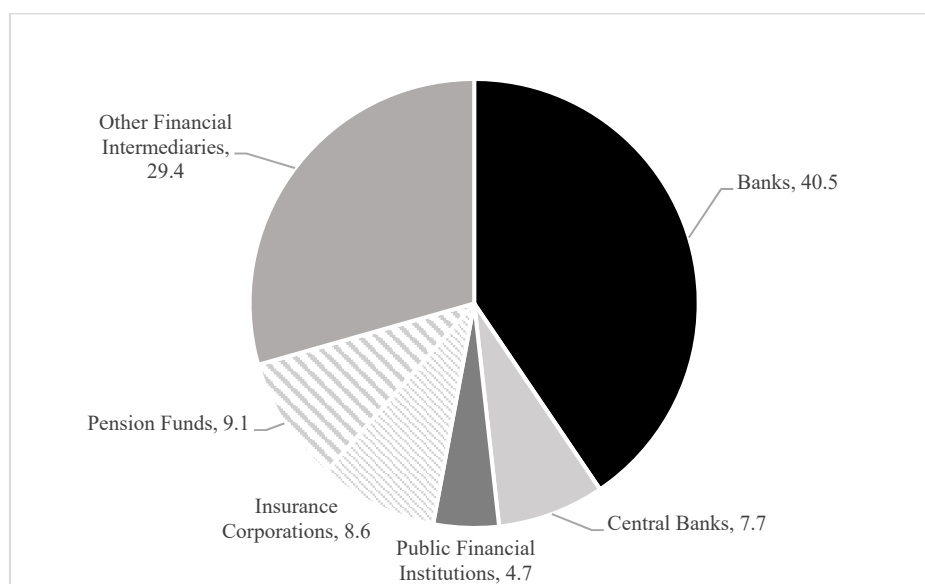
The role of the banks in this type of activity is quite normal since traditionally they finance economic development. We observe a growth in the share of both OFIs and banks. This testifies to the role of banks in SBS growth (cf. Figure 1). These features confirm the rise of

⁵ <https://ec.europa.eu/eurostat/documents/3859598/5925693/KS-02-13-269-EN.PDF/44cd9d01-bc64-40e5-bd40-d17df0c69334>.

⁶ <https://eur-lex.europa.eu/eli/reg/2017/1131/oj>.

the Originate-to-Distribute Model and the role of Banks in Financial Intermediation. This point is validated by the panel estimation run in sections 3 and 4.

Figure 1. Shares of financial intermediaries (% of total assets, 2016)



Source: FSB

1.2 OFIs and Shadow Banking: The narrow definition

This approach tends to monitor entities involved in liquidity/maturity transformation and/or leverage. Table 1 from the 2022 FSB report displays the different functions.

Table 1: Classification per Economic Function (EF)

EF	Definition	Typical entity types
EF1	Management of collective investment vehicles with features that make them susceptible to runs	MMFs, fixed income funds, mixed funds, credit hedge funds, real estate funds
EF2	Loan provision that is dependent on short-term funding	Finance companies, leasing/factoring companies, consumer credit companies
EF3	Intermediation of market activities that is dependent on short-term funding or on secured funding of client assets	Broker-dealers, securities finance companies
EF4	Facilitation of credit creation	Credit insurance companies, financial guarantors, monolines
EF5	Securitization-based credit intermediation and funding of financial entities	Securitization vehicles, structured finance vehicles, asset-backed securities

Note: “The FSB Policy Framework acknowledges that the narrow measure may take different forms across jurisdictions due to different legal and regulatory settings as well as the constant innovation and dynamic nature of the non-bank financial sector. It also enables authorities to capture new structures or innovations that may create financial stability risks from NBFIs, by looking through to their underlying economic functions and risks. Thus, the entity types listed should be taken as typical examples. For details, see FSB (2022)”

The increasing evolution and the size of the SBS raise some concerns. Financial sector interconnectedness is the most important problem related to non-banking activities. Moreover, it is worth noting that there are several levels (Banks, Cross borders and Insurance and pension funds) to analyze to deeply cover the SB scope.

1.3 Limitations

This last sub-section is devoted to limitations on measuring the scope of the SBS.

One of the most crucial limitations is data. Not all the variables have been recorded for various reasons. There is a need for granular data collection, but the cost of properly operating a national statistical organization, particularly for smaller countries, is not insignificant. Another limitation relates to legal frameworks. All countries are not authorized to provide granular data.

Currently, definitions of the SBS are not universally accepted. Often several rounds of discussion between the main interlocutors of the SBS are necessary in order to improve definitions that usually lead to new calculations or to more granular data collection. They can be confidential; disclosure is limited. Granular data also raise other problems. The most important concern is the heterogeneity of entities' business models. It is not always easy to have all the information about the building of complex financial products and to classify them, since there is a huge variety of financial packages. Finally, opacity is a trademark of this sector, making the work of statistical institutions more difficult. Thanks to the outstanding work of the FSB, there has been significant improvement. However, one of the problems for researchers is a lack of complete and high-frequency databases. It is impossible to study both the short-term and long-term processes with only annual variables covering short periods.

Building a good qualitative database takes time. There is also a lack of complete and high-frequency databases. This is a major problem for statistical practitioners since the choice to use different empirical methods is conditioned by the availability of variables according to their frequencies and time spans. In fact, it is impossible to study both short-term and long-term processes with only annual variables covering a short period. The number of observations determines which models can be used.

The study of interconnectedness is important. Putting together an indicator that takes into account the multifaceted nature of shadow banking is crucial, but in order to do that we need to understand the ins and outs of SBS development.

2. Empirical Survey of SB Drivers for Developed Countries

2.1 Usual Suspect Shadow Banking Drivers

The purpose of this section is to present the role of several variables in the development of the shadow banking system. Variables have been selected because they are assumed to affect the evolution of non-bank credit activities.

With the last financial crisis, the need to understand the origins and the development of the SBS grew in importance. Many empirical studies have looked at SBS determinants. Some of them have shed light on the banking system, others on stock markets. These studies contribute to a better understanding of key variables in SBS development. However, they often give only a partial view of the SBS. For example, the European SBS is frequently ignored.

Our key variables are macroeconomic, financial, monetary, and banking factors. The drivers of the SBS listed in Table 2 are not exhaustive. Only the most relevant variables “suspected” of affecting the SBS are described here. They are outlined in Table 1. SBS is multifaceted and relatively complex to deal with. It comprises a multitude of banking and financial operators interconnected via financial intermediation chains of varying lengths and with several degrees of sophistication. Credit intermediation also requires maturity and liquidity intermediation and the creation of leverage, all of which may raise the question of systemic risk. In addition, the SBS introduces the contagion risk notion, which may amplify systemic risk. Contagion risk is both sectoral (from banks to insurance companies, to stock markets, to industry) but also cross-border, via current account balance channels, for example. The sophistication of the assets makes the repo market more and more opaque. Finally, because of the lack of guarantees in case of failure, non-banking bank entities are compelled to rely on securities financing transactions (SFTs). SFTs are, roughly speaking, transactions that put up securities in order to borrow cash. They include sell/buy-back transaction lending activities and repurchase agreements (repos). Let us recall that repurchase agreements are recorded as collateralized deposits on the liability side of the balance sheet, whereas securities sold under such agreements remain on the balance sheet of the central bank. Repos are procyclical in the sense that they amplify credit growth rate in boom periods and exacerbate credit shrinkage in recession phases. The role of central banks in the development of the SBS is not neutral. The total reserves of the central banks are a good proxy for collateral. They are positively related to SB activities. In our case, the correlation coefficient between OFIs (assumed to measure the broad definition of the SBS) and the total reserves including gold is about 0.68.

Table 2 describes the main variables supposed to affect the evolution of the shadow banking system. Table 2 summarizes the variables selected for the panel estimation and describes the main mechanisms and channels that may distort SBS evolution. It also proposes a literature survey for each driver. The list of drivers is not exhaustive.

Table 2. Usual suspect SBS drivers and expected signs

Variables		Sources	Unit	Theoretical and empirical Survey	Expected signs
OFIs	Dependent variable	FBS	% GDP	Pozsar, Adrian, Ashcraft, and Boesky (2010) have done important studies on the characteristics of the shadow banking system. They explained in detail the transformation channels of loans into marketable securities. Soon afterwards, the FSB developed metrics and tools to measure SBS size and started publishing an annual report to monitor the evolution of SB and its main trends. Today the FSB is a reliable provider of databases and most of the recent empirical studies use its time series relative to SBS to analyze the SBS.	

Variables		Sources	Unit	Theoretical and empirical Survey	Expected signs
Lagged dependent variables (t-1 to 2)	Independent variable	FSB		The value of lagged dependent variables affects positively the evolution of SB. The OFI process is autoregressive. This means that the process has a memory.	+
Banks	Independent variable	FBS	% GDP	The linkage between the banking system and shadow banking is obvious. The collapse of huge banks such as Lehman Brothers, followed by the massive bailout of AIG during the crisis, are perfect illustrations (FSB reports since 2015). Shadow banking is correlated to the traditional banking system. Moreover, several studies (Noeth and Sengupta 2011; Pozsar et al 2013; Ceterelli et al.2014a; Ceterelli and Goldberg 2014b; Acemoglu et al, 2015; Unger 2016; Abad et al2017; and Martinez-Miera and Repullo 2019) show how the banking system and the SBS are interconnected.	+
Pension Funds	Independent variable	FSB	% GDP	Pension funds and stock markets are interrelated. With the increase in life expectancy, securitization is growing and this trend feeds the shadow banking system (Ordóñez and Piguillemz 2021; FSB since 2015).	+
Insurance	Independent variable	FSB	% GDP	As pension funds, insurance companies tend to develop shadow banking (Brooks et al.2012; Singh and Aitken 2010; Noeth and Sengupta 2011; Pozsar et al 2013; Aramonte et al 2015; Paces and Nabilou 2017; FSB reports since 2015).	+
Log(GDP per capita)	Independent variable	World Bank		The most important macroeconomic variable is GDP because it is the most used and evaluated in economic studies. Furthermore, it is obvious that GDP growth boosts the development of non-bank financial intermediation. We must bear in mind that the SBS is a component of financial innovation. Some studies demonstrate that above a certain threshold of financial development, there is a negative link between GDP and financial intermediation development (Acharya et al, 2011; Aghion et al 2010; Demirgüç-Kunt et al 2013; Arcand et al 2015, FSB report 2019). The uncontrolled development of SBS can create a systemic crisis (Goodspeed, 2011; Battiston et al 2012; Adrian, 2014; Shekhar et al. 2015; Langfield and Pagano 2016. Tasca et al. 2017).	+
Public debts	Independent variable	SDW ECB	% GDP	For public debt, the link is obvious because of the non-banking practices of securitization (Munteanu, 2010; Pakravan, 2011; Pozsar, 2008).	+
Current account balances	Independent variable	SDW ECB	% GDP	A negative current account is associated with a high level of shadow banking. For example, in many advanced economies with current account deficits, including the United States, shadow banking is quite developed. European banks also play a role in the SBS. Their off-balance sheet conduits and SIVs, and their asset management operations have been alternative sources for financing the U.S. deficit. The most famous case	+/-

Goldman, S., Zhelyazkova, V. (2023). *Drivers of Shadow Banking System: A Panel Empirical Approach for Developed Countries.*

Variables		Sources	Unit	Theoretical and empirical Survey	Expected signs
				is the German Landesbank case (Pozsar et al 2010).	
Total reserves	Independent variable	World Bank	% GDP	Total reserves may be a component of shadow banking since they seem to be good collateral. Collateral is necessary to ensure the intermediation between savers and borrowers. The use of collateral rose substantially after the last financial crisis, which may have “enhanced” SB activities. Repo is an illustration.	+
Bank net interest margin	Independent variable	SDW ECB	% Total income	The link between bank interest margins and OFIs is negative. Bank interest margins area kind of measure of the efficiency of financial intermediation (Saunders and Schumacher 2000; Arnold and van Ewijk 2014). This means that when the banking system deteriorates, alternative funding appears, particularly from SB finance.	-
Bankcapital ratio	Independent variable	World Bank	% Total assets	Increasing bank reserve requirements may result in boosting non-regulated financial activity. During the bank prudential regulation periods, banks find alternative solutions to finance economic growth (Fahri and Tirole 2017; Martinez-Miera and Repullo 2019) Plantin (2015) develops the idea that increasing capital regulation has driven the explosion of shadow banking activities. Gebauer and Mazelis (2018) find thanks to the DGSE model that tighter capital requirements on banks increase shadow bank intermediation activities. This result gives weight to the idea of a positive link between the bank capital ratio and the SBS.	+
Non-Performing loans	Independent variable	World Bank	% Total gross loans	“Bad debts are associated with companies experiencing serious financial difficulties” (Taseva, 2019).The stock of non-performing loans (NPLs) of banks leads to increasing lending rates on new loans. NPLs have been used to build financial diversified and complex instruments to alleviate regulatory burdens, such as non-performing loan provisions. These two facts contribute to the expansion of the shadow banking system (Ehlers et al 2018; Zhuang 2018, Zhu, 2021). Finally, NPLs maybe a relatively good proxy of credit quality. “After the credit crisis, securitization was blamed for allowing the ‘hot potato’ of bad loans to be passed to unsuspecting investors” (Shin, 2009).	+
Domestic credit provided by financial sector	Independent variable	World Bank	% GDP	During domestic credit booms, non-bank credit channels become more and more visible in the funding landscape, as the experience with the shadow banking system in the United States and in Europe testifies to (Mian and Sufi, 2009; Keys, Mukherjee, Seru, and Vig,2010; Borio and Disyatat, 2011;; Duca 2014; Jakab and Kumhof, 2015; Unger, 2016).	+

Variables		Sources	Unit	Theoretical and empirical Survey	Expected signs
				Moreover, direct cross-border (“offshore”) lending to non-banks and the cross-border components channeled by resident banks increase dramatically in the US and Europe during the credit boom phases. The best illustration of this is Ireland. According to the BIS, “cross-border claims on non-banks and net cross-border borrowing by banks accounted for more than half of total bank credit to non-banks in the country in 2008”.(BIS, 2011) ⁷ Credit booms tend to develop leverage and can lead to financial and systemic crises.	
Short-term interest Long-term interest	Independent variable	SDW ECB	%	For long-term and short-term interest rates, the link with SB activity is negative. Theory suggests that a decrease in interest rates has a positive impact on the banking sector. According to theory, monetary easing fosters increased loans since their cost is thus lowered. According to Beck and Kotz (2016), the low-interest rate environment also contributes to the expansion of the SBS.	-
Spread	Independent variable	SDW ECB	%	The spread is assumed to have a positive impact on SB development. This relationship indicates a search for higher yields (Chrétien and Lyonnet 2016).	+
Stock markets	Independent variable	World Bank	% GDP	The link between stock markets and the shadow banking system is positive. Sophisticated and complex financial products are traded on markets. The stock market is related to the SBS via the security channels (Ghosh et al, 2012; Gordon and Metrick 2012; Gorton 2007-2008; Acharya and Öncü 2013; Duca 2014; FSB report 2018).	+
Financial development	Independent variable	IMF	Index	The development of financial innovations boosts shadow banking activities. Duca (2014) notes that financial innovation contributed to developing the shadow banking system.	+
Banking crisis dummy	Independent variable	World Bank	Binary variable	Currently, we observe a significant change towards more simplicity and transparency for the intermediation of non-bank credit activities. We are far from the opaque nature of shadow banking during the pre-crisis period. Since the financial crisis, several measures have been taken to limit the development of shadow banking. The financial authorities require more and more details from complex business plans. This may explain the negative link between SB and the financial crisis. (Diamond and Dybvig 1983; Shin 2009).	+/-

Source: Authors.

⁷ <https://www.bis.org/publ/arpdf/ar2011e3.pdf>.

Undoubtedly, the importance of the shadow banking system cannot be underestimated, since it is systemically risky. To fully understand the phenomenon, it is crucial to evaluate the role of some relevant variables in the development of SB. Understanding the mechanisms of shadow banking and the interactions with other variables requires analytical models and tools. The first challenge in doing so is to present panel estimations with several variables assumed to theoretically affect the SBS. Most of the choices of the variables and countries are based on their role in the development of non-banking activities.

The (10) selected countries are: Belgium (BE), Germany (DE), Spain (SP), France (FR), United Kingdom (UK), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), and the United States (US). They have been chosen as they represent an important part of the developed financial markets and for this reason, the trends observable in them hold validity. The period which has been researched and analyzed starts in 2002 and ends in 2018. The number of observations is 170.

The variables selected, their definitions, and their sources are summarized in Table A2 in Appendices.

We explain below the determinants of shadow banking by means of empirical panel tests.

As emphasized by the traditional literature, the links between OFIs/GDP and other variables are not obvious, but some basic statistical tools suggest interesting directions for research. To keep the length of this article within reason, we will not report all the pre-tests used to select the signs of the variables, only the scatter plots that are reproduced in the Appendices (Figure A1 Scatter plots OFIs and Drivers).

Before running the estimation models, we first analyze the panel unit root results to verify the stationarity of all series. We choose the maximum lag length based on the Schwartz Information Criterion. The different methods are those traditionally used for panel stationary tests. Levin, Lin & Chu tests (LLC) assume a common unit root process where the Im, Pesaran and Shin test (IPS), ADF test and PP test assume individual unit root processes. All non-stationary variables are filtered. Table A3 in the Appendices reports all the results.

2.2 Empirical Model Presentation

Drivers cited in the previous section have been largely analyzed by the theoretical literature but seldom by econometric literature. The list of determinants is not exhaustive but it is sufficiently relevant to fit our first goal, namely describing the impact of variables on the expansion of non-banking finance. However, only a few empirical studies attempt to empirically explain the role of SB drivers. This lack of econometric analysis is likely related to the lack of qualitative and harmonized databases for countries and the limited time spans for the data that does exist. This paper intends to help fill this gap.

When the number of observations is low, it is delicate to interpret empirical results. This is the case for shadow banking given that researchers have only recently begun studying it. That is why it is helpful to use both panel and pool model estimations in order to highlight the role of various macro and micro economic variables and the place of each country in the development of the SBS.

For decades, the panel data approach has been very popular with the development of quantitative studies. It makes it possible to simultaneously analyze individual and time effects. It also provides information on model endogeneity and independent regressors. There are two kinds of panels: the static panel and the dynamic panel. Note that it is possible to use a panel approach and/or a pooled approach. Without going into too much detail, it may be said that these two approaches are complementary and provide different information. Panel analysis is more flexible in terms of methodology, which is not the case with pooling regressions. However, the pooling optic provides a detailed analysis of the importance of various cross-sections. When studying phenomena among countries/regions/cities, etc., and need to obtain a precise picture of the role of each country according to the selected variable, it is preferable to choose a pooled cross-section. In this section, we use both approaches to explain several results – general results (panel) and specific results (pooling).

We have begun this sub-section with the traditional panel approach.

With time, we observe that the number of time dimensions increases, but not necessarily the number of individuals. This point is sensitive since some panel tools are not always suitable to use in the case of long panels ($T > N$). Indeed, we observe several limitations on the use of the most famous tools, namely Arellano and Bond estimators. For $T > N$, a country's fixed effect shock will decrease with time and the lagged dependent variable will likely not be significant. Therefore, the Arellano-Bond estimator is not robust. When $T > N$ the over-identification risk is high (Ruiz-Porras, 2012).

Numerous empirical analyses use long panel databases to understand the effects of key factors on another variable, but most of the methodologies are valid for $N > T$.

For the static approach, we first used an OLS panel model. However, we have seen that least squares methods are not appropriate for this kind of database. Results are biased because of the presence of outliers. To tackle this problem, we run a static robust model. This class of estimators can be interpreted as a generalization of maximum-likelihood estimation. Due to space concerns, we will not report all the specifications tested. Only the most relevant specifications are displayed in Table 3.

Ordinary Least-Squares (OLS) has been the most used approach in analysis tools to explore drivers of phenomena. We traditionally assume that there are linear relations between variables and write the following linear regression:

$$y_i = x_i^T \beta + \varepsilon_i, i = 1, \dots, n \quad (1)$$

(x_i, y_i) is the independent and identically distributed (*iid*) vector and $E(\varepsilon_i | x_i) = 0$. β is a $p \times 1$ vector which minimize the sum of squared residuals.

$$\sum_1^n (y_i - x_i^T \beta)^2 \quad (2)$$

However, since years we have admitted that the OLS estimators are sensitive to outliers, even a unique outlier can be sufficient to distort estimations. By outliers, we mean an observation, which is not consistent with another set of data. Several works try to provide more detailed definitions (Krasker, 1980; Krasker et al. (1985); Hampel et al. (1986); Rousseeuw and Leroy

(1987); Judge et al. (1988)). Nowadays, we have a topology of outliers. Concisely, two types of errors appear: gross errors and outliers related to model failure.

In this paper, we choose to use a robust method to tackle the problem of outliers. Instead of using (2) we introduce the following optimization:

$$\beta^e = \arg \min_{\beta} \sum_1^n \rho \left(\frac{y_i - x_i^T \beta}{\sigma^e} \right) \quad (3)$$

With $\rho(\cdot)$ is assimilated to a robust loss function and σ^e is an estimated error scale. Commonly, the Huber's function is used for estimations. To run our models, we utilize E-views software.

We estimate the following equation (1) with several independent variables:

$$y_{it} = \sum_{i=1}^2 \alpha_{i,t} y_{i,t-i} + x_{i,t}^T \beta + dum_{i,t}^T \pi + \varepsilon_{i,t} \quad (4)$$

$y_{i,t}$ is the share of OFIs in relation to GDP (lhs)

$x_{i,t}^T$ is the explicative variable (rhs)

$dum_{i,t}$ is a binary variable assumed to materialize the crisis effect

$\varepsilon_{i,t}$ random errors

Table 3 provides estimation results according to different specifications.

The interpretation of the results is not obvious and the description of the interlinkage is of course partial and limited. Interlinkages could be complementary or show a certain degree of substitution, then, from this simple approach, it is delicate to measure in an accurate manner the relationship between the variables. For most of the specifications, the variable coefficients are significant and have the expected signs. The estimated results show that the bank-to-GDP variable has a big impact on the development of shadow banking. A 1% increase in the bank-to-GDP ratio leads to a 0.58–0.76% increase in OFI to GDP. Whatever the specification, the bank variable affects positively the development of SB.

For pension funds and insurance assets related to GDP, we have found interesting results. The insurance variable affects weakly and positively the OFI variable (from 0.02 to 0.07), whereas the impact of the pension funds variable is relatively more important (from 0.12 to 0.19). For instance, a 1% increase in the pension funds variable leads to a 0.15% increase (on average) in the OFI variable. As expected, the GDP per capita has a positive impact on the development of non-banking activity (from 0.26 to 0.35). This means that GDP growth involves the need for funding via non-banking activity.

Table 3. Estimation results

OFI/GDP (dependent variable)	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.02*** (0.00)	0.03*** (0.00)	0.05*** (0.00)	0.03*** (0.00)	0.04*** (0.07)
Bank/GDP	0.58*** (0.00)	0.76*** (0.00)	0.68*** (0.00)	0.71*** (0.00)	0.76*** (0.00)
Insurance/GDP	0.07*** (0.00)	0.03*** (0.00)	0.04*** (0.00)	0.02*** (0.23)	0.03*** (0.00)
Pension fund/GDP	0.19*** (0.00)	0.15*** (0.00)	0.12*** (0.00)	0.14*** (0.00)	0.15*** (0.00)
Spread		0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
Long-term interest		-0.01*** (0.00)		-0.02*** (0.00)	-0.01*** (0.00)
Short-term interest			-0.003*** (0.00)		
Per capita GDP		0.28*** (0.00)	0.20*** (0.00)	0.35*** (0.00)	0.34*** (0.00)
Public debts/GDP		-0.07*** (0.00)	-0.10*** (0.00)	-0.05*** (0.00)	-0.06*** (0.00)
Current account balances/GDP		0.01*** (0.00)	0.01*** (0.00)		0.01*** (0.00)
Total reserves/GDP				0.001 (0.57)	
Bank interest margin ratio		-0.02*** (0.00)	-0.02*** (0.00)	-0.02*** (0.00)	-0.02*** (0.00)
Bank capital ratio		0.18*** (0.00)	0.13*** (0.00)	0.15*** (0.00)	0.18*** (0.00)
Non-performing loans ratio		0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
Credit/GDP		-0.10*** (0.00)	-0.10*** (0.00)	-0.9*** (0.00)	-0.10*** (0.00)
Stock Market/GDP			0.06*** (0.00)	0.06*** (0.00)	
Financial development					0.07*** (0.00)
OFI/GDP lag=1	0.19*** (0.00)	0.09*** (0.00)	0.10*** (0.00)	0.09*** (0.01)	0.10*** (0.00)
OFI/GDP lag=2	0.09*** (0.00)	0.09*** (0.00)	0.10*** (0.00)	0.12*** (0.00)	0.10*** (0.00)
Crisis dummy		-0.01*** (0.00)	-0.004*** (0.00)	-0.003 (0.12)	-0.01*** (0.00)
Number of observations	126	126	126	126	126
Sample adjusted	2005-2018	2005-2018	2005-2018	2005-2018	2005-2018
Number of countries	10	10	10	10	10
Diagnostic Residuals (Autocorrelation/Partial Correlation)	MA(1)	MA(1)	MA(1)	MA(1)	MA(1)

Source : Authors

The role of interest rates is relatively weak but all the coefficients are significant. Both long interest rate (or short interest rate) and spread have the expected signs. For the banking variables such as interest margin and capital ratio, the signs are in line with the empirical

literature. The banking capital ratio tends to favor non-banking activity. A tightening of capital requirements has two effects. The first is to reduce the risk of loans to regulated institutions going bad, but loans granted from the non-regulated system increase and may raise the risk to the financial system since they have a lower (or no) capital requirement. According to estimations, a 1% increase in capital ratios leads to a 0.15-0.18% increase in OFIs. This point emphasizes the fact that forcing greater capital requirements on banks leads to the appearance of non-regulated financial innovations.

The current account balances affect positively the development of nonbanking activity. Unfortunately, for the total reserves reported to GDP, the coefficient is not significant.

For the credit variable, the sign is negative and significant. This result can be explained by the presence of the bank's total assets. They likely annihilate the role of the credit variable. For the non-performing loans, the sign is significant and positive as expected.

The stock market and the financial development (all entities except for the market, i.e. bank insurance, etc.) affect positively the non-banking funding. This result is not surprising.

For the lagged OFI variables, they are positive and significant. This signifies that the other financial intermediaries have memory. Hence, they depend on their past levels.

The dummy variable assumed to materialize the financial crisis has a negative impact. The coefficient is negative, significant and weak. This result may show that after the financial crisis, the size of SBS evolved sluggishly. According to the ESRB 2018 report, “the EU (EA) shadow banking system stood at €42.3 (€33.8) trillion at the end of 2017 compared with €42.3 (€33.4) trillion at the end of 2016”.⁸

4. Robustness

To be complete, we present in this section several estimations to verify the specifications' robustness. We propose to re-estimate the model 1 to 5 with a restrictive sample. Indeed, this time we exclude Luxembourg and the US because of their role in the development of non-banking activities. These exclusions reduce drastically the number of observations and may provide weaker interpretative results. However, some results persist.

Whatever the specification, the banking originate-distribution model dominates. These results reinforce the interlinkage of the banking system and the non-banking system. We have to underline the role of pension fund and the stock market in the non-banking activities booms.

⁸https://www.esrb.europa.eu/pub/pdf/reports/esrb.report180910_shadow_banking.en.pdf

Table 4. Estimation results without Luxembourg and the US

OFI/GDP (dependent variable)	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.02*** (0.00)	0.01 (0.34)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
Bank/GDP	0.62*** (0.00)	0.67*** (0.00)	0.46*** (0.00)	0.43*** (0.00)	0.68*** (0.00)
Insurance/GDP	0.05*** (0.00)	0.08 (0.15)	0.13*** (0.00)	0.12*** (0.00)	0.07*** (0.00)
Pension fund/GDP	0.27*** (0.00)	0.17** (0.02)	0.03*** (0.00)	0.05*** (0.00)	0.12*** (0.00)
Spread		-0.001 (0.21)	-0.001* (0.07)	-0.001*** (0.00)	-0.001*** (0.00)
Long-term interest		-0.003 (0.83)		0.004 (0.15)	-0.01*** (0.00)
Short-term interest			-0.003*** (0.01)		
Per capita GDP		0.13 (0.67)	-0.17 (0.37)	-0.15*** (0.00)	0.14*** (0.00)
Public debts/GDP		-0.18* (0.08)	-0.54*** (0.00)	-0.56*** (0.00)	-0.19*** (0.00)
Current account balances/GDP		0.01** (0.04)	0.01*** (0.00)		0.01*** (0.00)
Total reserves/GDP				0.04*** (0.00)	
Bank interest margin ratio		0.14*** (0.00)	0.07*** (0.00)	0.07*** (0.00)	0.15*** (0.00)
Bank capital ratio		0.21*** (0.00)	0.11*** (0.01)	0.09*** (0.00)	0.23*** (0.00)
Non-performing loans ratio		0.07*** (0.1)	0.08*** (0.00)	0.08*** (0.00)	0.06*** (0.00)
Credit/GDP		-0.26*** (0.00)	-0.13*** (0.01)	-0.12*** (0.00)	-0.26*** (0.00)
Stock Market/GDP			0.19*** (0.00)	0.20*** (0.00)	
Financial development					0.47*** (0.00)
OFI/GDP lag=1	-0.01*** (0.00)	-0.03 (0.56)	-0.02 (0.50)	-0.02*** (0.01)	-0.02*** (0.00)
OFI/GDP lag=2	0.03*** (0.00)	-0.08* (0.07)	-0.04 (0.33)	-0.001 (0.91)	-0.11*** (0.00)
Crisis dummy		0.01 (0.27)	0.04*** (0.00)	0.04*** (0.00)	0.02*** (0.00)
Number of observations	75	63	53	53	62
Sample adjusted	2006-2016	2006-2016	2006-2016	2006-2016	2006-2016
Number of countries	8	8	8	8	8
Diagnostic Residuals (Autocorrelation/Partial Correlation)	MA(1)	MA(1)	MA(1)	MA(1)	MA(1)

Source: Authors

5. Concluding remarks and policy implications

According to our panel and pooled estimations, a number of salient and common conclusions emerge. Whatever the specification, the Banks/GDP variable has a huge impact on the

development of SB. This means that banks dominate SB financing of the economy and validate the banking originate-distribution model assumptions. This point highlights the importance of monitoring the banking system. As for pension funds and insurance companies over GDP, the estimation results are more or less uneven. However, we cannot exclude their positive impact on the development of the SBS.

The introduction of non-performing loans (NPL) in the different specifications shows that this variable has a positive impact on the development of the SB. This is not surprising since NPLs are often incorporated in sophisticated financial products, such as special purpose vehicles. For the credit variable, there is no consensual result. In general, the coefficient is not significant or does not have the expected sign. The bank capital ratio and bank interest margin variables seem to impact the development of the SBS. The bank capital ratio compels banks to find solutions to avoid this capital constraint.

Despite these interesting results, we have to point out the limitations of our estimations. Leaving aside the database and definition limits, we would like to insist on the necessity of improving the quality and the harmonization of the existing and future database. Until now, the scalable definition of the Shadow bank (then a non-banking system) is based on a residual approach. OFIs are a kind of black box that measures our ignorance.

Finally, this paper is only the first step in analyzing the role of several variables in the development of the SBS. This topic is crucial to understanding the SBS. The non-banking system raises several questions barely touched on by our paper, namely the lack of transparency and regulation. The number of regulatory variables is not sufficient and the results cannot be generalized.

The most important policy recommendation is to develop more and more qualitative granular data and fix the definition issues to facilitate a reduction in the literature gap which will allow for a better understanding of SB and the design of the proper system for its management

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APPENDICES

Table A1. Key terms Used by the FSB

-	MUNFI (or Monitoring Universe of Non-bank Financial Intermediation, also referred to as non-bank financial intermediation) is a measure of all non-bank financial intermediation, comprising insurance corporations, pension funds, other financial intermediaries (OFIs) and financial auxiliaries.
-	OFIs comprise all financial institutions that are not central banks, banks, insurance corporations, pension funds, public financial institutions, or financial auxiliaries.
-	Narrow measure of shadow banking (or the “narrow measure”) includes non-bank financial entity types that authorities have assessed as being involved in credit intermediation that may pose financial stability risks, based on the FSB’s methodology and classification guidance

Source: p.2 *Global Shadow Banking Monitoring Report 2017, FSB March 2018.*

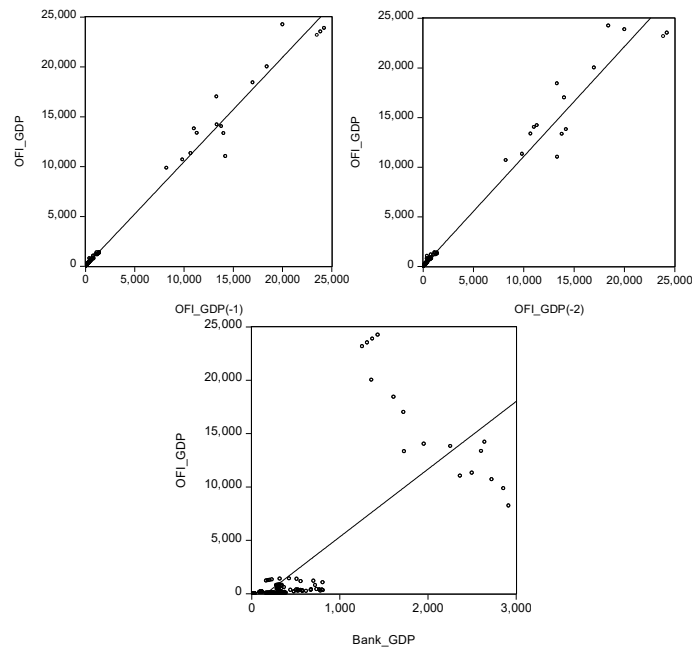
Table A2. Definitions variables and Sources

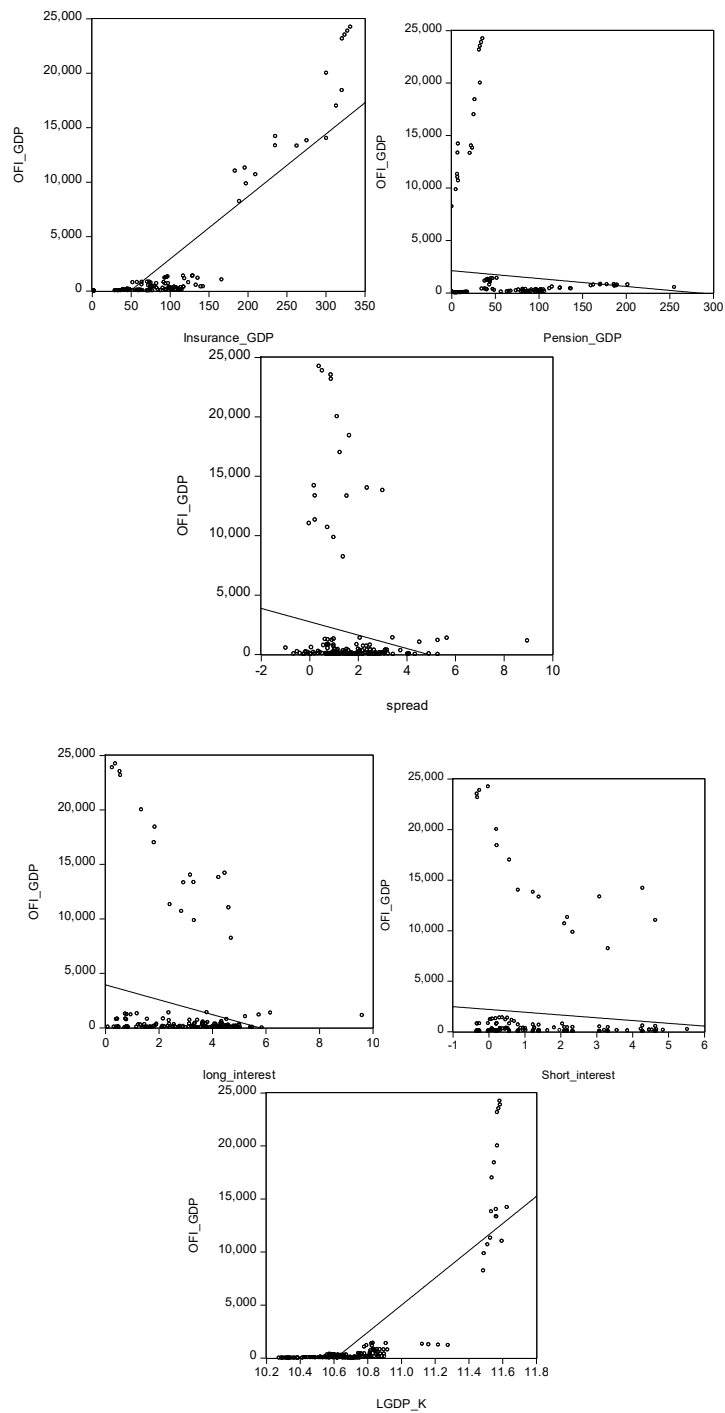
Variables	ID Codes	Definitions
OFI/GDP	NA /FSB	OFI - Other Financial Intermediaries OFI statistics currently contain selected balance sheet items for financial corporations engaged in lending to households and non-financial corporations (FCLs). FCLs resident in the euro area, which is a sub-sector of “Other financial intermediaries, except insurance corporations and pension funds” (OFIs), S.125, in the European System of Accounts 2010 (ESA 2010).
banks/GDP	NA/FSB	Assets of banks. Banks is defined as all deposit-taking Corporations
Insurance/GDP	NA/FSB	Assets of insurance corporations
Pension funds/GDP	NA/FSB	Assets of pension funds
Spread	FR.INR.LNDP	Interest rate spread is the interest rate charged by banks on loans to private sector customers minus the interest rate paid by commercial or similar banks for demand, time, or savings deposits. The terms and conditions attached to these rates differ by country, however, limiting their comparability
Short Interest rate	OECD (2019), Short-term interest rates (indicator). doi: 10.1787/2cc37d77-en (Accessed on 05 July 2019)	Short-term interest rates are the rates at which short-term borrowings are effected between financial institutions or the rate at which short-term government paper is issued or traded in the market. Short-term interest rates are generally averages of daily rates, measured as a percentage. Short-term interest rates are based on three-month money market rates where available

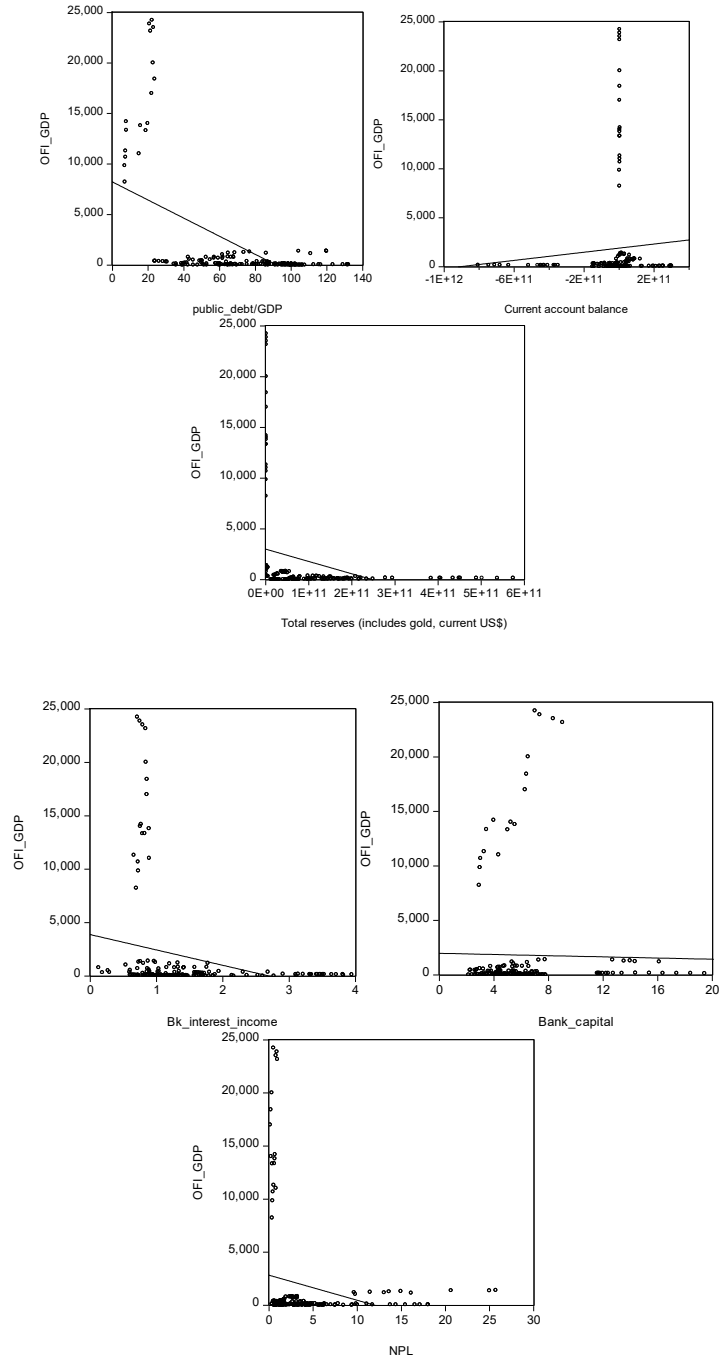
Variables	ID Codes	Definitions
Long term interest	OECD (2019), Long-term interest rates (indicator). doi: 10.1787/662d712c-en (Accessed on 05 July 2019)	Long-term interest rates refer to government bonds maturing in ten years. Rates are mainly determined by the price charged by the lender, the risk from the borrower and the fall in the capital value. Long-term interest rates are generally averages of daily rates, measured as a percentage. These interest rates are implied by the prices at which the government bonds are traded on financial markets, not the interest rates at which the loans were issued. In all cases, they refer to bonds whose capital repayment is guaranteed by governments. Long-term interest rates are one of the determinants of business investment.
GDP per capita	NY.GDP.PCAP.KD	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources
Public Debts/GDP	GFS.Q.N.COUNTRY.W0.S13.S1.C.L.LE.GD.T.Z.XDC_R_B1GQ_CY.T.F.V.N.T FRED	Closing balance sheet/Positions/Stocks - Maastricht debt - Liabilities (Net Incurrence of) - maturity: All original maturities - counterpart area: World (all entities, including reference area, including IO), counterpart sector: Total economy - Consolidated, Current prices, Face value - Domestic currency (incl. conversion to current currency made using a fixed parity); ratio to the annual moving sum of gross domestic product, Neither seasonally adjusted nor calendar adjusted - ESA 2010 (Government Finance Statistics)
Current account balances	BP6.Q.N.COUNTRY.W1.S1.S1.T.B.CA.Z.Z.Z.EUR.T.X.N FRED	Quarterly- Neither seasonally adjusted nor calendar adjusted data- Country vis-a-vis Rest of the World- sector: Total economy vis-a-vis Total economy- Transactions- Balance (Credits minus Debits)- Current account- Euro- All currencies- Compilation methodology based on international standards (Balance of Payments and International Investment Position (BPM6))
Total reserves	FI.RES.TOTL.CD	Total reserves comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities. The gold component of these reserves is valued at year-end (December 31) London prices. Data are in current U.S. dollars.
Non Performing Loans	FB.AST.NPER.ZS	Bank nonperforming loans to total gross loans are the value of nonperforming loans divided by the total value of the loan portfolio (including nonperforming loans before the deduction of specific loan-loss provisions). The loan amount recorded as nonperforming should be the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue.
Market capitalization	CM.MKT.LCAP.GD.ZS	Market capitalization (also known as market value) is the share price times the number of shares outstanding (including their several classes) for listed domestic companies. Investment funds, unit trusts, and companies whose only business goal is to hold shares of other listed companies are excluded. Data are end of year values.
Credits	FS.AST.DOMS.GD.ZS	Domestic credit provided by the financial sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The financial sector includes monetary authorities and deposit money banks, as well as other financial corporations where data are available (including corporations that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other financial corporations are finance and leasing companies, money lenders, insurance corporations, pension funds, and foreign exchange companies.

Variables	ID Codes	Definitions
Bank capital ratio	FB.BNK.CAPA.ZS	Bank capital to assets is the ratio of bank capital and reserves to total assets. Capital and reserves include funds contributed by owners, retained earnings, general and special reserves, provisions, and valuation adjustments. Capital includes tier 1 capital (paid-up shares and common stock), which is a common feature in all countries' banking systems, and total regulatory capital, which includes several specified types of subordinated debt instruments that need not be repaid if the funds are required to maintain minimum capital levels (these comprise tier 2 and tier 3 capital). Total assets include all nonfinancial and financial assets
Bank net interest margin	GFDD.EI.01	Raw data are from Bankscope. $\text{Data2080}[t] / ((\text{data2010}[t] + \text{data2010}[t-1])/2)$. Numerator and denominator are aggregated on the country level before division. Note that banks used in the calculation might differ between indicators. Calculated from underlying bank-by-bank unconsolidated data from Bankscope.
Financial development index	FD_FD_IX	The financial development index is constructed using a standard three-step approach found in the literature on reducing multidimensional data into one summary index: (i) normalization of variables; (ii) aggregation of normalized variables into the sub-indices representing a particular functional dimension; and (iii) aggregation of the sub-indices into the final index. This procedure follows the OECD Handbook on Constructing Composite Indicators (OECD, 2008), which is a good reference for methodological suggestions.

Figure A1. Scatter plots OFIs and drivers







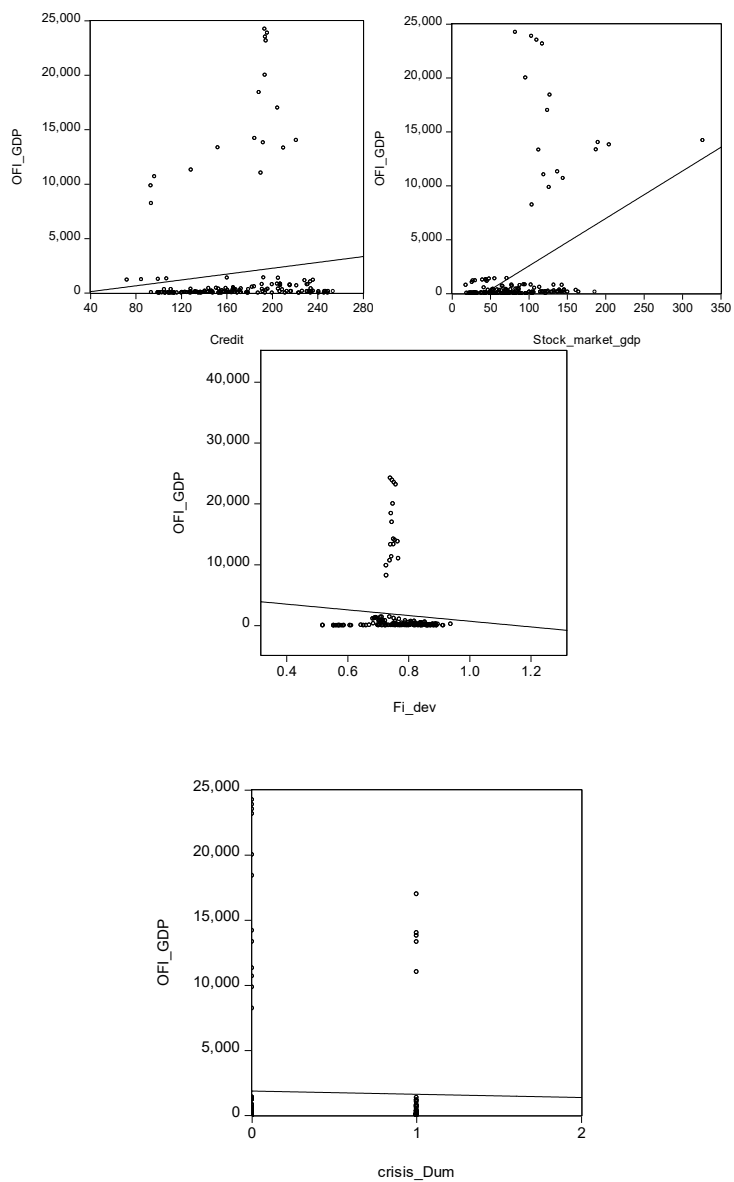


Table A3. Panel unit root results

Variables	Levin, Lin & Chu	Im, Pesaran and Shin	ADF - Fisher Chi-square	PP - Fisher Chi-square
OFI Level	-2.20 (0.01)	-0.51 (0.30)	20.06 (0.45)	24.63 (0.21)
OFI Δ	-7.93 (0.00)	-6.80 (0.00)	79.37 (0.00)	120.23 (0.00)
BANK Level	-0.96 (0.17)	0.85 (0.80)	13.08 (0.87)	18.16 (0.57)
BANK Δ	-4.91 (0.00)	-4.58 (0.00)	58.10 (0.00)	93.31 (0.00)
INSURANCE Level	-1.73 (0.04)	-0.26 (0.39)	19.71 (0.4)	34.23 (0.02)
INSURANCE Δ	-16.23 (0.00)	-13.63 (0.00)	150.10 (0.00)	222.15 (0.00)
PENSION Level	-0.98 (0.16)	0.92 (0.82)	15.11 (0.65)	16.33 (0.57)
PENSION Δ	-12.08 (0.00)	-9.86 (0.00)	109.19 (0.00)	178.05 (0.00)
SPREAD Level	-3.48 (0.00)	-3.23 (0.00)	42.47 (0.00)	28.71 (0.00)
SHORT INTEREST	-2.21 (0.01)	0.49 (0.69)	12.48 (0.90)	9.10 (0.98)
SHORT INTEREST Δ	-9.12 (0.00)	-6.26 (0.00)	75.46 (0.00)	85.52 (0.00)
LONG INTEREST	-5.11 (0.00)	-4.03 (0.00)	50.77 (0.00)	77.23 (0.00)
GDP per capital (log)	-1.07 (0.14)	0.42 (0.66)	16.18 (0.67)	11.01 (0.94)
GDP per capital (log) Δ	-5.99 (0.00)	-4.16 (0.00)	52.99 (0.00)	66.57 (0.00)
PUBLIC DEBT Level	-2.40 (0.01)	0.21 (0.58)	14.24 (0.81)	7.80 (0.99)
PUBLIC DEBT Δ	-2.75 (0.00)	-2.01 (0.02)	30.55 (0.06)	37.54 (0.01)
CURRENT ACCOUNT Level	-2.11 (0.01)	-0.44 (0.33)	24.89 (0.20)	21.61 (0.36)
CURRENT ACCOUNT Δ	-4.25 (0.00)	-4.16 (0.00)	53.23 (0.00)	95.07 (0.00)
TOTAL RESERVES Level	0.50 (0.69)	1.79 (0.96)	8.95 (0.98)	9.69 (0.97)
TOTAL RESERVES Δ	-1.60 (0.05)	-1.55 (0.06)	26.68 (0.14)	48.27 (0.00)
BANK INTEREST MARGIN Level	-2.47 (0.00)	-2.31 (0.01)	33.74 (0.03)	41.84 (0.00)
BANK CAPITAL Level	0.12 (0.54)	3.91 (1.00)	8.49 (0.99)	15.91 (0.72)
BANK CAPITAL Δ	-6.20 (0.00)	-6.20 (0.00)	76.94 (0.00)	155.46 (0.00)
NPL Level	-2.70 (0.00)	-0.289 (0.39)	17.54 (0.62)	19.67 (0.48)
NPL Δ	-2.51 (0.00)	-1.73 (0.04)	28.87 (0.09)	54.47 (0.00)

Goldman, S., Zhelyazkova, V. (2023). *Drivers of Shadow Banking System: A Panel Empirical Approach for Developed Countries.*

Variables	Levin, Lin & Chu	Im, Pesaran and Shin	ADF - Fisher Chi-square	PP - Fisher Chi-square
CREDIT Level	-3.57 (0.00)	-1.24 (0.11)	26.13 (0.16)	18.38 (0.56)
CREDIT Δ	0.26 (0.60)	-1.30 (0.10)	28.44 (0.10)	74.29 (0.00)
STOCK MARKET Level	-0.26 (0.40)	-0.23 (0.41)	17.17 (0.65)	57.18 (0.00)
STOCK MARKET Δ	-6.32 (0.00)	-7.08 (0.00)	85.10 (0.00)	146.28 (0.00)
FINANCIAL DEV Level	0.06 (0.52)	-0.48 (0.31)	23.42 (0.27)	23.14 (0.28)
FINANCIAL DEV Δ	-3.03 (0.00)	-3.51 (0.00)	45.15 (0.00)	92.02 (0.00)

Note: Δ is the first difference operator; Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution and are reported parentheses. All other tests assume asymptotic normality.

LESSEES' RIGHT-OF-USE ASSETS – CONCEPTS, REQUIREMENTS AND PRACTICES²

This work is dedicated to the definitions of control introduced by the Conceptual Framework for Financial Reporting which defines assets recognition based on the understanding that assets are an economic resource and as such a bundle of rights. The concept of assets recognition based on the relationship with the provisions of property law is analysed and on this basis, the reporting, presentation and disclosure of the right-of-use assets in the financial statements of Bulgarian companies for 2021 are studied.

Keywords: Conceptual Framework; lease; right-of-use asset; lease liability; presentation and disclosure of leases

JEL: M41

Introduction

Globalization of the economy, internationalization of business, and the introduction of new technologies and digitization predetermine challenges for professional accountants. Changes in the business environment and economy are coupled with changes in accounting concepts and financial reporting rules. The requirements of the Conceptual Framework concerning the recognition of assets and the definitions of control introduced create new challenges for accountants and businesses (IASB, 2018). An asset is an economic resource and as such is a bundle of rights. Based on this concept, assets arising from legal rights held are recognized. Such are lessees' right-of-use assets, as well as the rights of recovery in case of sales with the right of return of the assets sold.

The purpose of this work is to analyse the concept of assets recognition based on the relationship with the provisions of property law and examine on this basis the reporting, presentation and disclosure of the right-of-use assets in the financial statements of Bulgarian companies. The subject matter of the study is the financial statements of companies applying the International Accounting Standards (IAS) and the International Financial Reporting Standards (IFRS) for 2021.

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1. Accounting Concepts and Rules for Assets Recognition. Control as a Prerequisite for Assets Recognition

In terms of the law, items are separate physical objects. In some cases, legislation and jurisprudence have departed from the definition, and what has been stated is applicable not only to physical, but also to all objects of legal transactions (Kallwass, Abels, 2018, p. 256). According to the requirements of property law for a thing to exist, such thing must meet three conditions: it must be autonomous, material and able to serve the legal entities by satisfying legally relevant interests and to be placed under the authority of the legal entity (Dzherov, 2010, p. 35).

Most items are made up of clearly distinguishable components. In fact, there are many complex and elaborate things, such as a computer, a TV, a car, a building, a ship, etc.

If an item is attached to the property for a temporary purpose only or inserted into a building, then it shall not be treated as a component. The will of the inserter is decisive, so if a lessee installs certain items, he/she shall retain ownership of the elements installed (Kallwass, Abels, 2018, p. 258).

International Accounting Standard 16 – Property, Plant and Equipment (IAS 16) and Accounting Standard 16 – Tangible Fixed Assets (AS 16) show that assets that consist of materially distinguishable constituent parts (components) can be separated and each part shall be treated as an independent asset for the purposes of its amortization (IASB.2, 2022, IAS 16.44; Accounting Standard 16.3.2). This is necessary when component assets have different useful lives or provide different economic benefits to the enterprise, necessitating the use of different methods and rates of amortization.

A building, for example, can be divided into a number of separate physical components: a structure, a roof, an elevation system, an air-conditioning system, etc. Apart from the above, the components of a tangible fixed asset can be both physical and non-physical. In commercial shipping, for example, a ship as an asset also contains separate components. The components of a vessel that are separately identified include not only the distinguishable physical elements that will require replacement during the life of the vessel, but also those that will reflect the need for major repairs in the future. Insofar as the separation of components is required, it does not mean that the company will have to separate its vessels into multiple components. Some of these components may have substantially similar useful lives and residual values, in which case IAS 16 allows such components to be grouped together (IASB.2, 2022, IAS 16.45).

Marine vessels have a number of components that require replacement or overhaul at certain intervals during the vessel's operation. The frequency of repairs shall be in accordance with the rules and regulations relating to the vessel's classification. Due to the requirements associated with the individual components, it is imperative that they be depreciated using different useful lives and residual values. Importantly, it is often not possible to change engines before the ship is cut. An engine has the same useful life as the hull of a ship (Deloitte, 2021, p. 11).

Composite depreciation is defined as the process of averaging the useful lives of a number of units and depreciation accrual on the entire set as if it were a single operating unit. A component approach is preferable for a number of reasons:

- a. A component accounting allocates more accurately activity costs and profit over periods;
- b. The composite life cannot be determined with a high degree of accuracy and may not reflect the weighted average useful life of all components of the asset;
- c. The combined approach may hide inaccurate estimates of expected useful lives over long periods;
- d. The approach may not be able to adjust for changes in the use of the asset or other factors affecting the actual useful life compared to the expected useful life;
- e. Control over tangible fixed assets may be reduced because detailed records cannot be used;
- f. If individual components become inoperable, the depreciation of those nonoperating units cannot be determined with the same accuracy as if those units were individually depreciated (AICPA, 2001, p. 44).

A part of the daily maintenance and repair of the ship is carried out by the crew members. However, some repair operations cannot be carried out by the crew because they require special tools and special technical knowledge and skills, and these are entrusted to specific ship repair and shipbuilding companies. Added to that, the vessel will require seaworthiness checks, underwater hull inspections, intermediate and special surveys within its estimated service life.

Each of these inspections and repairs may qualify for capitalization under the criteria of IAS 16. This standard requires that significant repair costs (dry dock costs and special surveys) are capitalized as part of the asset and amortized until the occurrence of the next repair (Deloitte, 2019, p. 512; KPMG, 2013, p. 3).

This means that the basic accounting principles are confirmed and the component approach is contradicted:

- The confirmation is related to the importance of complying with the principle of comparability of revenues and costs, since the costs of major repairs refer to more than one accounting period and therefore must be amortized according to the period covering this repair until the next dry dock. This is also the period during which future economic benefits shall be gained;
- A contradiction to the component approach, which is not applicable to this case. As detailed in IAS 16, some components of property, plant and equipment may need to be replaced at regular intervals. In this case, the parts replaced should be written off from the carrying value and a cost at the price of the new parts – which is impossible in the case of dry dock and the special inspection – should be recognized (Hendawi, 2018).

Title (ownership) is a comprehensive, fundamental and absolute right to the property enforceable against everyone, not only against specific persons, unlike the obligation rights

(Dzherov, 2010, p. 80, 85). Title is the legal possibility of the owner to carry out transactions of disposal of his/her property. This is the ability of the owner to use and sell his/her property, donate it, replace it, mortgage it, and etc. The owner may transfer his/her right in whole or in part to a third party. He/she can reduce the scope of his/her right and establish limited rights in rem over his/her property to the benefit of a third party (*superficies or easement*). The title is also expressed in the possibility of actual disposal of the property.

The content of the title (property right) covers three actual and legal powers: to dispose of, to possess and to use the property (Dzherov, A., 2010, p. 85). If the entity owns any of these rights, it can recognize it as an asset. These entities' rights may be recognized as independent asset. However, for accounting purposes, related rights are often treated as one unit of account, as an individual asset (IASB, 2015, 4.11).

“An asset is a current economic resource controlled by the company as a result of past events” and “an economic resource is a right that has the potential to produce economic benefits” (IASB, 2018, 4.3, 4.4). The value of the economic resource depends on the possible economic benefits to be derived from it in the future, but as such it is rather a right that provides this opportunity, not the evaluation of future benefits to which this right will contribute for (IASB, 2018, 4.17).

According to the Conceptual Framework, the asset is not identified by the particular physical object, but represents the existence of rights over said object. It is also the understanding of the real right that the economic resource is not the physical object, but the bundle of rights associated with it. With a view to practical expediency, all rights, as elements of ownership of a physically distinguishable object, are taken into account as a separate reported object, ignoring the separate reporting of the rights over such asset. This ensures a more understandable presentation of the rights to the asset (IASB, 2018, 4.12).

The concept of control is based on the ownership as a legal opportunity for a person to possess, use and dispose of a particular property. Possession, use and disposal are actual and legal powers related to ownership. Possession is the right to exercise the actual power over the property. It is considered that an owner cannot use the property unless he/she owns it. The right to use is the right to derive the benefits from operating the property and to acquire income from it. The right to dispose of a property is the ability of the owner to establish any legal relationships regarding his/her property. The owner is the one who decides whether or not and how he or she will exercise the individual rights. He/she may have granted some of his/her powers to others, but still remains the owner. The title is absolute because the owner has the opportunity to prevent other persons' encroachment against the property and has the right to request from them to refrain from any actions with respect to such property.

The concept of control is the ability of a company to exercise its rights arising from the ownership of economic resources (IASB, 2018, 4.19). Assessment of the existence of control provides for the economic resource to be identified, which the entity will recognize and report as an asset. Control of economic resources gives the opportunity to guide the use of such resource and at the same time to acquire the economic benefits from such use. The ability to manage the use of an economic resource as well as to obtain economic benefits from it is based on the existence of control. It follows that if one person controls a particular economic resource, it is not possible for another person to control the same resource.

The definition of asset in the 2018 Conceptual Framework once again requires the economic resource to be “controlled by the company”. Control definitions were also introduced. They are based on the control definitions contained in IFRS 15 – Revenue from contracts with customers (IFRS 15), which contains the asset control indicators and in IFRS 10 – Consolidated Financial Statements (IFRS 10), which determines control over a subsidiary company. Although the definitions in these standards differ, they are based on the assumption that an entity has the ability to arrange the use of an asset (or enterprise) to obtain economic benefits (or for return from the investment).

When developing the concept of accounting for tangible assets as a set of rights, it should be noted that it does not correspond to the current understanding and practice of reporting. The understanding of the essence of the asset as a bundle of rights (which is also the presented understanding of property law) logically leads to these rights to be recognized as separate assets.

IFRS 15 uses five indicators, which give reason to assume that the client has the ability to manage the use of a particular asset and on this basis to receive the benefits associated with its use (IASB, 2022, IFRS 15.38). The time when the client acquires control over the promised asset is the time when the enterprise satisfied the obligations assumed, taking into account the requirements for control. On the other hand, we believe that it would be wrong to claim that these are accounting criteria only. Therefore, they cannot be detached and made independent from the legal elements of ownership. Not all indicators must be met for the entity to conclude that control is available. The management of the enterprise must use its production and economic experience and the business model adopted to determine whether or not the factors (or part of them) prove that the company exercises control. The assessment must be directed to a specific object and a specific transaction. When making the assessment of the existence of control, the entity takes into account the existence of the control indicators as follows:

1. **An entity has the right to receive payment for the asset** – if the client has taken the obligation to make a payment for a certain asset, it is reasonable to assume that the actual power and right to determine the manner of operation and to receive all income and other benefits from such asset were granted in return. A major criterion for recognizing sales revenue is the likelihood of receiving the sales amounts. This condition was laid down in IAS 18 (repealed) as well as in IFRS 15 and is required regardless of the fact that the principle of accrual is applied. One of the conditions to be met by contracts according to IFRS 15 is the likelihood of collecting the remuneration related to them.
2. **The enterprise is the legal owner of the rights to the asset** – the right of ownership is the ability of the owner to determine how the property shall be operated and how shall the benefits of such property be gained, as well how income shall be derived therefrom. The owner is the one who decides whether or not and how he/she will exercise his/her rights. He may have granted some of his rights to others. The title (property right) is absolute because the owner has the power to require others to refrain from actions with respect to the property. The transfer of ownership of an asset is usually bound by the transfer of control over it. If an entity reserves its title over certain property as a protective measure only, until it guarantees payment from the client, this cannot be a reason to state that the client has no control over the asset (IASB, 2022, IFRS 15.38.b).

An entity that holds legal property rights is usually the party that runs the use and receives the benefits from an asset. Ownership of the title reflects the owner's ability to dispose of the asset – to sell it, to mortgage/pledge it, and etc., indicating that the holder has control over it.

Depending on the type of sale, the sale contract should be concluded in the relevant form for validity. Commercial transactions are usually defined as informal. The [Bulgarian] Commerce Act stipulates that “written or other form is required for the validity of the commercial transaction only in the cases provided for by the law” (Commerce Act, 2022, Art. 293). The ordinary written form has been introduced in a number of places in the current legislation as a condition for the validity of the transaction. In order to conclude a sale contract in all other cases, it is sufficient to reach an agreement between the parties, which may be oral. The written form is recommended with a view to a possible legal dispute between the parties and in order to prove certain facts. The legislation introduces the requirement for compliance with a certain qualified written form as a condition for validity – a written form with Notary Public's certification of the signature, a written form with Notary Public's certification of the date, a written document in the form of a notarial deed, and etc. A special format is required, for example, for the sale of real estate or a right in rem over real estate, for the sale of registered vehicles, trailers, wheeled tractors and motorcycles with an engine volume of over 350 cm³, for the sale of a ship, an aircraft and others. US accounting standards also provide requirements for the form of the contract in accordance with the applicable jurisdiction “Some arrangements may require a written contract for compliance with laws or regulations in a particular jurisdiction and these requirements must be provided to determine a contract. The negotiation must be legally sustained in order to be within the scope of the standard model” (EY.1., 2020, p. 21).

3. **The entity has transferred the possession of the asset** – possession of the asset is an indication that the client has the ability to determine the way to use the asset and receive the benefits from its operation. This also implies the actual power of the owner to limit other persons' access to these benefits. Physical possession may not be sufficient to provide control over an asset. Contrary to ownership (the legal power), possession is a factual power over the property (Kallwass, W., Abels, P., 2018, p. 262). Legal possession is important in property law. For a legal possession to be available, six other elements must also be met, such as to be: constant, uninterrupted, calm, clear, undoubted and with an intent of holding the thing as its own (Dzherov, A., 2010, p. 72). The main element is the intention to hold the thing as its own. Legal possession is a legal fact, and as such it gives rise to legal consequences. They are expressed with the ability to seek legal protection of the possession (Dzherov, A., 2010, p. 72).

The possession of an asset does not yet prove the existence of control. This will be the case in contracts with a redemption clause and in consignment contracts. Conversely, it may also be valid in some contracts that provide for invoicing and detention, the entity may retain the physical possession of an asset that is under the control of the client or is already his/her property. Usually, the physical possession of the asset is an indicator of which person controls the asset, suggesting that it provides that person to determine the manner of use, as well as to receive the benefits from the possession. Of course, the clauses in the contracts should be analysed in order to conclude whether or not the physical possession grants control over the asset.

When the entity delivers the goods (production) to another entity in order to be sold to end customers, it must be considered whether or not the receiving entity shall acquire control at the date of receipt. In the case of delivery of consignment goods, the recipient is usually not required to pay until the sale of the product to a customer is effectuated. In such cases, the seller (or the consignor) reserves the ownership of the goods, and the counterparty (or the recipient) acts as a sales agent.

- 4. The customer bears the significant risks and ownership benefits from the asset** – the transfer of significant risks and benefits over the items sold is important for determining the time when the entity has transferred control to the buyer. If during the study of the circumstances of the transfer, of the risks and benefits of ownership it is established that the entity has still maintained to a great extent the risks and benefits of ownership, the transaction cannot be considered as revenue generating (Wiley, 2011, p. 183). During the period from the entering of the contract to the transfer of the property, the risk of accidental loss of the individually determined property is borne by the new owner – the buyer. If the items are fungibles, the risk shall pass on to the buyer from the time the goods are specified or delivered to the buyer (Obligations and Contracts Act, Art. 186A). According to the civil legislation, the ownership shall pass to the buyer with the transfer (usually with the receipt of the property) of the property sold – the danger of accidental loss and spoilage of the property sold shall pass on to the buyer (breaking, spoilage, theft, and etc.). The thing perishes for the owner (*res perit domino*) principle applies. Both the transfer of the benefits and the risks associated with the property arise from the transfer. There is sufficient practice under the application of IAS 18 that has developed in the years of its application, and in no way, it can be claimed that IFRS 15 has introduced this criterion. There is no unanimity on the matter of the importance of passing the risk of loss. According to some authors, passing the risk of loss is crucial for the importance of recognizing sales revenue (Adler, H., Daring, W., Schmalz, K., 1971, p. 494). According to other authors, recognition of realization is unfeasible until the danger of loss has passed away. The claim should be generally recognized when the seller has fulfilled everything necessary for the performance of the contract and the danger of accidental loss or damage has passed on to the buyer (Coenenberg, A., Von Wysocki, K., 1983, p. 401). According to a third group of authors, the passage of risk is just an ancillary criterion and it is only decisive in the case where the risk of loss is significantly large (Hachenberg, M., Ulmer, P., 1989, p. 42).

The obligation to hand over the property to the buyer in the state in which it was at the time of the sale arises for the seller upon the entering of the sale contract. The buyer is obliged to receive the goods and pay the price at the same time as the transfer of the goods is made or within the deadline agreed by the parties. The possession of the risks and benefits associated with the asset can be considered an indicator of the management capacity of the entity, for the use of the asset and for obtaining economic benefits from its operation,

- 5. The entity has accepted the asset** – the customer's acceptance of the asset may indicate that the acceptance of the thing, which is a formality, does not affect the conclusion of whether or not control has been transferred. Handing over the object is not a condition for entering of the contract, but a consequence of the sale. An acceptance clause that applies to goods meeting certain conditions and specifications may allow the transfer of

control and the generation of revenue once the entity demonstrates that these conditions are met before the goods are shipped. An acceptance clause that refers to certain specifications is not just a formality, as the entity has to ensure that these requirements exist and will be accepted by the customer. Acceptance should not be considered a formality even if the product sent is unique, since there is no analogue to compare with.

The customer has no control over the products received during the trial period until they are accepted, even if there is no obligation to pay for them. The concept of acceptance is used in civil law and is treated as the seller's obligation to hand over and the buyer's obligation to accept the item purchased. If the buyer is obligated to assume actual possession of the goods, the acceptance is covered by the acquisition of the right of ownership. In the event that the item purchased has been delivered and if the buyer has already accepted it, the risk of loss can no longer arise for the seller. In case the buyer delays the acceptance at the buyer's fault, recognition of revenue and profit shall depend on whether or not the seller shall protect his/her rights from such delay.

2. Lessees' Right-Of-Use Assets – Regulations and Practice

In recent decades leasing has become an important financing tool replacing bank loan financing. A lessee acquires the right to use an asset without having to immediately pay its purchase price. Ultimately the lease may stand for a purchase combined with financing from the lessor. The rights or assets acquired as a result of the lease contracts should reflect the economic content of the transactions and enable the parties to the contract to reflect accurately and honestly the financial situation with a view to these transactions. Operations may be accounted for as an ordinary lease, where the lessor acting as the legal owner accounts for the subject matter of the lease as an asset and depreciates it over the estimated period of practical use, and the lease instalment that has been agreed upon is periodically recognized as a rental income. The lessee, on the other hand, shall periodically report the lease payments as an expense. Such reporting however seems inadequate if other characteristics of the lease contract exist, for example:

- The lessee is granted the right to operate the leased asset for the period specified in the contract, which approximately corresponds to the probable useful life of the asset;
- The total contract lease to be paid is similar to the original fair value of the asset leased.

Although the lessee does not acquire legal ownership rights, he/she cannot be removed from the economic ownership and can use the asset for most of its expected useful life. And yet, this asset is recognized as an asset in the statement of financial position (financial lease) or is excluded from it (operating lease).

The financial lease is reflected as a debt-financed purchase in the lessee's balance sheet, not only the leased object is entered, but also the corresponding obligation to pay for it. As a result, assets increase, but more important is the impact on the liability of the balance sheet, as liabilities also increase. Due to the negative impact on the credit rating, the lessee might be interested in reporting and presenting the lease as an operating lease.

The purpose of the repealed IAS 17 Leases, was to identify when a lease is economically similar to the purchase of the leased asset, the lease is classified as a financial lease, and the lease is recognized in the lessee's balance sheet. Other leasing contracts, where there is no similarity to the purchase of the asset, are classified as operating leases and are not reflected in the balance sheet of the lessee's company – they are off-balance sheet leases. With a view to such policies of an on-balance sheet or off-balance sheet reporting and related information in the annual financial statements, the accounting rules for reporting, presentation and disclosure of the lease have changed. Unlike the 'all or nothing approach', almost all assets arising from rights under lease contracts will be recognized in the lessee's balance sheet.

A new control concept based on economic benefits is applied to asset accounting:

- economic benefits from ownership – the benefits of the lessor;
- economic benefits from ownership and operation – the benefits of the lessee having the right to direct the use of the asset rather than being just an operator.

In the case of an operating lease, the following treatment is applied – the lessee under an operating lease recognizes the right to use the asset leased as a right-of-use asset for the term of the lease (IASB.1, 2022, IFRS 16.22). In order to recognize a right-of-use asset, it is necessary that the lessee is able to direct the use and operation of the asset throughout the contract duration, as well as to be able to make decisions related to the conditions and objectives of the operation, which are predetermined (IASB.1, 2022, IFRS 16.B24).

The rights to operate the leased assets are capitalized. The initial valuation of such assets is carried out by calculating the present value of the lease payments throughout the term of the lease. The distinction existing in IAS 17 between an operating lease and a financial lease is eliminated by recognizing a lease asset (representing a right-of-use asset throughout the term of the contract) and a lease liability (representing the obligation to pay the leases/rents).

The new concept introduced by IFRS 16 Leasing (IFRS 16) and the control model introduced for identifying lease relationships leads to an accounting of rights over the leased asset by the controlling party – the lessee. At the same time, the asset leased is also reflected in the statement of financial position of the owner – the lessor, who reports the leased assets, as it has been until now.

The asset that is the subject matter of the lease agreement should be individually specified in the contract and must be specifically identified, or this should be done at the time when it is delivered to the lessee. (Pellens, B., R. Fulbier, J., Gassen, T. Sellhorn, 2017, p. 780).

The Accountancy Act regulates that companies in Bulgaria shall prepare their annual financial statements by applying the National Accounting Standards (NAS). Certain companies prepare their financial statements based on International Accounting Standards (IAS), as required by the Accountancy Act (Accountancy Act, 2021, Art. 34). The National Accounting Standards applicable in Bulgaria define an asset as “a resource controlled by the entity as a result of past events, from which future economic benefits are expected to flow to the entity” (National Accounting Standards). Therefore, lessee entities applying the NAS report contracts that are classified in the operating lease category as off-balance sheet leases and do not recognize them in the company's balance sheet (Accounting standard No. 17).

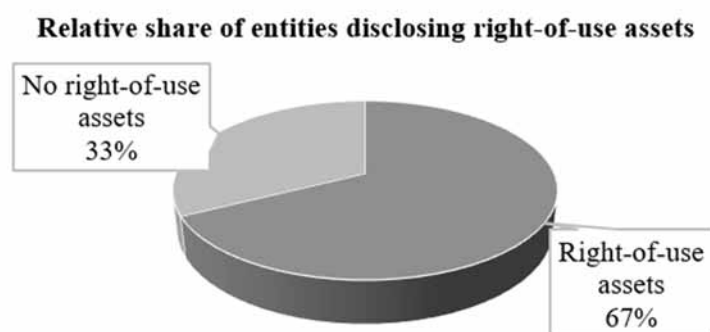
In order to analyse the application of the new rules contained in IFRS 16, this study includes companies applying IAS/IFRS.

The annual financial statements of public companies for 2021 were studied with the aim of establishing the application of the lease accounting rules by the lessees, the method of application, as well as the selected options available in IFRS 16. These are the companies in the index of the Bulgarian Stock Exchange stock exchange – BGBX40 (BSE-Sofia.bg). The study includes 40 companies applying IAS/IFRS in their individual financial statements. The study covers the individual financial statements to avoid the elimination of leasing relationships between the entities being part of an economic group. The study was mainly aimed at answering the following questions:

- What part of the entities present right-of-use assets?
- How significant are right-of-use assets compared to non-current assets and total assets?
- How significant are the lease liabilities compared to the liabilities of the relevant company?
- Which of the options available in IFRS 16 has the entities chosen regarding the right-of-use assets?
- How are the right-of-use assets presented and disclosed in the companies' financial statements?

Within the framework of the study, 27 of the entities or 67 percent of all the entities studied disclosed in their annual financial statements the presence of a right-of-use asset.

Figure 1. Relative share of the right-of-use assets vs non-current assets

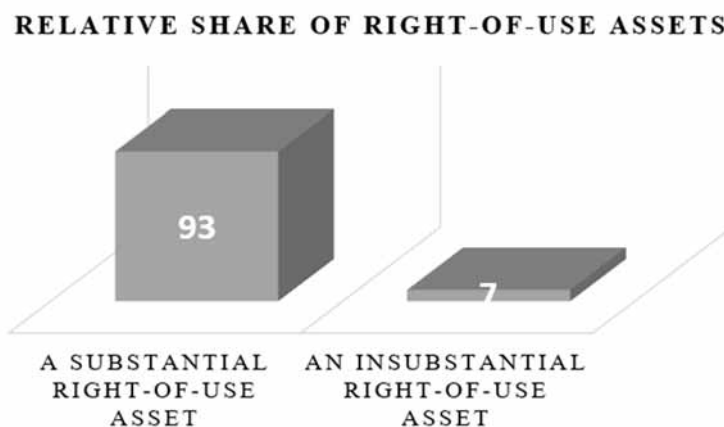


The lessee entities reporting the existence of right-of-use assets disclose in their explanatory notes the existence of the prerequisites for the existence of a lease control.

For the majority of the entities studied – approximately 81% of them – the lease assets recognized were not a significant part of their fixed assets, and for some of them – for 19 % of them – the lease assets recognized represent a significant part of their non-current assets.

The amount of leased assets compared to the balance sheet amount of assets is significant for only 7% of the twenty-seven companies studied (reporting leased assets).

Figure 2. Relative share of right-of-use assets vs non-current assets



Right-of-use assets at the beginning of the lease should be valued at cost (IASB.1, 2022, IFRS 16.23).

The companies studied disclose compliance with the rules for the valuation of the right-of-use asset specified in IFRS 16 at the inception date. The companies specify that they evaluate the lease liability as at the inception date at the present value of the lease payments that have not yet been paid at that date. Lease payments are discounted by using:

- the interest rate stipulated in the lease contract; or
- if the interest rate cannot be easily determined, the lessee's interest rate is used (IASB.1, 2022, IFRS 16.26).

Disclosures show that a differential (internal) interest rate is usually used for the right-of-use assets, for which no acquisition option (operating lease) is available or the interest rate stipulated in the contract for the assets where a significant transfer of risks and benefits (finance lease) is available.

Once the right-of-use assets are recognized at the inception date, they are evaluated using the cost model. It is permissible for the right-of-use asset to be evaluated subsequently by applying the valuation models provided for in IFRS 16.34 and 16.35.

If the company has chosen the acquisition cost model for the subsequent valuation of the lease asset, the right-of-use asset is evaluated at acquisition cost, less the accumulated depreciation and impairment losses accrued, and also by taking into account the adjustments caused by the change in the lease liability (IASB.1, 2022, IFRS 16.30).

When the lessee applies the fair value model to its investment property, he/she should also apply the fair value model to the right-of-use assets that are treated as investment property in IAS 40 (IASB.1, 2022, IFRS 16.34).

The lessee has the right to choose with respect to the right-of-use assets that relate to a class of property, plant and equipment to which the lessee applies the revaluation model set out in IAS 16. The lessee may apply the revaluation model to all right-of-use assets that relate to this class of property, plant or equipment (IASB.1, 2022, IFRS 16.35).

Therefore, for property, plant and equipment:

- if the class of own assets to which the right-of-use assets relate is accounted for by using the cost acquisition model, then this model must also be applied to the right-of-use assets;
- if the asset class to which the right-of-use assets relate is valued under the revaluation model set out in IAS 16, the lessee may choose:
 - to apply the fair value for the subsequent evaluation of the right-of-use assets;
 - to apply the acquisition cost model for subsequent valuation of the right-of-use assets.

In reality, the accounting model to be followed for right-of-use assets that are investment properties is determined by the lessee's accounting policy and the lessee's choices made for the investment properties owned.

85 % of the companies studied have disclosed that they apply the acquisition cost model for subsequent valuation of the right-of-use assets.

Right-of-use assets valued under the cost model should be depreciated by applying the requirements of IAS 16 as follows:

- if the lease contract transfers ownership of the leased asset to the lessee until the expiration of the lease term or if the cost of the right-of-use asset indicates that the lessee will exercise a purchase option, the asset should be depreciated over its useful life. Therefore, if ownership of the leased asset is transferred to the lessee at the end of the lease term, or it is reasonably certain that the lessee will exercise a purchase option, depreciation shall be based on the asset's useful life;
- if the above-mentioned conditions are not present, the right-of-use assets shall be depreciated until the earlier date – of the end of the asset's useful life *or* of the end of the term of the lease agreement (IASB.1, 2022, IFRS 16.31, IFRS 16.32).

These rules are disclosed by all the companies studied (reporting lease assets), depending on the type of lease – the useful life of the asset under the terms of a financial lease or until the earlier date – the end of the useful life of the right-of-use assets or the end of the lease term.

The companies studied have disclosed that they apply the straight-line method of depreciation of the right-of-use assets, and this is true for about 85 % of the companies.

A lessee may choose not to apply the requirements of IFRS 16 for:

- Short-term rental contracts. These are leases with a term of less than 12 months. (IFRS 16, Appendix A). If the lease contract contains a purchase option, it cannot be treated as a short-term lease.

Twenty-six of the companies studied, or 96 percent of them, disclosed that they have chosen not to apply the requirements of IFRS 16 for short-term leases and instead reflect the straight-line method of rent expense for the current reporting period.

- A lease where the value of the leased asset is low, based on its cost as new, regardless of its age. Lessees are not required to recognize low-value lease assets or liabilities. The IASB provided a threshold of \$ 5,000 regarding the value of the leased asset (when new) to help companies identify leased assets that could be covered by the exemption (IASB, 2016, p. 19, p. 39). This solution is optimal for practical reasons, but is a departure from the materiality principle applied in other IAS/IFRS. Assets that are highly dependent on or highly interconnected with other assets are not allowed to be qualified as low-value assets.

26 of the companies studied, or 96% of them, disclosed that they have chosen not to apply the requirements of IFRS 16 for leases where the underlying asset is of low value and instead reflected lease expenses for the current reporting period on a straight-line basis.

The lack of disclosure (for short-term leases and leases where the underlying asset is of low value) in some of the companies may also be due to the absence of such contracts.

After the inception date, the lease liability shall be valued by:

- a) increasing the book value so as to reflect the interest on the lease liability;
- b) reducing the book value so as to reflect the lease payments made; and
- c) revaluating the book value so as to reflect any revaluation or changes in the lease or to reflect revised in-substance fixed lease payments. (IASB.1, 2022, IFRS 16.36).

Liabilities under lease contracts are measured, like other financial liabilities, on an ongoing basis using the effective interest method. The lease liability is evaluated so that its carrying amount is equal to the amortized cost. Interest expenses distributed over the term of the lease are reflected as an increase in the liability, and payments provided for in the contract are reflected as a decrease of such liability. The lease liabilities of the companies studied compared to the liabilities in the balance sheet constitute a significant part for nearly 15 % of them, and for long-term lease liabilities, the ratio is about 11 %.

The interest on the lease liability in each period of the term of the lease agreement is the amount of the interest calculated on the balance/principal amount of the lease liability. Interest rate is the discount rate used in the initial valuation of the lease liability or the revised discount rate.

The costs for interest accrued on the 2021 lease presented in the profit or loss account or other comprehensive income statements compared to reported expenses for the period is immaterial for all the companies studied.

Lease contracts may contain lease and non-lease components to which different accounting recognition models apply. Non-lease components are items or activities that are associated with the promise to transfer a good or service to the lessee. IFRS 16 requires each individual component of a lease to be identified and accounted for separately. The right to use an underlying asset under the lease agreement provides the lessee with the opportunity to operate it individually or together with other goods and services. These criteria are similar to the criteria contained in IFRS 15 for analysing the distinctiveness of goods or services provided to customers.

Amounts owed by the lessee that are not related to the transfer of goods or services to the lessee – such as costs and fees for administrative services, taxes and insurance) should not be treated as separate components of the contract – they are included as part of the amount to be allocated to the identified components of the lease contract (IASB.1, 2022, IFRS 16.B33).

The remuneration agreed in the lease contract should be allocated for each component identified – both leasing and non-leasing. IFRS 16 provides the lessee with the possibility to estimate the individual prices of the lease components, as the lessee may not have information about the lessor's stand-alone prices.

IFRS 16 contains separate rules for lessees and lessors.

Lessees allocate the amounts due under the contract between the lease and non-lease components based on:

- the individual price of each lease component; and
- the individual total cost of the non-lease components.

Prices are determined on the basis of the lessor's or other supplier's price offer as a stand-alone price for the component at issue. The lessee determines the price by using mainly observable information instead. Lessors must allocate the contract consideration among the lease and non-lease components in accordance with the allocation rules required by IFRS 15. Furthermore, given the likelihood that the lessee will not have complete information about the lessor's pricing model, the IASB has provided an exemption from the requirement to separate non-lease components. When practicable, the entity shall account for the combined lease and non-lease component as a single lease component. This choice of policy should be made in accordance with the class of the underlying asset. If the components are not separated, the lessee will recognize a greater liability for the lease and this expedient option is likely to be used only when the service components are not material (PWC, 2017, p. 7).

If component separation is applied, the lease components shall be accounted for in accordance with IFRS 16, while the non-lease components shall be accounted for by applying other relevant standards. The lessor accounts for non-lease service components by applying the rules of IFRS 15.

The expediency-based method of separating lease and non-lease components is an option provided for lessees only, and not for lessors.

Individual identified lease components that have similar characteristics can be accounted for as a single portfolio. The application of this understanding is shown in the illustrative examples accompanying IFRS 16 (IASB.1, 2016, Illustrative Example 12).

A predominant part of the companies studied – 21 or 78 % of them – have disclosed that they benefit from the relief of not separating the lease and non-lease components. Only 6 of the companies or 22% of them have adopted a policy of component separation.

The lessee must apply IAS 36 Impairment of Assets to determine whether or not the right-of-use asset is impaired and account for identified impairment losses (EY, 2020, p. 67). All the companies studied disclose that right-of-use assets are subject to an impairment test.

The lease asset – a right-of-use asset – is a non-current non-financial asset and the lease liability is part of the current and non-current financial liabilities, depending on the term of the lease payments. The short-term lease payables of the companies studied compared to the total lease liabilities make up an average of about 33 %, and this percentage varies widely for the individual companies from 6 % to over 70 % and depends on the year and the term of the contract.

The book value of the leased asset under an individual lease usually reduces faster than the book value of the lease liability. The explanation for the faster depreciation (value reduction) of the leased asset is that it is generally depreciated using the straight-line method, and the lease liability is reduced by the amount of lease payments made and increased by the interest accrued for the period. Therefore, although the amounts of the lease asset and the lease liability are the same at the beginning and at the end of the lease, the value of the asset is usually lower than that of the liability over the life of the lease.

The ratio of the right-of-use asset and the lease liability is greater in value for 48 % of the companies studied, and for the remaining 52 %, the lease liability is greater.

The lessee presents the right-of-use assets separately in the statement of financial position or discloses them in the notes to the financial statement. The lessee presents them as follows:

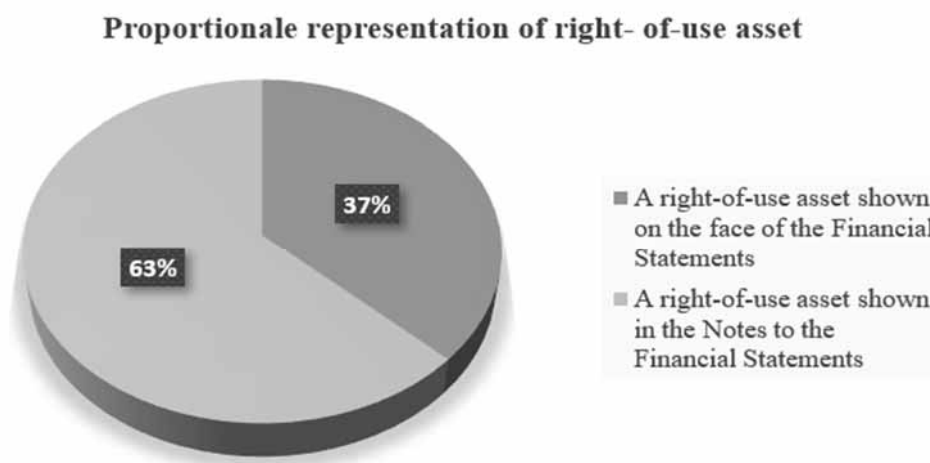
- lease assets are shown separately from other assets; and
- lease liabilities are shown separately from other liabilities.

The lessee presents in the statement of financial position or discloses in the explanatory notes:

- the right-of-use assets as a separate item.
- if the right-of-use assets are not presented on the face of the statement of financial position as an item, the lessee should group them together with the other assets by including them in the same item in which the assets would be presented if they were owned. It should be disclosed which items in the statement of financial position include those right-of-use assets (IASB.1, 2022, IFRS 16.47).

The companies studied used both approaches – presentation of the right-of-use assets on the face of the statement of financial position or in the information of the explanatory notes. 37 % of the companies present the right-of-use assets on the face of the statement of financial position.

Figure 3. Relative share of companies presenting the right-of-use assets in the statement of financial position and in the explanatory notes



The lease liabilities are also presented separately by part of the companies in the statement of financial position as lease payables and are divided into the current and non-current sections – as current and non-current liabilities. The predominant part of the companies presents the lease liabilities as part of the commercial obligations, their disclosure, including in the short-term and long-term section of the statement are indicated in the respective explanatory notes annexed.

Most of the companies present in the explanatory notes a separate statement of right-of-use assets providing data on the initial value, changes in book value, depreciation accrued for the period, accumulated depreciation, book value, etc. As a rule, this is the case with companies that have chosen to present the right-of-use assets on the face of the statement of financial position. Another part of the enterprises presents the right-of-use assets as part of the explanatory notes about property, plant and equipment or as a separate report in addition to the report on property, plant and equipment.

The requirement for separate presentation of right-of-use assets does not apply to right-of-use assets classified as an investment property, which should be presented in the statement of financial position as investment property (IASB.1, 2022, IFRS 16.48). These companies have presented them as investment properties in a separate report.

Operating lease expense, which is accounted for on a straight-line basis under operating leases, when applying IAS 17, is now the amortization expense of the estimated lease rights recognized as assets (included in the operating expenses) and interest expense on the lease liability (included in the financial expenses). The amortization rate is usually the same, and interest expense decreases over the lease term as lease payments are made thus reducing the principal. This leads to a reduction in overall costs when the individual lease is nearing the end of the agreed term. When applying IFRS 16, the sum of interest expenses and

depreciation expenses during the first half of the lease term is usually higher than the linear expense for operating leases recognized when applying IAS 17. Conversely, for the second half of the term of the lease – the sum of interest expense and depreciation expense is generally expected to be lower than the straight-line expense for operating leases (IASB, 2016, p. 44).

That is why the profit before interest (operating profit, EBIT) is higher compared to operating profit when applying IAS 17. The amount of the increase in operating profit and financial expenses depends on factors such as the importance of the lease to the company, the duration of the lease contracts and the discount rates applied (IASB, 2016, p. 45). Variable lease payments are classified as operating expenses because they are not included in the initial determination of the lease liability.

In the statement of profit or loss and other comprehensive income, interest expense on the lease liability must be presented separately from the amortization expense of the right-of-use asset and it is a component of the financial expense, which, in accordance with IAS 1 Presentation of Financial Statements, is presented separately in the statement of profit or loss and other comprehensive income (IASB.1, 2022, IFRS 16.49).

As a result of the study, it is not possible to express a definite opinion on whether or not and to what extent the introduction of the new rules has led to a different presentation of the financial status of the entities studied, since the rules for financial leasing have not changed. Only about 15 % of the companies presented the right-of-use assets with purchase options and right-of-use assets under an operating lease contract separately in the explanatory notes.

Conclusion

The balance sheet presentation of the right-of-use assets under the operating lease contracts created additional requirements for the organizations and their accounting. Given the existence of a large number of lease contracts, this posed serious challenges to the companies' management and their accounting staff. Despite the undeniable improvement in comparability between companies that lease assets and companies that receive loans for the purchase of assets, the accounting work was far from small when the requirements of the standard were initially implemented. The IASB expected that once a company had set up its systems to provide the information required by IFRS 16, the costs would be only marginally higher than those incurred in applying IAS 17. However, it is expected that the benefits and the information that will be available from the implementation of the new rules will exceed the costs of achieving them. (IASB, 2016, p. 38). On the other hand, the drafters of IFRS 16 probably did not expect such changes in lease contracts as were caused by COVID-19. In 2020 the lessees, who applied the new requirements in 2019, already had to take into account changes in the lease contracts, which given the existence of so many contracts was a difficult task, even an impossible one. On this basis, the IASB undertook to amend IFRS 16 related to COVID-19, which would allow lessees to apply a practically expedient treatment and therefore its introduction can be positively evaluated, since the users of the financial statements are not deprived of useful information (IASB, 2020).

On the basis of the research conducted, which by no means purports to be exhaustive and does not allow for any general conclusions, we can conclude that the companies studied have applied the rules for accounting for right-of-use assets and lease liabilities using one or another option for their presentation, subsequent evaluation, amortization, and etc. The conclusion that needs to be drawn is that the companies studied have applied IFRS 16 in its entirety and have presented in their individual financial statements the necessary and required information that is useful as a way of presentation for the users of the financial statements. However, we cannot confirm with certainty that the information presented for the above reasons justifies the costs of its achievement.

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THE USE OF UNIVERSITY RESEARCH PRODUCTS IN ENTREPRENEURIAL PRACTICE: SPECIFICS ACCORDING TO SIZE CLASS OF ENTERPRISES AND SECTORS OF ECONOMIC ACTIVITIES⁴

The partnership between universities and businesses, the transfer of research products created in higher education institutions and used in entrepreneurial practice are a source of innovation in a turbulent and highly unpredictable environment. This cooperation provides indisputable benefits not only for scientific and business organisations, but also for the economy and society as a whole. This, as expected, causes significant interest among researchers, as well as national and international institutions. Despite the scientific activity and the emphasized interest, there is a need for additional knowledge regarding the scope and extent of the use of research products created by academia, analysed and evaluated through the prism of entrepreneurs. The aim of this paper is to identify whether enterprises' size and sector affiliation influence the use of university research products in entrepreneurial practice, investigating the companies' perspective. Therefore 904 companies, operating in Bulgaria, were surveyed through a structured questionnaire. The methods for analysing the empirical data combine exploratory data analysis and confirmatory data analysis, in which the tools of diagrammatic images and contingency tables were used. The results show that as the size of enterprises increases, the use of research products does too, while at the same time, entrepreneurs' assessment of the need to establish partnerships with universities has a non-linear relation to the size of the enterprise. In addition, smaller businesses were found to be targeting university research products presented in publicly available forms while bigger ones are looking for interactive ways of knowledge transfer. Along with the size of the enterprises, it was found that their economic sector affiliation affects the intensity of cooperation with the academia highlighting as leading the sectors related to knowledge-based services, contrary to the prevailing perception that manufacturing and ITC sectors occupy leading positions.

Keywords: entrepreneurship; university-business cooperation; research products; knowledge transfer; SMEs

JEL: L14, L25, L26, O33, O36

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1. Introduction

The academia-business knowledge transfer is a source of a number of advantages for the parties involved in this process. The enhanced activity in building and deepening of these relations is a focus of attention not only of higher education institutions (HEIs) and entrepreneurs, but also of a number of institutions and organizations at national and international levels. This is due to many factors, among which are the changes in the characteristics of modern economies, whose major driving forces are scientific knowledge and the innovations based on them.

Over the past few decades, universities have evolved from their traditional roles in education and research to focus on contributing to society through knowledge and technology creation and transfer. Knowledge transfer, as well as its management and use by the business and particularly by SMEs, is considered in studies of many authors, as among the recent are Fitzky, Lang & Baltes (2023), Anand et al (2021), Prihandono et al (2021), Lövsund, Hillemyr, Krikis (2020), Farrukh, Athanassopoulou, Ilevbare (2019), etc. Lately, companies are constantly under pressure to change and innovate, which makes university-industry cooperation an important mechanism for survival and development. There has been a growing number of such relationships, as well as of studies devoted to them.

At the same time, unilateralism in research is observed (Shang, Zhang and Liu, 2021) and it is found that there are not enough studies examining in depth the central role of business organizations in this process (Bercovitz, Feldmann, 2006).

A large number of researchers distinguish enterprises by a number of characteristics, among which the size of the business is leading. Special attention in the studies is given to the group of small businesses (Liao, Barnes, 2015; de Zubielqui et al., 2015; Delfmann, Koster, 2010; Tether, 2002, etc.), due to their dominant share not only in a number of enterprises, but in added value and employment in most sectors of economic activity (Di Bella, Katsinis, Lagüera-González, 2023).

Differentiation in the company size leads to various types of university-business interactions, technology transfer, as well as competitive advantages and other benefits to the enterprises. What all these relations have in common is the drive to innovate, but beyond that, there are some specifics, revealed in a number of scientific investigations. For example, an extensive study on the state of university-business cooperation in Europe, made for the European Commission (Davey et al., 2018), revealed that the size of companies significantly impacts their interactions with HEIs, particularly in education and management cooperation.

The Oslo Manual (OECD, 2018) describes five main types of interaction between companies and HEIs (a significant part of which are universities) and public research institutes: ownership ties, sources of knowledge, transactions, cooperation and people-based interactions. Each major type of interaction corresponds to a set of possible channels for knowledge transfer. The idea underlying this typology is that the five types of interactions can exist independently of each other and reflect both the degree of formality in the relations and the type of knowledge that is the subject of the interaction, depending on its availability (existing and prospective) and embodiment in products (disembodied and embodied).

The question of typologizing the interactions between business and universities is the subject of the study of Ankrah and Al-Tabbaa (2015), in which they group almost all options into six organizational forms: personal informal relationships, personal formal relationships, third party, formal targeted agreements, formal non-targeted agreements, and focused structures.

From the comparison of the two typologies, as well as from the projections of other understandings applied in similar studies, it can be concluded that no restrictions should be placed on the interactions between enterprises and universities, and ultimately, an empirical study should be carried out with the idea that all possible interactions aiming at knowledge transfer should be analysed.

As for the channels of technology transfer (the various research products created by universities and used by businesses), the transfer media systematized by Arenas and Gonzalez (2019) can be mentioned: patents, prototypes, studies, presentations of conferences, publications, as well as mobility of researchers and informal discussions.

Some research papers consider the sector affiliation of companies in knowledge transfer and interaction between business and academia (Nicholls-Nixon et al, 2022; Ezeuduji et al, 2022). As expected, the effectiveness of the partnership between science and business, as well as the benefits and barriers in the process of scientific knowledge transfer to entrepreneurial practice have found their place in the activities of a number of researchers.

The growing interest of researchers in the problems of innovation activity in Bulgarian enterprises in recent decades is expressed in numerous studies and publications, but to a large extent they are either based on available statistical data collected according to established methods (CIS, EIS, NSI), or they focus on individual economic sectors or particular size groups of enterprises, from which it is difficult to assess the overall picture and especially that part of it which refers to the transfer of knowledge from universities to enterprises.

The assessment, made on the basis of the literature review below and focusing on some of the outlined unanswered questions, determines the **aim** of this paper: to identify whether enterprises' size and sector affiliation influence the use of university research products in the entrepreneurial practice, investigating the companies' perspective.

Achieving this goal would provide valuable insights into the importance of university research in entrepreneurial practice, a better understanding of entrepreneurs' and managers' perspectives on processes related to knowledge creation and transfer, and last but not least, some ideas that universities and other HEIs would apply in their research activities.

2. Literature Review

Studies dedicated to examining the interactions among universities, industries and governments show that strengthening the capacity of enterprises in R&D, as well as increasing the degree of their internationalization and competitiveness by dynamizing the partnership between the mentioned parties, is an essential prerequisite for the development of *entrepreneurship and innovation* (Shi, Yonezawa, 2012). In fact, knowledge transfer is a

strategic approach that ensures businesses maintain sustainable competitive advantages. Transfer that can take place in different ways – both through hard and soft knowledge delivery mechanisms (Jasimuddin, Zhang, 2009). Research done on the mechanisms of knowledge transfer takes into account the type of knowledge, the way of its transmission and the processing demands of the transfer task (Nokes, 2009).

The adoption and use of knowledge management practices, as evidenced by Alegre et al.'s study (2011) among biotech SMEs, is positively related to innovation performance. Another study (Liao, Barnes, 2015) concluded that, within SMEs, knowledge management practices tend to take place through interaction and collaboration on an informal basis.

University-business collaborations focus not only on the specific *process of knowledge transfer*, but also on the *key factors* for making it successful for the parties involved. Specifically, how different types of organizational climate affect knowledge transfer through the trust built and the commitment demonstrated (Luo, Lee, 2015). Bishop et al. (2011) assert that the outcomes of interactions between firms and universities are influenced by factors like firms' R&D commitments, university research quality, and geographical proximity. More recent quantitative analysis of over 2600 companies related to the "geographical proximity" factor (Østergaard, Drejer, 2022) revealed that nowadays it may facilitate the initiation of a collaboration between a firm and a university, but it does not matter for keeping them together in a persistent partnership.

Through a case study of six networks of Italian SMEs, Massaro et al. (2019) concluded that important factors for productive exchange relationships are both the maintenance and awareness of mutual and balanced interdependence (i.e. cohesion) between exchange partners. This can be facilitated by maintaining open communication channels that enhance perceptions of reciprocity and minimize perceptions of power and dominance among exchange partners. Another case study suggests that collaboration traditions influence the extent to which SMEs are open to external sources of innovation (Radziwon, Bogers, 2019).

Knowledge transfer, in addition to the factors mentioned, depends largely also on other major factors such as *size of the enterprises* and their *sector affiliation*. These factors have been considered in the analyses of Keith Pavitt whose taxonomy of industrial firms according to their sources of innovation (Pavitt, 1984) is well known. Having investigated data on about 2000 significant innovations in Britain in the period 1945-1979, he argued that the sources and purposes of innovation are sector-specific and depend on the company's size. The text presents a classification of companies by size, not comparable to the EU's current classification, dividing them into small (1-999 employees), medium (1000-9999 employees), and large (10000+ employees). Results of his investigation showed that 53.2% of innovations are distributed among large companies, while in the two other groups of enterprises, they are 21.9% (1000-9999) and 24.9% (1-999). Pavitt's taxonomy consists of three categories of industrial companies:

- Supplier-dominated: companies from mainly traditional manufacturing such as agriculture and textiles that rely on sources of innovation external to the firm.
- Production intensive: firms that are either scale-intensive or specialised suppliers.

- Science-based: high-tech firms, which rely on R&D from both in-house sources and university research, including industries such as pharmaceuticals and electronics.

Although Pavitt's taxonomy has been developed only for industrial enterprises and mostly for large companies, it could serve as a basis for distinguishing industrial sectors that are most expected to search for and use university know-how in their activities.

Knowledge transfer is, at the same time, determined by some regulatory, financial, resource and other types of obstacles, which the sustainable cooperation between universities and businesses faces. For example, a study conducted in Australia covering 1226 SMEs, showed that SMEs tend to use "generic" university-industry transfer pathways (e.g. published research results) rather than university-industry links with high "relational" involvement (de Zubielqui et al, 2015). The same study showed that SMEs are more likely to rely on organizations other than universities and related R&D enterprises for knowledge acquisition as clients/customers or suppliers.

In their study, Delfmann and Koster (2010) concluded that sufficient absorptive capacity of SMEs and cognitive proximity are two critical elements for interaction with HEIs, and four variables are important in explaining the likelihood of an organization interacting with HEIs: size of the firm and sector, level of education and year of graduation of the respondent (the entrepreneur). Pinto et al.'s (2013) research found that the use of technological and professional knowledge-intensive business services and university interactions are influenced by customer absorptive capacity related to R&D and innovation, suggesting that innovative firms tend to use all types of external knowledge sources.

Tether (2002) argued that smaller firms have fewer internal resources and need more external knowledge, which means searching for more cooperation partners (including universities). According to Santoro and Chakrabarti (2002), companies could accumulate knowledge and technologies from various external sources, such as customers, competitors, research organisations, government laboratories, industry research associations and universities, the latter being unique in terms of their potential. Tether (2002) also pointed out that since larger companies have more internal resources to engage in knowledge transfer collaborations, they are more likely to be aware of the capabilities of universities.

Rõigas et al. (2018) used data of the Community Innovation Survey (CIS) spanning the period from 2006 to 2008 for 14 European countries, in order to test four propositions concerning the university-company relation, one of which is connected with the firm's size. For this purpose, they previously summarized data from such CIS conducted before 2008 in different European countries, which revealed that the size of the firm has been positively related to the probability of cooperation with universities.

A 2016-2017 study on the state of university-business cooperation in Europe, made for the European Commission (Davey et al., 2018), also attempted to address the different size groups of enterprises. It has been found out that European academic institutions primarily establish scientific transfer contacts with large and medium-sized enterprises, and less often – with small ones or with entrepreneurs who are in the process of creating and developing their businesses. That is why the executive summary of the study's results not only

emphasizes on the possible mechanisms for intensifying cooperation between universities and businesses, but also offers specific recommendations and mechanisms that would ensure the wider participation of SMEs in these processes (Davey et al., 2018).

The need to introduce research products into entrepreneurial activity is investigated in the literature by looking for dependencies with the sectoral affiliation of the enterprises. Nicholls-Nixon et al (2022) examined the differences in needs between businesses from different sectors regarding the services provided by universities through business incubation. The results showed that *technology-based entrepreneurs* mainly use the physical capital, financial grants, technical and industry-specific knowledge, provided by the incubator. Entrepreneurs from the *creative industries* need physical capital to create products, secure financing for smaller-scale projects, as well as knowledge on fundamental problems arising in business practice (Nicholls-Nixon et al., 2022).

Enterprises from the *tourism* sector are also of interest to researchers in terms of establishing cooperation between them and universities, considering the international context of their activities. The focus was broadened to consider the effect of these partnerships on the students' preparedness and readiness to work in selected six universities, objects of a study conducted in Finland, the UK and South Africa (Ezeuduji et al., 2022).

Vivar-Simon, Errasti and Markuerkiaga (2022) focused on understanding organizational specifics and factors affecting them, considering various opportunities for academic-business cooperation and the growing focus on research and development aspects in partnerships. The objects of their research were 332 SMEs from the manufacturing sector, serving as a basis for analysing the impact of organisational context-related factors (such as general business characteristics, business openness, R&D, innovation, willingness to and support for university-business cooperation) on the activities of the universities related to their educational mission.

Bodas Freitas et al. (2013, p. 444) examined the differences between mature and emerging industries in terms of the process of building technological and innovative capabilities within them, and the role of universities in this process. The innovation environments in mature low- and medium-tech industries and in emerging high-tech industries differ considerably in terms of market and technology turbulence and knowledge input characteristics. Consequently, the strategies for sourcing external innovations, the role of networking, collaborations for innovation development, and the inputs themselves vary. The authors also presented the findings of other researchers, such as Grimpe and Sofka, who argued that firms in high-tech sectors seek technological knowledge from universities and/or suppliers, while firms in mature industries acquire market knowledge from customers or competitors. (Bodas Freitas et al., 2013, p. 445).

Thatcher et al (2016) examined the *benefits* of collaborative research projects for SMEs, universities and graduate students. The internal benefits for SMEs were found to be connected with sharing and/or reducing risk, opportunities for ensuring flexible, effective service; access to specialised research knowledge and enhanced internal capabilities, etc. The external benefits of SMEs' involvement in collaborative research projects with universities were generalized as follows: establishment of more and stronger SMEs and stimulating their

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growth; reducing the risk within R&D projects and enhancing collaboration with academia, etc. (Thatcher et al., 2016).

The research of Teixeira, Veiga and Fernandes (2019) also noted the importance of the small business sector's development through its collaboration with academia. The transfer of knowledge leads to *higher innovation intensity* and, ultimately, to *better financial performance* of companies. Their research also revealed that certain factors such as the larger number of workers (respectively the larger size of the company) is connected with a higher number of patent applications.

Dutrénit et al. (2010) shape two types of benefits for firms collaborating with universities: ones related to long-term innovation strategies and others related to short-term production activities. Their study reveals the interesting finding that medium-sized enterprises are relatively least active in their interactions with universities.

Hou, Hong, and Shi (2021) examined the *efficiency* of university-industry collaboration among 71 leading Chinese universities. Their findings revealed that factors determining collaboration efficiency include *university characteristics*, *government-generated scientific research funds*, and *regional economic status*, in addition to the intensity of partnerships and innovative enterprises.

In connection with the above, it should be noted that the regional economic status is a prerequisite for building and developing successful relations not only from an economic point of view, but also as a level of *awareness* and *desire* (motivation) of universities and businesses to cooperate. Harper and Georghiou (2005) used a "success scenario" approach to develop a shared vision of the future of business-university linkages in the region of Manchester to making it a 'Knowledge Capital' city. Five are the dimensions of this scenario – infrastructure, human resources, inward investment, university missions, and networking.

The impact of the *informal* knowledge transfer mechanisms on the level of innovation performance of enterprises was studied by Abdulai, Murphy and Thomas (2022) among 245 firms. The findings revealed that in order to achieve better innovation performance by informal means, firms need to have a well-coordinated *social system* to get knowledge from all possible university sources.

The barriers that hinder the transfer of knowledge and cooperation between science and enterprises, as well as the implementation of university research products in entrepreneurial practice, are of interest for scientists, practitioners and representatives of various supporting business institutions and organizations. According to Abreu et al. (2009) "it is commonly argued that there are cultural barriers that limit interactions because universities are different to business. For instance, the Lambert Report stated that: 'companies and universities are not natural partners: their cultures and their missions are different'." The authors claim that besides cultural differences, the conventional wisdom is that the conflict over intellectual property (IP) is also an important barrier. Nevertheless, according to them, this is not supported when asking the academicians – the last ones point out the lack of time as the most important constraint.

A major gap in the research practice within the current article's problematic area revealed Shang, Zhang and Liu (2021). They emphasized the *unilateralism* in research done on business-university collaboration, which is why they considered this relationship bilaterally. They examined the relation between knowledge potential matching and innovation performance of university-enterprise cooperation using data over a period of ten years (2010-2020) for the joint patents applied for (Shang, Zhang, Liu, 2021).

In an earlier publication, Bercovitz and Feldmann (2006) also emphasized the *unilateralism* of research, pointing out that university-industry technology transfer could not be fully understood if it is not considered also from the firm's perspective. The authors noted that there are unfortunately only a few studies that consider the firm, rather than the university, as the focal actor in these relationships. That is why the present article is aimed at **examining the university-business interactions from the companies' point of view**.

State-of-the-art and practice in Bulgaria

The first study of innovations in Bulgaria in strict compliance with the Eurostat and OECD methodology was conducted in 1997 by the scientists A. Dimitrov, R. Chobanova, P. Ilieva, T. Lekova and R. Kazandzhieva. The results of this study outline alarming trends in the development of innovation in the country and pose questions related to the causes of the negative situation. Among these trends is the declining innovation activity of the business enterprises (Dimitrov et al., 1998). This, to some extent, is explained by the fact that Bulgarian companies have a low innovation culture related to the national economic genotype (Chobanova, 2012a).

In particular, among the first analyses of the influence of the size, structure and branch affiliation of enterprises and institutional interactions and own scientific and technical potential on the level of innovativeness of the Bulgarian economy, are those made by Chobanova (2012b).

Bulgarian enterprises, predominantly micro and small-sized, often face resource shortages or lack of necessary resources for R&D. The data shows that large enterprises are the biggest contributors to the development of technological innovations, but in general, the share of innovative enterprises in Bulgaria is lower compared to the average level for EU countries (Kirova, Zareva, 2021). Despite lagging behind the EU, the SMEs sector in the country has seen a steady trend of increasing innovation activity since 2015. The number of innovative SMEs that offer new and/or improved product innovations and business process innovations is growing (Georgieva, Yalamov, 2021, 2022).

The majority of Bulgarian enterprises do not operate in high-tech sectors, leading to a lack of clear need for R&D product implementation or use, except in cases where specific problems need to be solved (Kirova, Zareva, 2021). This, in turn, determines the degree of interest and the intensity of knowledge transfer and, respectively, the motivation for building and developing partnership relations between enterprises and universities.

A study, aimed at identifying the obstacles in the establishment of cooperation between academia (scientific organizations and universities) and businesses in Bulgaria, found the

following problematic areas: available strategic and regulatory base; public and private sector funding; human capital; capacity of businesses and academia; non-commercial and commercial forms of cooperation and commercialization of innovations and technologies; scientific and technological infrastructure that mediates and facilitates the knowledge and technology transfers (Zareva, Kirova, 2021).

Among the available data characterizing innovation activity in the country as a whole, as well as the use of research products by enterprises, are those obtained within the framework of the Community Innovation Survey (CIS) and the European Innovation Scoreboard (EIS).

CIS for the period 2018-2020 examines the cooperation of innovative enterprises with various external organizations, including with universities and other HEIs. The research covers 14,800 enterprises from Bulgaria of various size classes without micro-enterprises.

The share of identified innovative enterprises⁵ in Bulgaria is only 36.2% compared to the EU average of 52.7%, which can be interpreted as a significant lag. Of these, only 1184 cooperate with external organizations (22.1%, at 25.7% for the EU-27), and the cases in which the cooperation is with universities or other HEIs are 212 (4% at 10.5% for EU-27). Of these 212 enterprises, 195 (3.6% vs. 10.2% for EU-27) cooperate with national universities and other HEIs, 33 with those from EU and EFTA countries, and 16 with universities and other HEIs outside the EU and EFTA.

According to the economic activity carried out by enterprises cooperating with universities and other HEIs, the picture is as follows: 90 of them (42%) are from the processing industry, and 76 (36%) – with economic activity ‘Creation and dissemination of information and creative products; Telecommunications’. Of the latter, 59 enterprises have economic activities in the field of information technologies (28%). Other economic activities that have more significant shares (over 5%) are: ‘Manufacturing of machines and equipment, with general and special purpose’ – 19 enterprises, and ‘R&D activity’ – 14 enterprises.

As for the size of innovative enterprises that cooperate with universities and other HEIs, the picture is as follows: 50% are small, 32% are medium and 18% are large-scaled. When comparing these shares with the shares of the corresponding size classes of enterprises (83%, 15% and 2% of the total without micro-enterprises), it can be seen that as the size of enterprises increases, the share of those who are innovative and cooperate with universities and other HEI.

From the CIS (2018-2020) it is clear that the innovation activity of enterprises from the extractive (mining and quarrying) (B) and manufacturing (C) industries, as well as those whose activity is the production and distribution of electric and thermal energy and gaseous fuels (D), and supply of water, sewage services, waste management and remediation activities (E), is significantly higher than that of enterprises with activities in the service sector, and in relation to the two types of innovations covered by the study – product and

⁵ The enterprise is considered as innovative if during the reference period it successfully introduced a product or business process innovation, had ongoing innovation activities, abandoned innovation activities or was engaged in in-house R&D or R&D contracted out.

process. After the industrial sectors are the services covered in sectors H, J, K and sections 46, 71, 72,7 (National Statistical Institute (NSI), 2022a).

An important aspect of CIS research is the knowledge acquisition channels of enterprises. These channels are grouped in the following order:

- Conferences, trade fairs or exhibitions
- Scientific/technical journals or trade publications
- Information from professional or industry associations
- Information from published patents
- Information from standardisation documents or committees
- Social web-based networks or crowd-sourcing
- Open business-to-business platforms or open-source software
- Extracting knowledge or design information from goods or services (reverse engineering)

Unfortunately, in the study for the period 2018-2020, no data were obtained, but it is useful to present the data for the previous study – 2016-2018, which covered 15495 enterprises, of which 4665 (30%) were defined as innovative.

The research data indicates that innovative enterprises use various knowledge sources more intensely than non-innovative ones, with differences more evident in small firms and in more expensive and complex knowledge acquisition channels.

The data does not reveal significant differences between enterprise size classes, but there is a notable increase in the use of accessible sources like conferences, fairs, exhibitions, scientific journals, and trade publications with increasing enterprise size. Larger enterprises use professional and industrial associations, patents, and standardization documents more frequently, while smaller enterprises are more active in social web-based networks and crowdsourcing.

The picture thus presented could serve as a basis on which to highlight explanations related to the use of research results of universities and other HEIs. For example, scientific conferences can attract enterprises by offering well-presented results, while active university participation in fairs and exhibitions can increase the visibility of their scientific findings.

Data from the European Innovation Scoreboard (EIS) survey also provide a good basis for outlining the problems in the use of the research products of universities and other HEIs by enterprises.

From the latest data (2023), the following strengths in the innovation activity of enterprises stand out the high (relative to the average) indexes for EU Design applications (149.2 out of an average of 100) and for EU Trademark applications (118.9 on an average of 100), as well as close to average product innovation index (78.8). The EIS survey also reveal significant progress compared to 2016 in the following areas:

- Product innovation – 67.4% increase;
- Cooperation of innovative SMEs – 51.8% increase;

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- Business process innovation – 45.4% increase.

At the same time, the lack of lifelong learning (index 0), extremely low index for state support of company R&D resource productivity (3.2), low resource productivity index (12.3), and low index for innovation costs per employee (15.6) are among the weaknesses stated by EIS.

Although with a far below-average innovation index (46.7), it can be said that there are trends towards increased motivation of SMEs to innovate despite the environmental constraints they face. The question is: to what extent does this motivation direct entrepreneurs' attention to the use of university research results?

According to NSI data, the R&D expenditures incurred by the participants involved in this process (1 074 004 kBGN⁶ in total) show that in 2021, business enterprises invested the most funds – 65.8%, followed by the state sector, which allocated 27.1%. HEIs follow – 6.5% and non-commercial organizations – 0.6%. However, the huge share of these funds is for current expenses, not for the acquisition of fixed assets (NSI, 2023a).

There are large territorial disparities in R&D expenditures: 77% were invested only in the Southwest planning region, of which 550 244 kBGN were the expenditures by the enterprises (51.2% of the total or 66.5% of the regional), 239 989 kBGN from the state sector, 33 769 kBGN – from the HEI and 3 262 kBGN from non-commercial organizations. For comparison, the share in the total amount of R&D expenditures in the Northwest region is 4.5%, and in the North-Central region – 3.0% (NSI, 2023b). The reason for these disproportions can be found in the fact that the capital city of Sofia, the economic and educational centre of Bulgaria, is in the Southwest region. The Northwest region is facing the greatest difficulties in its development in the country. The region's insufficient R&D expenditures indicate a lack of current capacity and limited investment activity, which could lead to future disparities.

Disproportions are found not only in terms of the territorial distribution of R&D expenditures, but also in particular scientific fields. The most funds were invested in engineering and technology sciences (51.5%), as well as in medical and health sciences (19.2%). The least R&D funds were spent in social sciences (2.4%) and in humanities and the arts (4.1%) (NSI, 2023c).

Among enterprises, the amount of funds invested in R&D varies significantly according to their economic activity (KID–2008). Enterprises developing activities in the creation and distribution of information and creative products, as well as telecommunications, invested 262 798 kBGN, followed by professional activities and scientific research – 235 595 kBGN and processing industry – 178 943 kBGN. Of the sectors for which information is provided, the lowest activity among enterprises is found in the following sectors: agriculture, forestry and fisheries – 167 kBGN, education – 283 kBGN and administrative and auxiliary activities – 604 kBGN (NSI, 2023d).

Significant differences are found depending on the size of the enterprises regarding the funds spent by them for R&D. Large enterprises (>250 employees) are expected to be the most

⁶ kBGN – thousand Bulgarian levs.

active, which share in total expenditures made by business enterprises is 57.4%. With a share of 22.7% are medium-sized (50-249) enterprises, followed by small ones (10-49) with a share of 13.3%, and micro (<9) firms with 6.5% (NSI, 2023e). The data show a directly proportional relationship between the size of enterprises and the expenditures they make in R&D.

In summary, the following limitations of the available research on the state of knowledge transfer from universities and other HEI to enterprises in Bulgaria should be highlighted:

1. CIS overlooks micro-enterprises in Bulgaria, which play a significant economic and social role, providing 30.6% employment and 18.2% added value;
2. CIS focuses on product and process innovation (which of course leads because of their undoubted distinctiveness), but does not examine other types of innovation – among them those defined by Schumpeter, but also some new ones – e.g. green and responsible innovations;
3. Focusing on industrial sectors and excluding micro-enterprises from CIS, the idea emerges that only industrial enterprises can be innovative;
4. Despite the clarity provided by statistical data on universities' and other higher schools' research results in Bulgaria, no studies have been conducted in recent years to track their use by enterprises of all sizes;
5. Cooperation between enterprises and universities (and other HEI) for the purpose of knowledge transfer has been investigated sporadically (as in CIS 2016-2018), and without going into depth about the motivation of enterprises for this cooperation;
6. Despite the availability of data (although not from the latest CIS) on the channels through which knowledge is transferred, it lacks detail on the forms through which knowledge is transferred in the respective channel.

These limitations determine the motivation to conduct an original empirical study, aiming to cover as wide a range of enterprises as possible in terms of size and sectors of economic activity, and with a focus on various types of research results of universities and other HEIs that can be transferred as knowledge and applied in the activities of enterprises.

Based on the literature review, the data of CIS, EIS, the NSI, and authors' expert observations in the current article's problematic field, the following hypotheses have been developed:

Hypothesis 1. The increase in the enterprises' size is positively related to the intensity of established relationships with HEIs in the field of knowledge transfer.

Hypothesis 2. As the size of the enterprises decreases, their orientation towards standard and generally available university research products increases.

Hypothesis 3. The enterprises' sectoral affiliation has an impact on the intensity of the relationships built with HEIs in the field of knowledge transfer.

The empirical study is **limited** to achieving the aim and testing the hypotheses, not investigating some other basic questions having been raised out of the literature review such as types of channels for knowledge transfer, benefits to and better performance of companies using university products, regional and international aspects of university-business cooperation.

3. Research Methodology

904 enterprises operating in the Bulgarian market were surveyed in the period 2020-2021. The survey was carried out within the framework of a research assignment of the Institute of Entrepreneurship of the University of National and World Economy (Sofia, Bulgaria) titled “Strategies and models for using the results of the University Science in Entrepreneurial Activity”. Bulgarian universities and companies were surveyed by two different questionnaires. Detection and thorough analysis of the relationship between science and business, as well as the process of implementing research results created in HEIs, from the point of view of businesses, has been pursued by surveying companies within the research assignment.

The survey of firms, results of which are analysed in this paper, was conducted through a standardized online questionnaire. The online form provided a brief introduction to the research assignment, its objectives, the research team and institution, and contact information for respondents. This was done to ensure transparency, public awareness, clarity about the methodology, and the importance of the credibility of the expected answers. In addition, the commitment of the researchers to ensure the confidentiality of the information received from the respondents was stated there.

The questionnaire included several questions that have provided information about: the companies’ characteristics and their competitive advantages; the HEIs whose research products or services are used (in the cases of such usage); the types of products or services used by enterprises; the reasons why companies do not use products or services from HEIs in their activities (in the cases of not-usage).

The survey was aimed at reaching as many companies operating on the Bulgarian market as possible and thus covered a wide range of enterprises, initially not having into consideration their size, economic activities carried out, legal status, age, location, etc. Entrepreneurs, managers and key experts/employees were sought as the most suitable persons to fill in the questionnaire, as they could give reliable answers to the formulated questions.

A set of channels was used to reach respondents. The main ones were: a contact database of the members of the team working for the implementation of the research assignment; through assistance from supporting institutions and organizations, including branch chambers, units of the Bulgarian Chamber of Commerce and Industry, business associations and others; through posts in specialized groups in the social media. Support for the conduct of the research was provided by organizations that published information about the research assignment and provided a link to the survey on their websites as well as in their newsletters.

The analysis of the data obtained was done by groups of enterprises (formed by economic sectors and size). The methods used for analysing the empirical data were comparative analyses, exploratory data analysis (EDA) and confirmatory data analysis (CDA), in which the tools of diagrammatic images and contingency tables were also used.

According to their size structure, using the official EU classification, the enterprises in the research sample were represented disproportionately with the increase in their size – micro enterprises (0-9 employees) were 64%, small ones (10-49 employees) – 23%, medium-sized

(50-249 employees) – 9%, and large companies (over 250 employees) – 4%, while their shares in the overall number of Bulgarian enterprises are respectively 92%, 6.6%, 1.2% and 0.2%. Such over-proportionality implies more positive generalizations, but at the same time reduces the risk of misleading conclusions for the enterprises of the higher size classes – especially the large ones.

The Bulgarian national classification of economic activities was used to analyse the sectoral affiliation of enterprises. As expected, enterprises with economic activity “Wholesale and retail trade” (according to the national classifier) have the largest share in the sample (26%), followed by those in the “Manufacturing” (18%) and in “Professional, scientific and technical activities” (14%). With 6% shares are the enterprises sectors “Construction” and “Transportation, storage and posts”. With 5% shares are firms in “Accommodation and food service activities”, “Information and communication” and “Agriculture, forestry and fishing”.

Regarding the extent of using university research results by the companies investigated, out of 901 respondents having answered to this question, 117 (13%) of them stated that they use research services and/or products developed in higher schools/ universities in their activity. The particular HE/universities whose research results the companies are using are various and depending on firms’ specialization and needs. Among the most often pointed by the respondents HE/universities are not only industry-focused and specialised ones but also classical universities with a broad range of research areas, etc.

4. Empirical Study Results

4.1. Company size and use of research results

The results of the survey clearly show that with a growth in the enterprise’s size, the use of research results also increases – from 10.8% for micro-enterprises, through 12.1% for small enterprises, to 23.8% for medium-sized enterprises and 25.7% for large enterprises. What is striking is the almost double difference in the reported shares between small, on one hand, and medium-sized enterprises, on other, despite the proximity of the two size groups. Obviously, the differences in motivation and opportunities to use research results between micro- and small enterprises are significantly smaller than between small and medium-sized enterprises. The picture outlined in this way can be explained not so much by the motivation to use research results in the activity of the relevant size class of enterprises, as by the increased absorption capacity of the enterprises of the higher size class. Important elements of analyses necessary to clarify the small shares of enterprises using research results in all size classes are the sectors of economic activities, implying different needs for new knowledge, as well as the perceived importance of individual types of competitive advantages used by enterprises.

4.2. Sectors of economic activities and use of research results

The data from the survey shows that among the enterprises in the sectors “Education”, “Human health and social work activities”, “Agriculture, forestry and fishing” and

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“Professional, scientific and technical activities”, the shares of those who use scientific results were the highest – respectively 31%, 29%, 24% and 21%. Close to them but with lower shares are the enterprises in the sectors “Information and communication”, “Construction” – both with 18% and “Manufacturing” – 15%.

These results, somewhat expectedly, create a different picture of the relationships between the sector of economic activity and the use of university research outputs than that outlined by the CIS. The difference can be explained by the wider range of forms in which these results are presented – not only product and process innovations, but any new knowledge applicable in the activities of enterprises.

Relatively small are the shares of enterprises using research results in the sectors “Financial and insurance activities” (9%), “Wholesale and retail trade”, “Accommodation and food service activities”, “Administrative and support service activities” (all with 8%). No enterprises from the other sectors have stated that they use results from scientific research.

The obtained results can be a confirmation of the assumption that sectors with higher shares of enterprises that are using results from scientific research have a greater need for new scientific knowledge in order to build competitive opportunities and develop in the long term. On the other hand, the absence of such enterprises in the “Transporting and storage” sector, in which 6% of all surveyed enterprises operate, is somewhat puzzling. The explanation for the other sectors, in which there are no enterprises using research results, is in the single cases or in the small number of enterprises covered by the study.

4.3. Types of research products and their use by size classes of enterprises

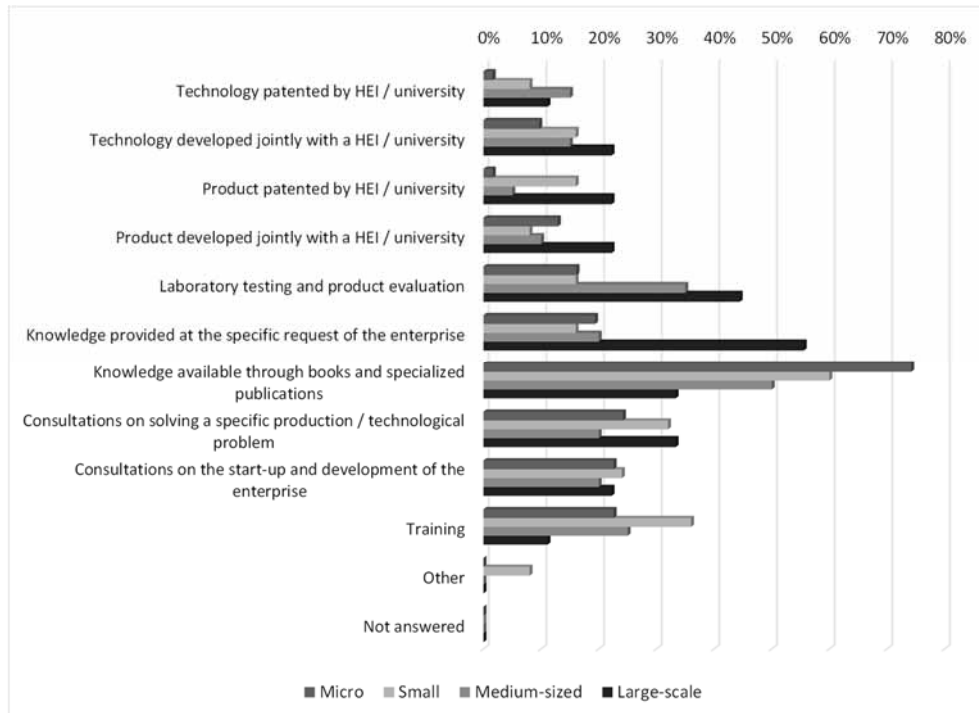
It is known that the results of the research activities of the universities can be offered in different forms and with different degrees of accessibility to the enterprises interested in their use. In the study, the different types of outcomes were distinguished in the manner presented in Figure 1.

When distinguishing the individual forms of research results, both their classification according to CIS, Oslo Manual (OECD, 2018), but also the systematization of transfer media proposed by Arenas and González (2019) were considered.

An impression is made by the strong predominance of knowledge as a form of research product in the given answers. Is it generally available (used by enterprises without it being considered in the universities) or is it presented to the enterprises by request? In both cases, it is a matter of scientific production, which is anyway developed in the universities (mostly without taking into consideration its usefulness for the business), while its adoption into the practice is initiated by the businesses. The state with the products and technologies, patented by HEIs and afterwards used by businesses, is similar. In this case, however, it can be expected that by working on these research products, universities are taking into consideration the eventual interest from the business.

The results from the analysis revealed an interesting picture, showing substantial variations between the enterprises of different size classes regarding the research products they most commonly use (Figure 1).

Figure 1. Most commonly used research products by enterprises of different size classes



Source: Own analysis.

The most popular research products are those that are most accessible, including in terms of price, such as – the knowledge presented in books and specialized journal publications. It is noticeable that when using these types of products there is a decrease in their utilization as the size of the enterprise increases – from over 74% in microenterprises to 33% in large enterprises. This decrease is compensated for by using knowledge provided upon specific requests by companies, with utilization reaching 56% in large enterprises. However, in micro, small, and medium-sized enterprises, the utilization is relatively modest – 19%, 16%, and 20%, respectively. The data shows that small enterprises more frequently rely on consultations and training as a means of acquiring new knowledge, as well as jointly developed technologies and products patented by universities. Laboratory testing and product evaluations are more commonly utilized by medium and large enterprises.

It appears that technologies and products patented by universities are scarcely used by microenterprises (only single cases) but at the same time, this size of enterprises does utilize jointly developed technologies and products (10% and 13% of the cases).

In summary, the results of the empirical study confirm the assumption that the utilization of universities' research products is influenced by both the accessibility of these products and their correspondence with the specific needs of the respective enterprise. In this context, it can be argued that larger enterprises are more likely to engage in more expensive forms of acquiring and using research products, including those obtained through collaborative activities. A picture which to different extents was proven from previous studies – de Zubielqui et al. (2015), Delfmann and Koster (2010), Pinto et al. (2013), Tether (2002), and Rõigas et al. (2018).

4.4. Reasons for non-use of research products

The results of the conducted empirical survey do contradict the generalizations and conclusions made on the problem, and the resulting assumptions about the relatively scarce knowledge about this issue in Bulgaria. Nevertheless, a major problem in the national context remains the high percentage of enterprises that do not use the research products of HEIs (as it is also proofed by CIS). This high percentage (87% in the present survey) directs attention to the investigation of the reasons underlying it. Despite established opinions on reasons like low absorptive capacity and lack of resources, it's crucial to learn from entrepreneurs' or managers' explanations.

The most frequently cited reason in the study is that “The company does not need research services/products created by HEIs” – from 54% for micro-enterprises to 29% for large enterprises. The survey shows that as the size of the enterprise increases, the frequency of citing this reason decreases.

The reason cited in the second place is the inconsistency of the HEIs' research products with the needs of the enterprise. An interesting fact regarding this reason is that it is more prevalent among small and large enterprises, while it is less common among micro and medium-sized. The explanation of this non-linear relationship between enterprise size and the perceived inconsistency of research products offered and needs should be sought in further research.

Thirdly (but relatively less often), the inconsistency between the perceived need for the use of research products and the need for a corresponding capacity for this use is cited as a reason. This reason is more often mentioned by micro and medium-sized enterprises, and less frequently by small and large ones, which raises the question: why do small enterprises not fit into the assumption that their capacity to use research products increases with the size of the enterprise?

In addition, a number of responses were received for inadequate attitude from HEIs in cases when businesses look for their products and services. This indicates the need for Bulgarian universities and other HEI to take corrective actions in this regard.

5. Hypothesis Testing

An important component of the analysis, necessary for proving hypotheses 1 and 3, is the adoption of a measure of the intensity of relationships between enterprises and universities and other HEI. In this case, the combination of two elements is considered as such a measure: the frequency of enterprises using research products and the mechanism (form) through which the creation and transfer of research products are realized.

Regarding the first element, the data unambiguously show that as the size of the enterprises increases, the proportion of enterprises in the respective size class using research products also increases. The performed Chi-Square test proves that the relationship is statistically significant, but at the same time weak in strength (Cramer's $V = 0,124$).

Concerning the second element, however, the analysis of the data reveals a non-linear dependency among the lower-size classes. At the same time, it can be observed that the relationships between large enterprises and HEI exhibit higher intensity compared to the general sample of SMEs.

Thus, with the assumption that it is difficult to point out a significant difference in intensity between small, on one hand, and medium-sized enterprises, on the other, hypothesis 1 can be accepted. Supporting the acceptance of the hypothesis are also the answers clarifying the reasons for not using research products – it is evident that with the increase in enterprise size, the assessment of the necessity to establish relationships with HEI also changes – large enterprises are more demanding in their search of the right research product compared the medium, and small enterprises too compared to micro-enterprises.

As for hypothesis 2, it is undoubtedly proven by the data on the types of research products used by different size classes of enterprises. The hypothesis was tested using the Chi-Square test, applied to the individual types of research products used by the respective class of enterprises. It is important to note, however, that as the size of the enterprise increases, the reduction in the use of research results in generally available forms is replaced by the use of results provided on a specific request, but not from fundamentally more expensive and complex forms for knowledge transfer (Confirmed by Chi-Square test).

Hypothesis 3 can also be accepted on the condition that the sectoral affiliation suggests not only specific needs for research products but also a specific size structure of enterprises. The existence of some inconsistency between the sectoral composition in the research sample and that in the total population of Bulgarian enterprises requires additional sector-specific studies to definitively prove the hypothesis.

The results of the empirical study conducted, which can be claimed to add new understandings to existing knowledge, are:

1. The identification of sectors of economic activity classified as services, for which the assumption that they would have an interest in the use of university research products is rare due to the dominant understanding that the main users are manufacturing and ICT enterprises;

2. The disclosure of a non-linear relationship between the size of the investigated enterprises and the assessment of the compliance of the research products offered by universities with the needs of the enterprise;
3. Each size class of enterprises, although to a different degree, is interested in the use of knowledge (research products) of universities and other higher schools, but the form of presentation and transfer of this knowledge determines the degree of its use. Among the main characteristics of the forms of presentation and transfer are the costs and the correspondence of knowledge to specific problems of enterprises.

6. Policy Implications

Policymakers should differentiate specific programme measures for intensifying knowledge transfer from universities and HEIs to enterprises based on their size class. This includes reducing barriers to transfer, such as costs and human resources engagement. Supporting micro-enterprises should focus on university policies and practices while encouraging bigger enterprises to build their own absorption capacity and implement joint projects with universities.

The limitations of the conducted empirical study do not allow for particularly detailed policy recommendations to promote the use of university research results in entrepreneurial activity, but they provide the basis for the following recommendations for further research on the topic:

- Deepening research in sectors of economic activities in which neglect of the need for the use of research products is registered – mostly traditional services that are affected by recent technological development and new knowledge.
- Expansion of research in the direction of identifying the most common problems in individual economic sectors, for the resolution of which the creation and transfer of knowledge from universities is critical.
- The identification and modelling of cooperation mechanisms between enterprises and universities, which ensure mutual interest and, together with this, protect the public interest in spending public funds for R&D.

7. Conclusions

The proof, albeit with certain conventions, of the hypotheses formulated based on the literature review, emphasizes the need for the development of specific policies and programmes to encourage the establishment of effective relationships between enterprises of different size classes and HEIs to facilitate the processes of creation and transfer of research results into the practice of these enterprises.

Objects of special support should be the micro and small enterprises operating in sectors of economic activity often considered as non-typical users of university research products – mostly providing traditional services and being pressed by other economic sectors to achieve higher productivity in order to survive and develop further. This support should primarily be directed towards providing entrepreneurs with knowledge of the benefits that research products could bring to their businesses, and secondly, towards developing the absorptive capacity of the enterprises they manage.

Finally, referring to some of the arguments for the non-use of research products by enterprises, in-depth analyses of the processes for creating such products in HEIs should be conducted, with a focus on the motivation for research activities and the alignment of these activities with the current and strategic needs of each economic sector.

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HOW TO APPLY DIGITIZATION IN THE TOURISM AND HOSPITALITY?²

Information and communication technologies have moved us from an industrialized society to an information society, driven and regulated by the information content. The content of the website, the automation and robotisation as technologies used by hospitality organizations have become necessary conditions, providing a warranty that the company will be recognized on one hand. Tourism and hospitality are industries that have been most significantly affected by the information age in which we live. Due to digitization, the tourist has the opportunity to obtain preliminary information about the given destination, to take a virtual tour and to create expectations about the future destination he/she plans to visit. The digital technologies also support and help the tourist in the preplanning, planning stage as well during the trip and after it. In other words, the digitalization of tourism facilitates and contributes to the quality service of tourists. The current paper addresses the essence of digitalization through application of the artificial intelligence in the example of tourism and hospitality. What is more, it discusses how the digitalization can impact on the tourism industry. Best practices for the application of digitization in the sphere of hospitality and tourism have been also presented in the current paper.

Keywords: digitization; robots; artificial intelligence; chatbots; travel blogs; AI; hospitality robots; emotional intelligence; digital maturity

JEL: L83

Introduction

Tourism and hospitality are industries that have been significantly affected by the information age in which we live. Due to digitization, the tourist has the opportunity to obtain preliminary information about the given destination, to take a virtual tour and to create expectations about the future destination he/she plans to visit. The digital technologies also support and help the tourist in the preplanning, planning stage as well during the trip and after it. In other words, the digitalization of tourism facilitates and contributes to the quality service of tourists.

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Digitization of tourism promotes self-service for consumers. In this sense, the successful application and use of IT depends not only on the technology, but also on the way the user perceives and uses this technology (Yordanova, 2016). What is more, the level of adoption of digital technologies reflects the digital readiness of the organizations from the hospitality and tourism industry.

Main body

Digitization can be considered from several aspects. From an information point of view, it represents the process of changes and transformations that move and build on the foundation of digital technologies as within an organization. In other words, digital transformation is defined as an organization moving to big data, analytics, cloud, mobile and social media platforms. whereas organizations are constantly transforming and evolving in response to the changes in the business environment, also a process of fundamental changes in existing and creation of new business models in response to the proliferation of digital technologies such as cloud computing, mobile Internet, social media and big data.

In other words, *digital transformation represents all changes based on the digital technologies leading to unique changes in the way business operates, processes and creates value* (Via, 2019).

From a marketing point of view, digitization can be expressed by the use of new digital technologies, such as social media, mobile, analytics or embedded devices, to achieve improvements and refinement of business processes (Via, 2019).

From a managerial point of view, digitization can be considered as a transformation achieved through digital technologies in the company's business model, resulting in changed products or organizational structures or in the automation of processes. These changes can be observed in the growing demand for Internet-based media (Via, 2019).

As a term, digitization reflects the regulation on a government level, expressed in the strategy and vision for tourism development. During the COVID-19 crisis, we witnessed how some industries flourished while other businesses were faced with the question of their survival. In March 2020, the whole world faced a new challenge that had surprised many businesses. A worldwide pandemic was declared and very strict regulations by the World Health Organization have been introduced all over the world. On the one hand, social contacts were prohibited, a strict regime of disinfection and social distancing was introduced. The social experiment itself turned out to be disastrous for one of the most developed industries in the world, namely tourism which together with the hotel industry, suffered the most significantly, because many excursions were cancelled, and hotels and restaurants were forced to close for a while due to the announced statistics of increasing cases of infection worldwide. The unsuspecting tourism businesses had to adapt somehow to survive the harsh measures affecting mostly this business of creating the tourist experience.

As a result, in 2020, the number of nights spent in tourist accommodation facilities in the European Union (EU) have decreased by 51% compared to 2019 year. The EU accommodation sector only has started to recover in 2021, by 28% more overnight stays

compared to 2020, reaching almost two-thirds of pre-pandemic levels in 2019 (<https://ec.europa.eu/eurostat>).

In 2020 year, 51 million fewer European Union residents made private trips. Comparing 2019 year to 2020 year, there was a 21% decline to 193 million in 2020. In percentage terms, as a share of the population (aged 15 or older), 52% participated in tourism in 2020, a decline from 65% in 2019).

The issue of digitization has gained significant relevance in the context of the pandemic crisis, which has proven detrimental to this specific industry. Many of the restaurants were faced with the dilemma of how to survive and position competitively in the new economic reality. Considering the strict regulations introduced all over the world, in some countries the restrictions were extremely restrictive and detrimental to entire industries, tourism and hospitality were forced to react post factum in order to survive in the first place, to be able to cover their costs. In this regard, their transition to a digital mode of doing business and the inclusion of digital models in their way of functioning were critical and very essential as the only alternatives for business activity (Bankova, 2021).

2020 was quite a dramatic year for the whole world. The widely announced COVID epidemic has been devastating for the hospitality and restaurant industries, where direct contact with guests has been prohibited for some time. After the introduction of a state of emergency in 96% of the world's countries, restrictions and bans on travel, holding organized events, including tourist trips, increased the sense of risk while traveling and a number of hotel reservations were cancelled. Despite the fact that the Ministry of Tourism of the Republic of Bulgaria announced the country "a tourist destination with a seal of safety and hygiene (safe travel seal) from the World Travel and Tourism Council, an outflow of tourists was recorded, which led to a serious stagnation in tourism as an industry and serious negative consequences for the industry (Zheleva, Mutafov, 2021).

The Safe Travels stamp itself aims to reassure and assist travelers in choosing a safe destination and accommodations worldwide that have implemented high standards of safety and hygiene by following specific safe travel protocols, providing guidance to travel providers and tourists regarding hygiene, disinfection and physical distancing.

Considering the remote access and the impossibility of physically visiting many of the tourist sites, restaurants and bars, the virtual model of activity has proven to save many of the businesses during COVID crisis.

The development of tourism and hospitality in the Republic of Bulgaria as part of the EU is carried out with the support of a number of institutions as the Ministry of Tourism, and is regulated by the tourism development strategy for the period 2018-2030.

The level of digital maturity is a term that does not only mean the degree of readiness of the organization to use digital technologies in its activity, but also strategic and operational readiness for the operationalization of processes and compliance with the requirements of the information society (Dencheva, 2004).

The digitalization process itself depends on several circumstances. On one hand, it is up to the available infrastructure of the organization enabling the self-service of the tourist, and on

the other depends on the level of the digital skills of the potential tourist himself, the user (Bankova, 2022).

On the other hand, the state as a regulatory body has played a life-saving role for organizations in the field of tourism and hospitality. It not only created the restrictions themselves, but also introduced an option for conducting sales over the Internet, for online orders and for on-site delivery. Thus, many of the restaurants have been able to survive by reporting increased sales volume through their virtual platforms.

The digitization of tourism organizations took place abruptly, without a smooth transition and gradual introduction of innovations. The purpose of the present paper is to present on the one hand the phenomenon of digitization, and on the other to consider its impact on business, in particular hospitality and tourism.

Before we proceed to consider artificial intelligence we need to clarify what intelligence is as a concept. By intelligence is meant the ability of a person to think in a reasonable and logical way. There are many tools for measuring the level of general intelligence, the most popular of which is the so-called IQ. Approximately 80% coefficient of intelligence is inherited from parents, and the rest is formed in the first 2 years from the life of the person. There are several types of intelligence: emotional, spiritual and intellectual.

One of the main criteria for measuring the level of general intelligence is through IQ which measures an individual's ability to learn a language, for example, through verbal intelligence, logical and abstract thinking. In their study, Mura et al. (2019), found a positive relationship between intellectual intelligence and the ability level for understanding. In other words, if the person has a high intellectual intelligence possessed by the individual, it will lead to a high level of understanding and awareness. And vice versa, the less intelligence people have, their ability to understand will be low.

In many ways, robots have an intellectual intelligence. They are currently being used in the field of the hospitality industry in positions where they replace employees, performing routine and simple operations such as meeting guests, transportation and food preparation in the restaurant (Yordanova, 2023). As digital machines, robots are fully equipped with a different operating system (digital vs biological) and with correspondingly different cognitive qualities and abilities than biological beings such as humans and other animals (Muhammad, et al., 2019).

Digitization as it became clear has different forms of application, some of which are more popular and others not so much. With the development of the last wave of the information society, we are witnessing the entry of artificial intelligence into all spheres of our life and especially in the field of tourism and hospitality. Many occupations will surely be replaced by robots. We are about to look at what artificial intelligence is and how it can affect the tourism and hospitality industry. A huge challenge for these two sectors was the crisis itself during the pandemic. These sectors were threatened by the severe restrictive regimes. In this sense, their survival and successful functioning were in an extremely critical condition that is why many micro and small family hotels and restaurants failed to adapt and survive. Therefore, how artificial intelligence and robots could improve the financial health of tourism and hospitality organizations, their efficiency and overall adaptation to changing

environments and how they transform and expand their services to meet the needs and expectations of their customers (Citak et al. 2021).

As a result, the hospitality and tourism industry is using cutting-edge technologies such as artificial intelligence and robotics (AIR) to deliver a different experience to its potential customers, tourists and guests. These technological advances have been transformed into intelligent tools for providing customer service and they are used to improve customer experience (Goel, et al., 2022).

Furthermore, the rapid advancement of AI in hospitality management also has the potential to increase business performance from the collection of user data to their subsequent analysis. In this regard, the artificial intelligence offers a lot of opportunities to optimize processes in the field of tourism and hospitality by:

- *Providing Personalized customer service;*
- *Reducing the costs for staff;*
- *Optimizing the organizational structure.*

In this regard, using natural language processing techniques and the ability to learn quickly, AI solutions can "speak" in human language, and artificial intelligence and robots can be applied in the hospitality industry in the following activities: front office, reservations rooms, reservations, checking out, answering customer requests as well as with solving typical problems or even assisting with hotel services.

In terms of hotel operations, artificial intelligence (AI) can significantly improve hotel operations by:

- Automating routine tasks such as reservation processes and contactless check-in, allowing staff to have more time to provide personalized service to guests;

AI can also offer an enhanced tourist experience achieved through the use of chatbots and virtual assistants to consult and assist in the booking process, while also responding to customer queries and making recommendations when requested by guests.

- Artificial intelligence can also optimize the room cleaning process through the use of sensors and cameras to monitor and control the temperature, lighting and security of guest rooms, optimize pricing and revenue management through data analysis and predictive modelling and improve energy efficiency through the use of intelligent building systems (<https://hoteltechreport.com>).
- AI can also improve the overall efficiency of hotel operations to forecast the demand, to manage inventory and optimize logistics, ultimately improving the guest experience by providing more personalized recommendations and experiences (<https://hoteltechreport.com>).

In terms of hotel revenue management, the artificial Intelligence (AI) can significantly improve hotel revenue management by using forecasting models based on previous periods, as well as forecasting future demand and revenue, incl. optimizing pricing and availability to maximize revenue (Citak et al. 2021).

The artificial intelligence can help the hotel or other travel organization to use energy more efficiently and economically (<https://hospitality.economictimes.indiatimes.com>)

Another opportunity to apply digitization in the hospitality industry is through the use of chatbots, a software solution that is implemented on a website, in a messenger, in a mobile application or elsewhere, providing users with information through text, images, video, audio, links, etc. Chatbots offer the ability to perform a variety of tasks, from answering frequently asked questions to automated assistance with reservations and service inquiries, collecting customer information, questionnaires, and more. Another aspect is that they can be accessed through a QR code with a link to the bot or a specific part of the bot, such as information, a form, a menu or anything else, which creates an even more pleasant experience for the guest, having the possibility of quick inquiries, sales and upgrades. The functionalities of each specific chatbot depend on the needs of the business, where it will be implemented and with whom it will communicate – with customers, partners or employees (umni.bg).

Chatbots have been used on social media platforms, providing support to customers by responding to their questions and giving near-instant answers, 24 hours a day, seven days a week. This is invaluable to hotels because it provides speed and instant response times that are almost impossible to maintain in human-to-human interaction.

One of the most recognizable examples is Sam, an intelligent travel chatbot that is particularly useful for frequent travelers and business travelers (Citak et al, 2021).

The functionalities of each specific chatbot depend on the needs of the business, where it will be implemented and with whom it will communicate – with customers, partners or employees (umni.bg). With the help of chatbots, the customer engagement costs can be reduced and thus to improve customer experience in the following directions by:

- Responding to guest inquiries at every stage of the guest experience. Before the stay, the chatbot can assist with the booking and make the process easier for the guest himself. When the guest is in the hotel, the chatbot can also answer questions about the hotel services (<https://hoteltechreport.com>).
- Processing requests with the aim of facilitating transactions for guests. For example, an in-house guest can ask the chatbot to make an additional movie or car rental reservation (<https://hoteltechreport.com>).
- Encouraging direct bookings and upselling by offering special promotions or offers for direct bookings or room upgrades on the checkout page. During the guest's stay, the chatbot can be useful in promoting the restaurant or additional services offered by the hotel complex.
- Increasing the efficiency of communication with guests as they will receive faster and more accurate answers to their inquiries and will be able to easily communicate with the chatbot through their preferred channel. At the same time, hotel staff are also facilitated as the chatbot answers routine questions, leaving them time to deal with other crisis situations at work.

- Increasing revenue and direct bookings by using artificial intelligence to recommend upsells and offers to guests at every step of their journey. Indirectly, a chatbot can also increase revenue by boosting your guest review scores (<https://hoteltechreport.com>).

Choosing the right hotel chatbots for the hotel depends on several variables, some of which come down to personal preference, but most of which depend on the hotel's characteristics and budget, its location, and how it is positioned and promoted to potential travelers and hotel guests based on property characteristics that typically show similar product choices.

In this regard, according to a survey of hoteliers, the following part-bots are the most used and popular among hotels (<https://hoteltechreport.com>):

- The highest high score is for Asksuite (98% rated by 417 hoteliers).
- The most recommended chatbot is again Asksuite (98% rated by 417 hoteliers).
- Famous restaurant chains like Burger King and Taco Bell have introduced their chatbots in the hospitality and travel industries to stand out from the competition as well as serve their customers quickly. The function of the chatbots in this case is to welcome the customers by recommending the menu after which the shopper selects the pickup location, pays and is told when he can go to collect his food (<https://marutitech.com>).
- Chatbots are not only useful for restaurant staff as they reduce work, but they can also provide a better customer experience.

There is a wide variety of hotel robots, each designed to serve a unique purpose. We will focus on the most popular models of robots based on their purpose and the tasks they are intended to perform.

- *Robots designed to welcome guests*

Sometimes referred to by titles such as "guest ambassadors", these robots are strategically placed within the site, aiming to guide tourists by providing directions on the location of a room and how to get there, as well as making local recommendations. food or a specific local restaurant located near the hotel. The humanoid appearance of these robots is also intended to be welcoming and helpful in cases where staff are busy with work of a different nature during peak times of the year (<https://www.revfine.com>).

Another example of front desk robots is the service robots at Hen na Hotels, Japan. The automated hotel chain popularized the concept of robot receptionists.

- *Robots providing transportation assistance*

A robot suitcase called Travelmate is an example of robotics used for luggage purposes. It's essentially an autonomous suitcase that can follow you around on its own. It uses anti-collision technology, has 360-degree rotation capabilities and eliminates the need to carry, pull or push a suitcase.

- *Robots to work in travel agencies*

Some travel agents Amadeus have experimented with a robot called 1A-TA powered by artificial intelligence. The purpose of the robot is to assist in the work of the travel agency by

serving customers depending on their needs and destination preferences (<https://www.revfine.com>).

- Service robots can be equipped with different levels of artificial intelligence: mechanical, analytical, intuitive and empathic (Huang & Rust, 2018). Mechanical intelligence refers to the performance of standardized and routine tasks that require a minimal level of training (e.g. YO2D2, a room service robot, at Yotel Boston). Analytical intelligence uses systematic and rule-based learning from big data and offers the option of applying logical thinking to decision-making. For example, chatbots find a suitable answer to a customer query by extracting it from big data collected from customer FAQs (<https://www.revfine.com>).

Most of the researchers study what is artificial intelligence and its positive impact on industries. We believe that robots will change the business processes as well as the relationships between people inside the organizations. We share the opinion that the disadvantages of using them for the hospitality industry will be more than the advantages.

Artificial intelligence still copies human faces, trying to recognize human emotions but not showing emotional intelligence. For sure the errors will be decreased, but people prefer to work with other people, to receive positive energy and feedback from others. This is the success of travel blogs as instruments to digitalize the hospitality industry. Travellers trust other travelers with similar hobbies that share their experiences. This form of electronic word of mouth has become very popular. Most of all people are driven by different motives in their search behaviour of information. They want to satisfy their social needs as Yordanova, 2016, says, they seek advice from other people and they look for empathy.

Intelligence and artificial intelligence are too different terms. Humans possess intelligence and it can be a subject of measurement in many ways. What about the emotional intelligence? Robots do not have such and will never show. This skill is crucial especially for the travel industry as the main focus are people and the experience they receive. Travelers go to specific places as they have specific expectations formed by word-of-mouth, some travel blogs, etc. No matter if they face a robot at the entry of the hotel and are accommodated by a robot, they want to share their emotions and this can not happen with robots.

A very popular form of application of digitization in the hospitality industry are travel blogs. Travel blogs are defined as “*individual entries that relate to planned, current or past travel...are the equivalent of personal online diaries...typically written by tourists to report to friends and families about their activities and experiences during travels*” (Banyai, 2016). Blogs are primarily used as a social form of interaction and self-expression, where people can post positive and negative experiences, but also opinions and beliefs (Banyai, 2016). People blog because it is a form of expression free from external censorship where people are able to provide the “real” self (Banyai, 2016).

A travel blog is an online travel journal full of travel stories, photos and videos that document travellers’ experiences and allow them to share those experiences with friends and family members, fellow travellers, and even strangers they meet online” (Winsky, Dickow, 2021). In addition, travel blogs represent purposeful actions through which bloggers want to help fellow travellers, as bloggers create and present narratives of their travels that are completely

realistic (Winsky, Dickow, 2021). Thus, this multimedia format is directly connected to the life worlds of its authors and to the worlds of its readers who seek information and inspiration for their upcoming travels. In this regard, researchers Jeuring and Peters (2013, p. 211) define the travel blog "as having its own dynamics of information flows, allowing writers to express themselves and to influence and inform people around the world" (Winsky, Dickow, 2021).

Travel blogs are electronic versions of word-of-mouth advertising, which yields excellent results. Typical of this form of digital technology in tourism is that the type of interaction is user-user, i.e. the information content is created and directed by users who, guided by their positive experience, want to share it with others interested in the respective tourist destination (Parusheva, 2023).

What is interesting in this case concerns the information, which can be in the form of a story, photo material or video, created by the tourist user himself and aimed at people with similar activities and hobbies who read blogs (Yordanova, 2016). In the conditions of a pandemic crisis, these travel blogs seem to have gained even more popularity, where information related to travel and excursions is mostly published.

Weblogs offer dynamic content thus making them more attractive to users as they have the option of either reading textual content or viewing video or photos of a travel destination, making them different in format and content from traditional media. There the tourists share about their experience in the form of a story, but the sharing of audio and video material is increasingly entering (Yordanova, 2016). Many of the blogs in the virtual space provide an opportunity for readers to post their comments and add photo material as well. Travel blogs are equally valuable both in terms of making the decision of the given tourist, reading or sharing video and text, and as a tool for the organizations themselves if they are created by a hotel or tourist site (Yordanova, 2023).

There is also an opportunity for promotion of own tourist sites. It is a case where travel bloggers create their own brands and implement business models that are the result of their main activity as bloggers (Winsky & Dickow, 2021). In their personal blog, many web bloggers share their experiences and thus form certain expectations for potential tourists. In this regard, Yordanova, 2016 considers the travel blog as a communication channel of the many-to-many type, similar to word-of-mouth advertising. An example of a travel blog, discussed by Winsky & Dickow, 2021, is the blog for internal travel *The Travellette* and *Mochileando por el mundo*, written in German and Spanish languages.

Web blogs were mainly studied by ch.t. of the advantages they bring to the visitors and to the organizations in the field of tourism. There are a few publications, including Banuyia, 2016, analyzing 30 travel blogs across three different travel blog websites: *travelpod.com*, *travelblog.org* and *travbuddy.com*, which sets out as a research objective to establish how tourists construct order and make sense of their experiences.

According to Banuyia, 2016, the majority of bloggers wish to communicate with an audience by using terms such as "you", use personal characteristics in the narrative, which shows that bloggers have had a historical social relationship with readers. In their blogs, they use a narrative style, detailing all the steps of their journey through the moment of leaving their

home, the journey itself, and the end of it, thus seeking empathy and easier inclusion of readers in their experiences.

We consider that during the search for information about a given tourist destination, the reading of publications and comments by the potential tourist passes through both types, the aesthetic being important in view of making the final decision to visit the tourist site. ideas, views, traditions, financial relationships, hyperlinks and more.

Social networks, a very old and widespread mechanism for distally mediating interactions between people, have become prevalent in the Internet age thanks to the abundance of interfaces that allow people to follow the lives of friends, acquaintances and families, the number of people on social networks has grown exponentially since the beginning of this century. Facebook, LinkedIn and MySpace, contain millions of members who use these networks to monitor each other, find experts and engage in trade deals when necessary. Social networks themselves provide many opportunities for organizations in the field of tourism from a marketing point of view, demographic profiling and targeting only people who are interested in purchasing the relevant tourist package (Wilcox, Stephen, 2012).

However, the success of social networks is not only based on the number of active users, but also on the amount of time users spend on these websites. Online social networks are used by hundreds of millions of people every day to communicate and share experiences with others. They have become a vital tool for connecting people and sharing information. Social networks allow people to create profiles containing information about themselves (eg photos, interests and personal information) and are therefore a great opportunity to create virtual relationships as well as maintain family relationships by allowing people to easily share personal thoughts, pictures and achievements (Wilcox, Stephen, 2012).

Of course, there are differences between social media and social networks in their nature and purpose. There is a distinction between social networks and social media. It is expressed in their different purposes. Social media, which are a mixture of social networking sites, blogs and wikis are places where authored content is created. At the same time, social networks are used to communicate between users with similar hobbies and interests.

Best practices examples

1. Travelling Buzz is an English-language blog about travels and adventures in Europe in which they perform different types of tourism from extreme sports such as skydiving and kayaking in the Black Sea to interesting city trips, the blog itself provides useful and interesting information for foreigners who want to visit Bulgaria and to see its sights (<https://www.travelsmart.bg/>).
2. Trips with Rosie is a blog from which you can get inspired for your next trip, its creator is Rossi from Varna – a dreamer, a traveler in love with the sea, sunrises and photography. Whether abroad or in Bulgaria, the blog provides a lot of stories to read for a given destination, hidden sights, as well photo locations, as well as lots of tips on how to preserve nature clean and safe while travelling (<https://www.travelsmart.bg/>).

3. When Woman Travels is a travel blog targeted to the tender part of humanity and discussion of problems, that women face when they travel. The author, Gerry Vladeva, uses her own experience over the years spent as an expat in different countries and from her own travels to give specific advice and recommendations to women who want to travel more (<https://www.travelsmart.bg/>).
4. "Endless Journeys" is an author's blog by Veneta Nikolova – journalist and traveller, wherever there are travelogues, videos and photos from her travels around Bulgaria and abroad, focusing mostly on little-known corners – ethnographic villages, old monasteries and fortresses, abandoned churches, sheltered natural areas, as well as interviews with interesting people she met during her travels from Bulgaria.

“Journeys Without End” was nominated for The annual award of the Ministry of Tourism in the category "Publication on tourism in Bulgaria for 2016 in an Internet blog" (www.pateshestvia.net).

Digitization can take the form when a hotel or restaurant uses social media for social media campaigns or mere advertising channels. The goals of the virtual presence of the hotels and restaurants are various and reflect their digital maturity as we have discussed above.

Data from the study found that 73% of people agree that they are more likely to stay in a hotel that offers self-service technology to minimize contact with staff and other guests. According to the data, 77% of travelers are interested in using automated messages or chatbots to make service requests, with 38% of respondents wanting a fully self-service model, with staff only available on demand. And 39% want to order room service from their phone or chatbot. That's why 96% of hotels are already investing in contactless technology, with 62% noting that a “completely contactless experience” is likely to be the most prevalent technology in the industry in the next three years (<https://umni.bg/>).

Choosing the right hotel chatbots for the hotel depends on several variables, some of which come down to personal preference, but most of which come down to the hotel's characteristics and budget, its location, and how it is positioned and promoted to potential travelers and hotel guests based on property characteristics that typically show similar product choices.

Chatbots are not only useful for restaurant staff as they reduce work, but they can also provide a better user experience for customers.

For example, Taco Bell's Chatbot uses Slack messenger where the customer has the option to order food from the restaurant's “tacobot” and order from the menu. They can ask questions about available items and even customize the order by removing or adding items using a normal human voice (<https://marutitech.com>).

The best example of this so far is an AI robot called Connie used at the Hilton hotel chain. It is used for consultation and information support, providing information about the hotel, sites and attractions that are located near the given destination and are worth visiting (Citak et al., 2021). What is special about it is its ability to learn from human speech and adapt to individuals. In other words, its capacity and productivity increase with each contact with a tourist (Citak et al., 2021). For example, ALICE Housekeeping uses artificial intelligence to automate and optimize room allocation.

EasyWay Guest Sentiment uses AI and machine learning to detect and track guest sentiments and emotions by analyzing words, phrases and emoticons used in messages throughout the tourist journey.

Conclusion

In the evolutionary aspect, at first web technologies have been used as well as hotel reservation systems before the emergence of artificial intelligence and automation processes in tourism. Subsequently, this development trajectory continued with the widespread adoption and dissemination of social media and tourism communities and a shift to the realization of mobile tourism in recognition of the high mobility of users of tourism information and tourism services.

Rapid technological development and innovation lead to paradigm shifts, making a transition from an industrial society to an information society. We are witnessing the information transition, which has greatly affected all spheres of life and industry. If the first industrial revolution involved the process of mechanization and the introduction of steam and water power, and the second industrial revolution involved the introduction of mass production and assembly lines based on electricity; the third went under the motto of automation of production and the emergence of computers (Youssef, Zeqirl, 2021). Today, we observe how artificial intelligence and robotics inevitably enter life, change communication patterns and create new added value.

The fourth industrial revolution includes a range of technological developments such as CPS, IoT, AR, VR, AI, robotics, big data, blockchain and 3D printing. There is a stream of work that examines the connections between the hospitality industry and the various pillars of Industry 4.0 such as the Internet of Things, artificial intelligence, virtual reality, big data and robotics (Youssef, Zeqirl, 2021).

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APPLICATION OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN THE CONDUCT OF MONETARY POLICY BY CENTRAL BANKS²

Over the past few years, artificial intelligence (AI) and machine learning (ML) have become increasingly important in central banks' policy-making and monetary policy-making processes. The global financial crisis of 2008-2009, the COVID-19 pandemic, as well as various other episodes of high economic uncertainty since the turn of the millennium have adjusted central banks to a number of serious challenges and have led to the expansion of these mandates and emerging and exploiting new and extensive data. The study briefly notes on this as a big database (big data) and applications of AI/ML-based techniques that can provide support on monetary policy decisions, especially during times of uncertainty in the economy, referring to the latest research in this area. Also, concrete examples based on the creation of big data and AI/ML techniques applied in the activities of the European Central Bank and other central banks in Europe and the rest of the world are considered and analyzed. The analysis reveals that big data and AI/ML methods have demonstrated successful utility in conducting monetary policy by central banks. Although useful as a complement, these tools cannot be regarded as replacements for conventional data and methods due to issues related to statistics, the ability to interpret outcomes and ethical dilemmas.

Keywords: artificial intelligence; big data; machine learning; central banks; monetary policy; economic uncertainty

JEL: E52; E58; D81; C55

Introduction

In the past, central banks, particularly the European Central Bank (ECB), focused primarily on maintaining price stability, utilizing conventional monetary policy instruments to achieve this goal. However, following the onset of the global financial crisis in 2008-2009, and especially in response to overcoming the adverse effects of the COVID-19 pandemic, the

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toolkit of central banks evolved to include “non-traditional instruments” of monetary policy, such as additional asset purchases, quantitative easing, targeted longer-term refinancing operations, and others. Additionally, central banks are assigned various new responsibilities, including assessing systemic risk, banking regulation and supervision, digital currencies, and addressing climate change.³ These expanded responsibilities are partly a response to the presence and utilization of new sources of data, often referred to as big data, which provide valuable information to central banks (Chakraborty, Joseph, 2017). In their project at the Frankfurt School of Finance and Management, Kinywamaghana & Steffen (2021) examine the important role of big data and AI/ML in supporting the decision-making activities of central banks in the conduct of monetary policy, with an emphasis on the improvement and refinement of statistical information and analytical capacity, preparation of macroeconomic analyzes and forecasts, monitoring of financial markets and assessment of financial risk.

What is big data?

While in engineering sciences and statistics, there are clear definitions of what big data is, in the field of economics there is still no comprehensive definition of the concept. The study approach, proposed by Goldstein et al. (2021), serves as a conditional definition that helps to understand the main characteristics of this type of information. Big data has great potential for economic analysis and decision-making, but its use requires special skills and tools for processing and analysis. According to their perspective, big data is characterized by three main properties (Kinywamaghana, Steffen, 2021). **First**, a large size in terms of sample size, which involves a significantly larger amount of data than the size of the usual data samples that are used in traditional statistics. This data can be collected from various sources, such as sensors, websites, social media, and other sources. **Second**, high dimensionality (high frequency of data), which refers to the number of variables (parameters) compared to the sample size. Big data often covers a significant number of variables, allowing for more detailed analyses and the discovery of complex relationships and dependencies. This aspect is also discussed by Martin & Nagel (2019). **Third**, big data is characterized by great variety and complex structure. They contain different forms of information such as text, photos, or audio, and very often this data is unstructured. This means that the data is not organized in traditional tables or databases, which causes the need to use new methods to analyze and process the information.

What is the source of big data?

Different data sources contributing to the generation of big data used by central banks in decision-making processes encompass various categories. Among the most prevalent sources

³ Central banks increasingly recognize the potential risks that climate change poses to price stability, such as the impact of weather-related events leading to increased inflation. For example, on January 25th, 2021, the ECB has made important announcements regarding initiatives aimed at addressing climate change. These initiatives include the establishment of a climate change center. More information about this announcement is on https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210125_1~3fc4ebb4c6.en.html.

are internet-based indicators primarily obtained from web-based platforms. Additionally, datasets related to trade, financial market indicators, and administrative records are also used.⁴ According to a study by Doerr et al. (2021), approximately 80% of central banks have incorporated big data into their operations by 2020, representing a significant increase of 30% compared to 2015. Furthermore, about 40% of central banks have specifically utilized big data for announcing their policy decisions. However, it is important to note that, compared to the private sector, only a limited number of central banks have fully embraced big data (Tissot, 2018). This may be attributed to various factors, including the complexities of implementing new technologies and the specific requirements of central banks when processing and analyzing financial information. Nonetheless, the growing interest and involvement of central banks in big data demonstrate their significant potential for improving and optimizing economic analyses and decision-making in the future.

One of the crucial questions is how to make the analysis of big data as effective as possible (Kinywamaghana, Steffen, 2021). Financial experts often face the challenge of extracting information from high-frequency or unstructured data (Goldstein et al., 2021). Furthermore, financial big data is frequently characterized by challenges such as white noise, fat-tailed distributions, non-linear models, and time dependencies, rendering traditional econometric methods inapplicable for such analysis (Petropoulos et al., 2018). In response to the challenges posed by the complexity of big data, AI and ML have emerged, often applied in combination with other approaches.

According to the 2018 European Artificial Intelligence Strategy⁵, AI is the concept of creating computer systems capable of exhibiting intelligent behaviours, which involves analyzing their surroundings and taking actions, to some extent independently, to achieve specific objectives. (AI) has the potential to function in two primary ways. It can exist as software within the digital realm, examples of which include voice assistants, image analysis software, search engines, and systems for speech and face recognition. Alternatively, AI can be seamlessly incorporated into hardware devices, giving rise to sophisticated robots, self-driving cars, drones, and applications within the context of the Internet of Things (IoT). People interact with AI regularly in their daily lives, such as using language translation services, generating subtitles for videos, or blocking email spam. Moreover, AI goes beyond just easing day-to-day activities; it plays a vital role in addressing some of the world's most significant challenges, including in areas like health care, road safety, combating climate change, predicting cyber security threats, conducting economic policy, and many more.

As Chakraborty & Joseph (2017) postulate, machine learning (ML) can be described as an algorithmic approach to solving problems, which automatically optimizes itself through experience, primarily derived from data, and requires minimal to no human intervention (FSB⁶, 2017). ML algorithms are a subset of AI techniques and are commonly classified into

⁴ An illustrative example of big data used by central banks is credit registries. These registries are widely utilized in academic research, as evident from studies such as Altavilla et al. (2020). Credit registries provide valuable information that can be used by central banks for a better understanding of credit dynamics and risk assessment within the financial system.

⁵ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:237:FIN>.

⁶ Financial Stability Board (FSB) is an international body that monitors and makes recommendations about the global financial system. <https://www.fsb.org/>.

four main types: supervised, unsupervised, reinforcement, and deep learning (Wibisono et al., 2019). These ML techniques have seen increasing adoption in academic and practical settings within the economic and financial domains, and central banks have also embraced their application. A key factor behind this trend is the availability of extensive and intricate databases (Israël, Tissot, 2021) and the advancement of big data analytics, which have empowered central banks to leverage ML tools to aid their policymaking, especially in the realms of monetary and financial stability, as well as in associated statistical, analytical, and communication tasks (Chakraborty, Joseph, 2017; Doerr et al, 2021; Bruno, Marcucci, 2021).

Undoubtedly, the fact is that AI and ML become increasingly significant in improving the database used by central banks in decision-making during monetary policy implementation. The application of AI- and ML-based techniques offers several potential advantages:

Expansion of existing macroeconomic indicators: AI and ML can complement traditional macroeconomic indicators by providing additional insights through the inclusion of more comprehensive and detailed real-time information. This helps central banks gain a deeper understanding of economic conditions and potential risks. Although big data has the capacity to enhance GDP and other macroeconomic predictions, their complete potential can be fully harnessed by utilizing ML algorithms. In numerous instances, the enhancement in forecasting accuracy is tied to particular scenarios, like when conventional monthly indicators for the relevant quarter are not yet accessible.

Utilization of new data sources: AI and ML enable central banks to leverage non-traditional data sources such as Google searches, real estate data, online consumer prices, or social media activity.⁷ These alternative data sources can offer valuable information for assessing economic trends, consumer sentiments, and market dynamics.

Introduction of innovative data collection techniques: AI and ML techniques facilitate the adoption of advanced data collection methods, including web scraping, text mining, and integration of multiple data sources. These techniques allow central banks to gather and analyze data more efficiently, enhancing the timeliness and quality of information used in decision-making processes, but also have the capability to address specific problems. Additionally, ML tools are primarily focused on forecasting issues and have the ability to discover overarching patterns in data (Mullainatha, Spiess, 2017). These techniques are designed to identify predictive models that can effectively forecast outcomes based on the models and relationships found in the data. This transition from parameter estimation to forecasting is a key distinction between traditional approaches and the application of ML in economics.

⁷ The advent of smartphones and cloud computing has led to the generation of vast volumes of data, providing valuable opportunities for the financial sector and central banks to enhance their decision-making processes. An example is the ability of market participants to monitor information dissemination through social media platforms. Wibisono et. al. (2018) offer a comprehensive review of the application of AI/ML in the context of central banking. Their work provides valuable insights into the utilization of AI/ML techniques and their potential impact on central bank operations.

1. Application of AI/ML in Supporting Decision-Making Processes by Central Banks in the Conduct of Monetary Policy

The use of AI/ML by central banks raises significant questions about their role in supporting monetary policy decision-making. This study examines four key questions, discussed also in Kinywamaghana & Steffen (2021), related to the use of AI/ML in central banks' monetary policy-making activities, addressing issues like opportunities for AI/ML to improve policy-making; monetary policy decisions; AI/ML application areas; way of applying AI/ML in practice; potential risks and challenges associated with the use of AI/ML. These questions aim to explore the benefits, applications, current practices, and potential pitfalls of integrating AI/ML into central bank decision-making processes.

AI/ML play a critical role in enhancing the capabilities of collecting, processing, and analyzing data for central banks. AI/ML contribute to more precise and timely data collection by enabling regulators to extract real-time data from firms' systems at various levels of granularity. Additionally, they can leverage third-party sources to gather data on consumer behaviour, including spending and saving patterns (Proudman, 2020). Furthermore, AI enhances and refines analytical abilities by efficiently identifying non-linear models within the data. According to Genberg & Karagedikli (2021), the strength of ML lies in its predictive power, enabling the discovery of data patterns that are not pre-defined. Techniques like aggregating models from online ML can be employed to obtain the most accurate predictor for systemic financial crises in scenarios beyond the sample data (Fouliard et al., 2020).

AI/ML contribute to reducing operational costs by automating repetitive tasks, thereby freeing supervisors from performing these tasks manually. This automation helps to minimize the occurrence of human errors in the process. AI and ML technologies lead to reduced application processing times for banks, offering them improved transparency in the decision-making process. By using online application forms with mandatory fields, supervisors receive more comprehensive applications, thereby minimizing the need for additional document requests after the initial submission (Hakkarainen, 2020).

Central banks face various responsibilities like ensuring price stability, assessing systemic risk, regulating commercial banks, overseeing digital currencies, and addressing climate change. To address these challenges, central banks have embraced AI/ML techniques, offering promising prospects for future research in financial economics. Kinwamaghana & Steffen (2021) identify the areas where AI/ML can support and improve decision-making in the conduct of monetary policy by central banks.

Improving the communication of the central bank

Text analytics can be used to create metrics to measure central bank communication and examine the conveyed information and used channels, and analyze market reactions and responses to these signals. Central banks use a variety of communication channels, including press conferences, meetings, social media platforms, and future guidance and recommendations to continue their attempts to strengthen communication with the public (Haldane, McMahon, 2018). For example, Schmeling & Wagner (2019) show that changes in the tone of the central bank communication have a significant effect on asset prices. The

tone captures how the central bank sets economic fundamentals and its monetary policy. When the tone turns more positive, stock prices rise, especially for stocks with high systematic risk, while credit spreads and volatility risk premia decline. Using Twitter data, Ehrmann & Wabitsch (2021) examine English and German Twitter traffic for the ECB. The results show that Twitter traffic is responsive to the ECB's communication. In another paper, Ehrmann & Talmi (2020) examine the extent to which central bank reporting similarity affects financial market volatility. They show that similar press releases generate less volatility in markets, and more substantial textual changes following a series of very similar announcements lead to much more volatility.

Improving banking supervision

The ECB actively uses various projects under the umbrella of Supervisory Technologies (SupTech)⁸, which include advanced data analysis and text analysis⁹. SupTech refers to the application of innovative technologies to support financial supervision, such as cloud computing and ML techniques. For example, Hannes et al. (2018) propose a model derivation framework for early warning of impending European banking shocks. Goldsmith-Pinkham et al. (2016) utilize a computational linguistics strategy to gauge banking oversight. This approach involves analyzing a database of supervisory concerns, referred to as “matters requiring attention” or “immediate attention”, which are identified by Federal Reserve examiners in relation to banking institutions.

Development of assessments to increase financial stability

Network analysis proves to be an effective tool for examining the interrelationships between financial and non-financial services, thus identifying potential sources of systemic risk. This approach offers an improvement over other “small data” methods, as described in Cai et al. (2018). Applying a new measure of bank interconnectedness, the authors conclude that diversification ignores negative externalities in an interconnected financial system and underlies its enhanced financial stability. A recent illustrative case where high-frequency data could be valuable is GameStop's January 2021 episode¹⁰ involving retailers coordinating via social media. The interplay between these retail traders and sophisticated investors leads to significant market volatility and breeds concerns about financial stability.

⁸ SupTech refers to the use of technology to facilitate and improve supervisory processes from the perspective of the supervisors, https://www.bankingsupervision.europa.eu/press/publications/newsletter/2020/html/ssm.nl200812_3.en.html.

⁹https://www.bankingsupervision.europa.eu/press/publications/newsletter/2021/html/ssm.nl210217_3.en.html.

¹⁰ A 2022 documentary about the history of GameStop Corp, the world's largest American retailer of video games, consumer electronics, and games headquartered in Grapevine, Texas. The documentary chronicles GameStop's brief decline in 2021, which saw GameStop stock soar more than 2500% amid rampant volatility. This story is told mostly from the perspective of a few value investors who have been involved in sharing their due diligence on social media, <https://www.wsj.com/articles/melvin-capital-lost-53-in-january-hurt-by-gamestop-and-other-bets-11612103117>.

Improving credit rating and scoring analysis

According to a speech by Enria (2019), big data and AI can effectively serve many purposes, including overcoming information asymmetries in credit rating and scoring. These new tools can help banks assess the credit ratings of customers with limited credit and history, helping them eliminate human bias, all at a low cost. Using natural language processing to analyze reports and social media can offer valuable information about the creditworthiness of businesses' customers. In their study, Khandani et al. (2010) apply ML techniques to predict consumer credit risk using non-linear non-parametric models. They suggest that this technique may have important applications in predicting systemic risk in the banking system.

Improving investigations against financial crimes and money laundering

The application of AI can improve efficiency and effectiveness in financial crime investigations and risk management in both financial and non-financial institutions. Proudman (2018) believes that the growth of AI techniques opens up the prospect of supporting ML or "cyborg" supervision of banks. There is a shift from a rules-based approach to anti-money laundering monitoring to ML methods that use customer data and publicly available information from the Internet to identify suspicious activities and detect the flow of funds.

Improving complaint handling

In his speech on November 30th, 2020, Hakkarainen (2020) points out that ML-based tools could perform supervisory tasks previously performed by humans, such as answering and resolving customer complaints. Also, by applying AI that mimics human thinking, insights can be extracted from unstructured data and actionable models can be suggested. Institutions like the Central Bank of Italy use AI techniques to streamline the handling of customer complaints. Similarly, the Central Bank of France develops an algorithm that can automatically assess the compliance of banks' regular supervisory reports and other submissions, as well as assess the quality of information using natural language processing.

Enhance decision-making processes and expand the customer base for goods and services

AI-based models can be utilized by banks to reach a broader customer base, including individuals who are underserved and have limited access to banking services. Blumenstock et al. (2015) and Blumenstock (2016) explore the possibilities of inferring the socio-economic status of mobile phone users through their usage patterns. In countries around the world with limited resources, where household surveys and studies are rare, this approach offers the opportunity to gather localized and timely information at a significantly lower cost than the traditional methods. This initiative can be seen as a potential contribution to addressing poverty.

Improving economic forecasting and nowcasting

Big data, along with AI/ML techniques, are used to forecast business cycles, including key components such as gross domestic product (GDP), inflation, and monetary aggregates. According to Tissot (2018), by observing consumer durables (such as cars) and analyzing job advertisements, we could for example model real economic indicators such as economic activity, unemployment created in the economy as a whole, or specific sectors (such as tourism). ML methods are particularly well-suited to predictive analytics, which are extremely attractive in predicting returns on financial assets and measuring risk premiums. Gu et al. (2020) perform a benchmarking analysis based on ML methods to measure activity risk premiums. They double large economic gains for investors by driving out with the help of ML, in some cases the performance of the leading strategies based on regression from the literature.

Improving the Quantitative Measurement of Uncertainty in Economics

Baker et al. (2016) created an index to measure economic uncertainty (Economic Policy Uncertainty – EPU) based on text analysis and ML of business news in newspapers. Using firm-level data, they find that political uncertainty is associated with greater stock price volatility and reduced investment and employment in politically sensitive sectors such as defence, health, finance, and infrastructure construction. At a macro level, innovation in policy uncertainty predicts declines in investment, output, and employment in the US and 12 major economies over the period 1900-2015. Bybee et al. (2021) developed an approach to measure the economy’s performance through a textual analysis of 800,000 articles in the Wall Street Journals for the period 1984-2017 to forecast macroeconomic performance. Using a standard vector auto-regression VAR, they show that the attention a publication attracts to a particular topic contains meaningful information about future economic performance beyond the standard indicators.

2. Application of AI/ML in the Conduct of Monetary Policy by Central Banks – Practical Examples

In conducting monetary policy, policymakers act in real-time, based on limited information about current economic conditions. In recent years, political institutions have explored a large number of new data sources and alternative statistical methods to assess economic activity in real-time (Appendix 1). Here are presented examples of how central banks use AI, ML techniques, and big data to analyze the business cycle. These new data sources and tools are primarily used to improve forecasts of economic activity and short-term forecasting of real GDP. In addition, they provide valuable insights for assessing cyclical trends and creating an objective description of a series of events. Discussed here are two illustrative examples presented in Hirschbühl, et al. (2021), namely: indicators of economic sentiment for the euro area derived from newspaper articles and the application of big data analytics and ML to measure uncertainty using textual data.

2.1. *Nowcasting euro area real GDP growth with newspaper-based sentiment*

Here are presented the main findings in a study by Ashwin, et al. (2021). Economic sentiment indicators for the euro area, drawn from newspaper articles in the four largest euro area countries known as the Big Four (Germany, France, Italy, and Spain) in their main national languages, are examined here. The dataset includes a massive collection of 5 million articles spanning the period from January 1998 to December 2020, originating from 15 different newspapers¹¹, retrieved through the Dow Jones Factiva DNA database. Specifically, they focus on articles categorized as economic, corporate, or financial markets to minimize irrelevant information such as sports and lifestyle topics. These indicators are available on a daily basis and contain timely economic signals that can be compared to well-known sentiment indicators such as the Purchasing Managers' Index (PMI¹²). Moreover, they may substantially improve current forecasts for real GDP growth in the euro area.

In the literature, two approaches are most often used to construct sentiment indicators from textual data. The predominant approach involves utilizing a straightforward word count technique based on predefined collections of words, often referred to as dictionaries or lexicons. Nonetheless, a significant portion of these dictionaries was designed for the English language. Given the multilingual context within the Eurozone, addressing this requires either devising new dictionaries for other languages or translating texts into English. Alternatively, more resource-intensive model-based techniques such as semantic clustering or topic modelling can extract subjects that can be likened to emotions and their triggers. The sentiment indicators outlined in this context rely on the word count from news articles, which are translated into English. This translation process employs the Google Translate API (Application Programming Interface) for converting news articles into English. To ensure accuracy, the methodology has undergone validation checks that encompass comparing it against dictionaries in national languages and even translating these dictionaries into English. In general, the translation of articles into English shows the most reliable and stable results. Only the sentiment indicators referring to the Financial Stability Based Dictionary (taken from Correa et al., 2017) and the VADER¹³ General Purpose Dictionary (taken from Hutto, Gilbert, 2014) are presented here.

Regardless of the used vocabulary and despite the presence of some noise, sentiment indicators that are based on newspaper articles are highly correlated with the composite PMI over the period 2000-2019 (Figure 1a). This is evidence that these measures actually capture the sentiment. When it comes to detecting turning points, however, the choice of vocabulary matters. The first sentiment indicator captures the Global Financial Crisis very well, which is not surprising given the financial nature of this crisis. But on the other hand, this indicator

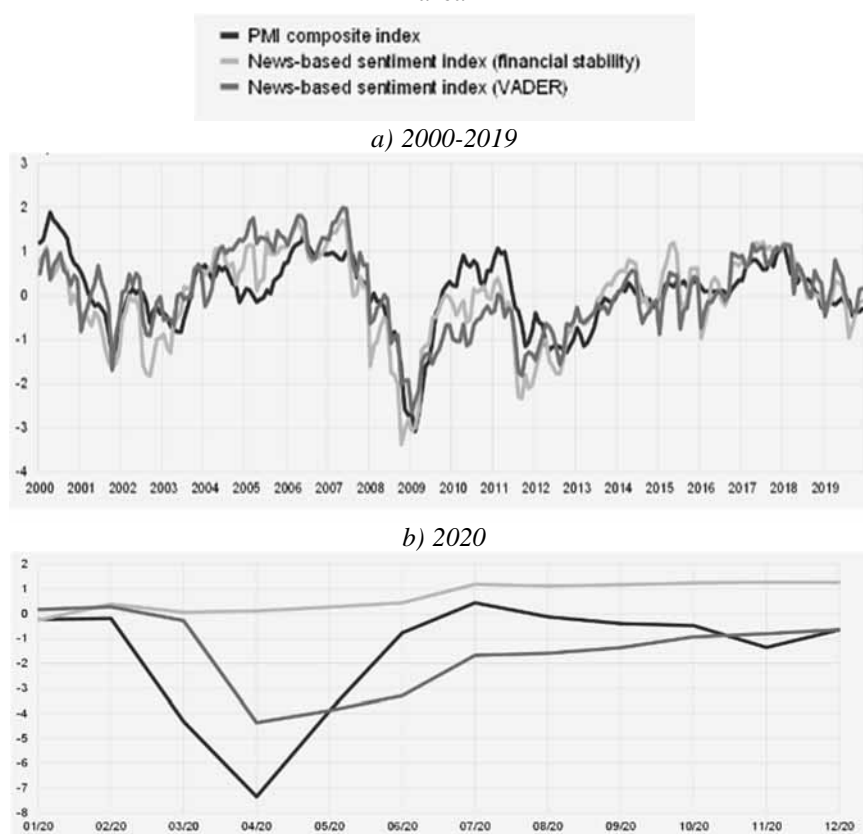
¹¹ In France – Les Echos, Le Figaro, Le Monde; in Germany – Die Welt, Süddeutsche Zeitung, Der Tagesspiegel, German Collection; in Italy – Corriere della Sera, La Repubblica, Il Sole 24 Ore, La Stampa; in Spain – Expansión, El Mundo, El País, La Vanguardia.

¹² Purchasing Managers' Index (PMI) is an index of the prevailing direction of economic trends in the manufacturing and service sectors. It consists of a diffusion index that summarizes whether market conditions are expanding, staying the same, or contracting as viewed by purchasing managers. The purpose of the PMI is to provide information about current and future business conditions to company decision-makers, analysts, and investors. <https://www.investopedia.com/>.

¹³ The VADER (Valence Aware Dictionary and sEntiment Reasoner).

fails to capture the COVID-19 crisis (Figure 1b), though its development is consistent with the behaviour of financial markets and funding conditions, which have remained favourable in the context of a very strong policy response. In contrast, general-purpose vocabulary is more consistent and stable over time. This, therefore, shows that in identifying the most appropriate text dictionary to use, the nature of economic shocks may play an important role.

Figure 1. PMI and newspaper-based sentiment indexes for the “Big Four” in the euro area

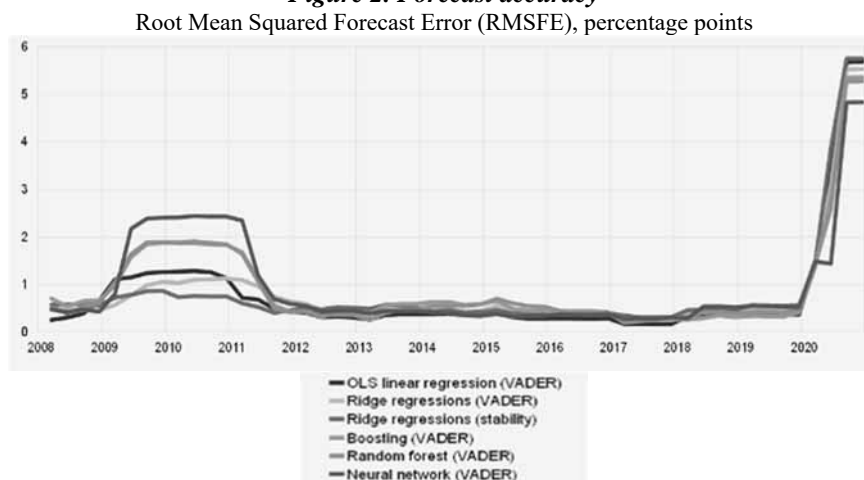


Source: Ashwin, J. et al., 2021; Factiva; IHS Markit; Eurostat.

Several studies in the field, including those by Thorsrud (2020), Larsen & Thorsrud (2019), and Kalamara et al. (2020), have identified that text analytics can substantially enhance the accuracy of forecasts for important macroeconomic indicators. Notably, improvements in forecast precision are observed for real-time GDP forecasts utilizing the PMI composite index and text sentiment indicators as pivotal predictors (specific improvements are not displayed). These enhancements tend to be most prominent in current forecasts generated during the initial half of the quarter (first six weeks), a period when various other indicators for estimating current GDP are yet to be available. This outcome aligns with findings from existing literature. It's essential to underscore that the effectiveness of leveraging text-based

information in a timely manner depends on the model utilized. Traditional linear methods like the Least Squares Regression Method, such as ordinary least squares linear regression, prove effective during stable economic conditions with minimal alterations in the economic outlook. However, during periods of significant economic shocks, Machine Learning (ML) models come into play by capturing nonlinearities and filtering out noise (depicted in Figure 2). Ridge regressions¹⁴, for instance, outperformed other methods during the financial crisis, as evidenced by the lowest Root Mean Square Error (RMSFE)¹⁵, particularly when incorporating the sentiment indicator derived from the Financial Stability Dictionary. Interestingly, during the pandemic, neural networks emerged as the most effective models, despite being the least effective models during the financial crisis. This divergence is attributed to the fact that there were no comparable crises in the training data prior to the financial crisis, hence limiting the neural networks' ability to learn. This underscores a drawback of more complex ML models: their requirement for substantial training data (in other words, they are "data hungry").

Figure 2. Forecast accuracy



Notes: Figure 2 reports Root Mean Squared Forecast Error (RMSFE) for a Rolling-window¹⁶ of 8 quarters. Forecasts are revised by the conclusion of the initial month in the quarter of reference. The variable under consideration is the representation of actual growth in real Gross Domestic Product (GDP) as of March 24, 2021.

Source: Ashwin, et al., 2021; Factiva; IHS Markit; Eurostat.

¹⁴ Ridge Regression is a specialized technique used to analyze multiple regression data that is multicollinear in nature. It is a fundamental regularization technique, but it is not used very widely because of the complex science behind it. <https://www.engati.com/>.

¹⁵ Root Mean Square Error (RMSE) measures the average difference between a statistical model's predicted values and the actual values. Mathematically, it is the standard deviation of the residuals. Residuals represent the distance between the regression line and the data points. RMSE quantifies how dispersed these residuals are, revealing how tightly the observed data clusters around the predicted values. <https://statisticsbyjim.com/>.

¹⁶ Rolling-window analysis of a time-series model is expressed relative to the delivery date and automatically shifts forward with the passage of time. For example, a customer with a 5-year Rolling window who gets a delivery on 04.05.2016 would receive data covering the period from 04.05.2016 to 04.05.2021. <https://www.mathworks.com/>.

2.2. Sources of uncertainty in economic policies within the euro area and how they affect various demand elements

Economic policy uncertainty arises from a variety of sources that affect consumer and firm decisions differently. As an illustration, heightened uncertainty surrounding forthcoming tax adjustments and customs tariffs can influence a company's deliberation on constructing a new manufacturing facility or venturing into a new market for exports. This stems from the fact that future circumstances significantly impact weighty, unalterable investment choices. In contrast, uncertainty pertaining to the forthcoming direction of monetary policy holds significance for both business entities and consumers when it comes to making spending determinations. This is because it influences their projections concerning forthcoming economic shifts and the availability of funding.

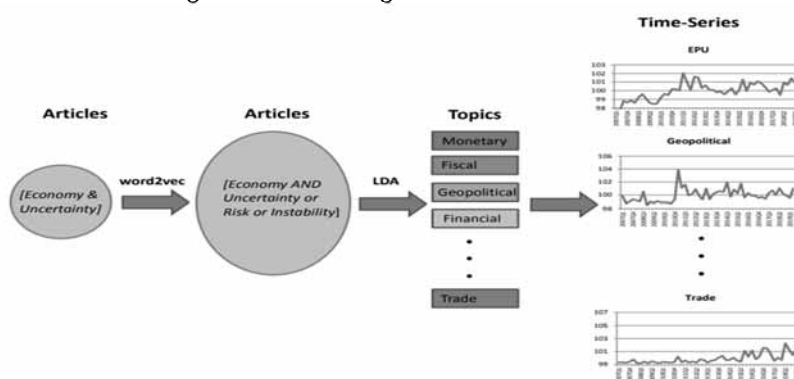
In recent years, the euro area has been affected by an unprecedented number of episodes of uncertainty, including the Great Recession (2008-2014); the euro area sovereign debt crisis (2010-2012); the sanctions imposed on Russia by the European Union (EU) following the crisis in Ukraine (March 2014); the Brexit vote (June 2016); the COVID-19 pandemic (2020); unprecedented levels of inflation (2021-2022); the military conflict between Russia and Ukraine (2022); the sanctions imposed against Russia (2022-2023); the recession in the economy (2023) and the subsequent disruptions in the global supply chains of goods and services. These instances have played a role in fostering elevated levels of political uncertainty within the Eurozone. Grasping the origins and the dynamic nature of uncertainty that impacts the economy holds substantial importance for decision-makers, including central banks. Companies are particularly attuned to this uncertainty factor while deliberating their investment choices. When confronted with shocks of uncertainty, they might curtail their investments, employment opportunities, or dealings with foreign intermediaries, which can then result in a trade deceleration and a reduction in overall investment activities. Subsequently, consumers might react to heightened uncertainty by deferring their spending and increasing precautionary savings, as exemplified by the increase in household savings rates during 2018 and 2021. Briefly examined here is how the capabilities of big data and ML are applied in the practice to measure the effect of different episodes of policy uncertainty on investment in the euro area for the period January 2000 to May 2019 (Azqueta-Gavaldón et al., 2019; Azqueta-Gavaldón et al., 2020). For this purpose, the Economic Uncertainty Index (EPU) of the four largest economies in the Eurozone (The Big Four) is modelled using a pre-selected set of keywords in newspaper articles.¹⁷ The EPU is constructed by aggregating various components (sub-indices) such as political; monetary policy; fiscal policy; trade policy; geopolitical policy; European regulation; domestic regulation and energy policy.

Figure 3 illustrates the procedure of transforming news articles into time series data for modelling individual components of uncertainty. The process involves several straightforward steps: a) gathering all news articles containing the terms “economy” and

¹⁷ *German newspapers:* Handelsblatt, Frankfurter Allgemeine Zeitung, Die Welt, Süddeutsche Zeitung; *French newspapers:* Le Figaro, Le Monde; *Italian newspapers:* Corriere della Sera, La Repubblica, La Stampa; *Spanish newspapers:* El País, El Mundo, La Vanguardia. From January 2000 to May 2019, the total number of news articles containing any form of the word “economy” and “uncertainty” is 14 695 in Germany, 11 308 in France, 30 346 in Italy, and 32 289 in Spain.

“uncertainty”; b) broadening the selection of articles related to economic uncertainty by incorporating words that are semantically most similar to the aforementioned terms in each language, using the “word2vec” algorithm¹⁸; c) utilizing Latent Dirichlet Allocation (LDA) topic modelling algorithms to identify distinct economic uncertainty topics; d) constructing time series based on these identified themes.

Figure 3. Converting news into time series



Note: The gray circles represent the hull, i.e. the aggregate of all news articles; “word2vec” stands for the continuous bag-of-words model¹⁹ developed by Mikolov et al. (2013); LDA stands for Latent Dirichlet Allocation Algorithm, developed by Blei, Ng, and Jordan (2003).

Source: Azqueta-Gavaldón et al., 2020.

The primary benefit of employing this approach lies in its versatility across various languages, negating the need for reliance on particular keywords. This characteristic enhances its resistance to selection bias. Furthermore, this method identifies overarching themes that underpin broader economic policy uncertainties (such as fiscal, monetary, or trade policy uncertainties) within newspaper articles. This attribute proves particularly advantageous in constructing narratives and conducting economic analyses (Azqueta-Gavaldón et al., 2019).

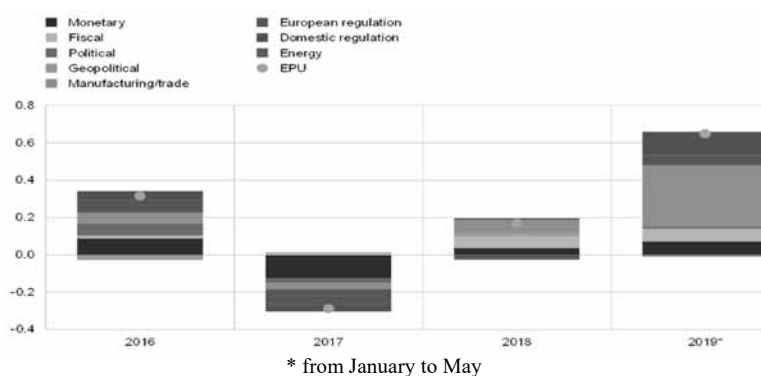
Following the standard procedure in the literature, Azqueta-Gavaldón et al. (2019) use a structural vector autoregression (SVAR) model to document the relationship between business investment through investment in machinery and equipment and the created EPU index and eight sub-indices (Figure 4).

¹⁸ Word2vec is a technique for natural language processing (NLP) published in 2013. The word2vec algorithm uses a neural network model to learn word associations from a large corpus of text. Word2vec is not a singular algorithm, it is rather a family of model architectures and optimizations that can be used to learn word embeddings from large datasets. Embeddings learned through word2vec have proven to be successful on a variety of downstream natural language processing tasks, <https://www.tensorflow.org/>.

¹⁹ The bag-of-words model is a way of representing text data when modeling text with machine learning algorithms. The bag-of-words model is simple to understand and implement and has seen great success in problems like language modeling and document classification, <https://machinelearningmastery.com/>.

The various components of the index indicate that trade, domestic regulation, and fiscal policy have been the primary sources of policy uncertainty since 2016. The contributions of individual uncertainty components to overall economic policy uncertainty have been quite dynamic during this period. In 2016, during the Brexit referendum year, the main drivers of policy uncertainty in the euro area were linked to monetary policy, European regulation, and trade. However, in 2017, the reduction in policy uncertainty is mainly due to a significant decrease in uncertainty related to monetary policy. This decrease is attributed to the clarity provided by the ECB on the future interest rate policy for an extended period after cutting interest rates in 2016.

Figure 4. Sources of uncertainty in economic policies within the euro area (average annual percentage changes and percentage point contributions)



Source: Azqueta-Gavaldón et al., 2019.

Moving on to 2018 and up to 2019, a consistent and notable increase in the euro area Economic Policy Uncertainty (EPU) index can be observed. This increase is primarily driven by uncertainty related to trade, influenced by global trade disputes involving the United States and China, which are likely to impact the euro area exports and imports. Additionally, uncertainties surrounding the Brexit negotiations and concerns regarding domestic and fiscal policies in some euro area countries contribute to this rise in uncertainty. These concerns are connected to factors like the uncertain effects of new emission standards in domestic regulation and the enforcement of EU budget rules in certain member states. It is worth noting that these increased uncertainties are not associated with the conduct of monetary policy.

The impulse responses, presented in Figures 5a and 5b when applying structural vector autoregression (SVAR) in the study by Azqueta-Gavaldón et al. (2020), confirm that the EPU increases based on ML have a significant negative shock on private consumption and business investment as expressed by machinery and equipment investment in the euro area. The effect on investment is more pronounced compared to consumption, implying that uncertainty might exert a larger influence on supply factors. This observation aligns with the research of Born & Pfeifer (2014). Addressing the sources of economic policy uncertainty, the scope is confined to energy, trade, and monetary policy uncertainties due to space limitations. As anticipated, shocks stemming from uncertainties in monetary policy exert a clearly negative impact on both investment and consumption. Conversely, an escalation in

trade policy uncertainty demonstrates an inconsequential effect in both instances. Moreover, amplifications in energy policy uncertainty lead to a more substantial reduction in consumption compared to other sources, while their influence on investment, though less intense, sustains over a longer period. While these findings are based on aggregate outcomes, Economic Policy Uncertainty (EPU) is likely to exert a more substantial role in capital investment at the firm level as opposed to the aggregate level.

Figure 5a. Impulse responses of consumption

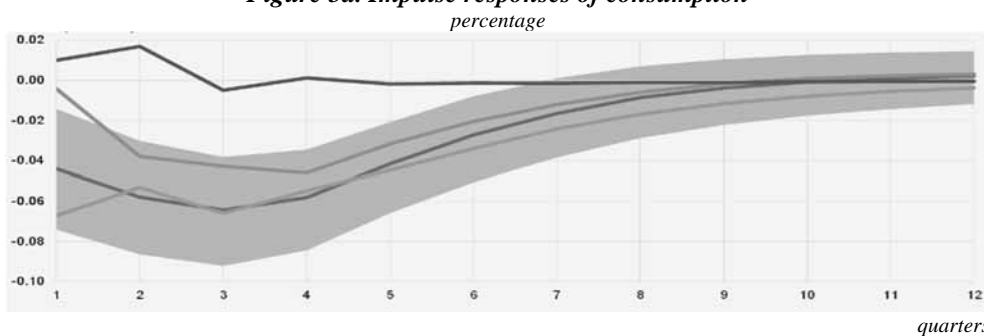
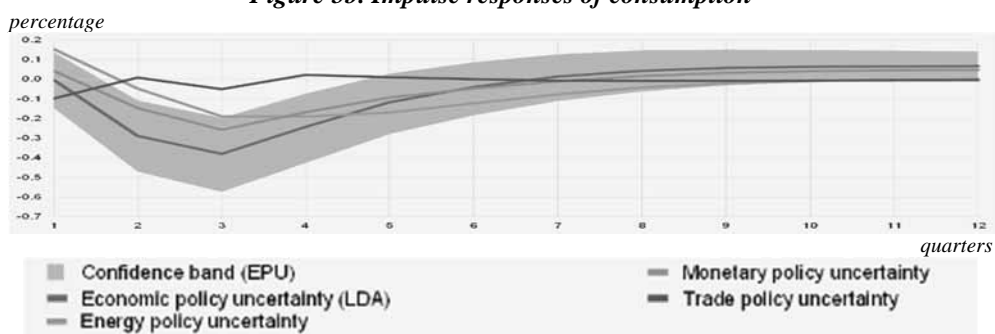


Figure 5b. Impulse responses of consumption



Source: Azqueta-Gavaldón et al., 2020.

Supporting the aforementioned findings, Gulen & Ion (2016) present evidence that the connection between political uncertainty and capital investment is not consistent across the board. Instead, it is notably more pronounced for companies characterized by greater investment irreversibility and those with heightened reliance on government expenditure. In a similar vein, Husted et al. (2020) offer documentation indicating that monetary policy uncertainty distinctly hampers investment at the firm level in the United States. Studies by Baker et al. (2016); Gulen & Ion (2016); and Meinen & Roehle (2017) report a strong relationship between investment and overall political uncertainty.

3. Potential Challenges in the Use of AI/ML in the Conduct of Monetary Policy by Central Banks

It is clear that the applications of AI/ML are undeniably leading to positive transformations in the process of conducting monetary policy by central banks, but these innovations also come with inherent risks. These challenges can be categorized into four main areas: data risks, methodological risks, interpretive risks, and ethical risks (Kinywamaghana, Steffen, 2021).

Data risks (data challenge)

Significant risks are related to the availability and quality of the used data. The challenges come from the limited access to data that is both timely and suitable for analysis, as well as from the existence of the so-called “knightian uncertainty”²⁰. In his speech on October 23rd, 2018, Marc Carney, Bank of England Governor, points out that AI relies on well-defined questions and historical data to draw conclusions, such as in the case of detecting fraud or abuse in insurance valuations (Carney, 2018). Additionally, the presence of bias in the data combined with heightened correlations between them can lead to potentially procyclical behaviour, as AI/ML systems may inadvertently perpetuate existing biases.

According to Tissot (2018), highly granular and detailed data may contain confidential and personal information, which increases the risk of potential misuse by unauthorized parties. As a result, it is essential that robust procedures and safeguards are in place to protect data security. According to Santor (2021), to ensure responsible use of data it is critical that central banks establish clear standards and a governance framework. Di Castri et al. (2019) believe that the use of reliable data is essential to maintain the integrity of AI/ML-based analytics and decision-making processes. For example, samples of data collected from social media platforms may not always be representative or reliable. To address this, economists and researchers should use validation checks and apply quality control to ensure the accuracy and reliability of the information obtained.

Challenges concerning the used methodology

Integrating AI-collected data into a comprehensive information model poses challenges due to its diverse sources, formats, and structures. Ensuring seamless integration requires careful thought and complex technical processes. Establishing robust data integration frameworks and methodologies becomes critical to effectively incorporate AI-generated data into existing information models (Di Castri et al., 2019). According to Danielsson et al. (2021), AI is effective in assessing exogenous risks that are of limited relevance to macro institutions. On the other hand, endogenous risks arise from the interactions between market participants, such as regulators and financial institutions, as they pursue their goals. These are interactions with vague goals and data, established statistical techniques, and repetitive events that serve

²⁰ In economics, Knightian uncertainty is the absence of any quantifiable knowledge about some possible event, as opposed to the presence of quantifiable risk (e.g. that in statistical noise or the confidence interval of a parameter), <https://www.learnsignal.com/>.

small purposes. Periods of stress can constrain the behaviour of agents, causing behavioural synchronization and eventually major stress events or crisis.

The application of ML creates prerequisites for the emergence of reputational risk, as algorithms have stronger predictive capabilities and weak explanatory ones. As such, they can be exposed to public criticism when the gained insights are used to justify policy decisions. This situation may invite public scrutiny if the insights obtained from ML are used to justify policy decisions, as noted by Wibisono et al. (2019). Another challenge is in the so-called biased algorithms. The reason is that they tend to reproduce biases present in the underlying data. The way the data is collected can affect the results, leading to potential bias. Moreover, ML predictions can generate biased estimates of causal effects (Athey (2017).

Interpretability of models

AI-based models often lack transparency²¹, making it difficult to understand how and why they reach specific conclusions. Users cannot see the inner workings of the model, only the final result (black box effect). Also, in a number of cases, complex calculations can be challenging to understand.²² Wibisono et al. (2019) emphasize on the need for specialized expertise to work with AI systems. Specialists from private and public institutions need to possess different skills to manage an effective supervision, risk, and control environment. According to Danielsson et al. (2020), overreliance on AI by supervisory staff can have detrimental consequences. Contingency planning and preventive regulatory measures can be underestimated, leading to a false sense of security. This highlights the importance of maintaining a balanced approach and relying not only on AI for decision-making and risk management.

Ethical challenges (discrimination)

According to Prince & Schwarcz (2020), the advent of big data and AI has brought about a revolution in how companies, governments, and employers categorize individuals. This transformation presents a lot of complex challenges for anti-discrimination regulations. An evident concern is that poorly designed algorithms or flawed data can disproportionately harm specific groups of the population. Even when algorithms are well-programmed and utilize accurate data, they may still perpetuate historical discriminatory patterns. Surprisingly, however, the existing legal literature largely overlooks or misunderstands one of the most critical threats posed by big data and AI to anti-discrimination efforts. This threat involves the possibility that modern AI systems may lead to “proxy discrimination”.

Proxy discrimination refers to a harmful form of disparate impact, where a seemingly unbiased practice unfairly affects individuals belonging to a protected class. While disparate

²¹ Bank to the future: supervisors take on fintech innovation - https://www.bankingsupervision.europa.eu/press/publications/newsletter/2019/html/ssm.nl191113_1.en.html.

²² Bringing artificial intelligence to banking supervision - https://www.bankingsupervision.europa.eu/press/publications/newsletter/2019/html/ssm.nl191113_4.en.html.

impact involves practices that have unintentional unequal outcomes, proxy discrimination occurs when a second condition is met. This condition demands that the discriminator gains some advantage or benefit from the fact that the facially neutral practice produces unequal effects. This advantage can be either the intentional desire to impact the protected group disproportionately or when a legally prohibited characteristic predicts the discriminator's goals in ways that cannot be accurately represented by non-suspect data.

Conclusion

Highlighted here is how big data and AI/ML methods can complement traditional economic analysis and support central banks in conducting monetary policy. The financial crisis of 2008-2009 and the COVID-19 pandemic have accelerated the adoption and refinement of AI/ML and big data techniques. These extraordinary shocks to the economy have demonstrated the value of alternative data sources, which can provide more timely insights into the state of the economy and help monitor economic activity. Moreover, these major shocks have introduced non-linearities in the economy, necessitating adjustments to existing statistical models or the development of new approaches. ML methods are particularly well-suited to handle such non-linearities, offering advantages over traditional methods in this regard. By leveraging big data and AI/ML techniques, central banks can gain a more comprehensive and dynamic understandings of economic conditions. This, in turn, enables them to make more informed and effective monetary policy decisions, responding more proactively to economic challenges and supporting economic stability and growth.

In addition, the adoption of new data sources and methods in central banks brings forth certain challenges as well. While big data enable the use of a broader array of timely indicators like text-based or Internet-based data, they may result in duplication and reporting problems. Text-based sentiment indicators, though valuable due to their higher frequency and cost-effectiveness compared to survey-based indicators, can present unique challenges as well. The main challenge comes from the fact that alternative data sources are not primarily collected for economic analysis and lack the standardized procedures followed in conventional economic data collection. As a result, their extraction and validation are not carried out by independent statistical offices, raising concerns about the reliability and comparability of the data. The application of such alternative data in decision-making processes exposes central banks to various risks, as the reproducibility of results and accountability might be compromised. Alternative data, such as credit card transactions or news articles from digitized newspapers, often exhibit high levels of noise and require meticulous treatment. Additionally, data availability issues and restrictions on data sharing can further hinder the reproducibility of results. These risks necessitate careful consideration when investing resources in software development, addressing legal issues, and customizing IT infrastructure. To mitigate these challenges, central banks should be vigilant in ensuring data quality, implementing rigorous data validation processes, and addressing issues related to data privacy and sharing. Proper methodologies for handling noisy data and handling data discrepancies should be devised. Collaborations with relevant stakeholders, such as industry partners and academic institutions, can also enhance data credibility and reproducibility. While embracing big data and AI/ML methods offers significant benefits, it is crucial to

approach their integration thoughtfully, keeping in mind the potential risks and challenges that come with using alternative data sources.

Although, while big data and ML methods offer significant advantages and can enhance economic forecasting, they cannot currently replace standard data and traditional statistical methods. ML methods can help address some of the limitations of big data and unlock its full potential. When combined with large datasets, ML methods often outperform traditional statistical techniques, providing more accurate insights into economic developments. However, the complexity of ML models can hinder their interpretability, making it difficult to understand forecast revisions and communicate them effectively. Communicating complex ML-driven forecasts to policymakers and the public clearly and understandably remains a challenge. Another significant limitation of ML methods is their original lack of focus on identifying causal relationships, which are crucial for policymakers. Improving ML techniques' ability to capture causality is currently a major area of research, and addressing this challenge could make ML methods more promising complements and alternatives to established methods. While big data and ML methods have the potential to revolutionize economic analysis, it is essential to continue refining these techniques to ensure their accuracy, interpretability, and ability to identify causal relationships effectively (Joseph, 2019). By overcoming these challenges, ML can become a valuable tool for policymakers and central bankers, providing them with more robust and actionable insights to support their decision-making processes (Farrell et al., 2021).

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Appendix 1

Participants in the conduct of monetary policy	Application of AI/ML in conducting monetary policy by central banks
European Central Bank	Truffle Analytics is a ML-based tool integrated into the Supervisory Review and Evaluation Process (SREP) ²³ . Its purpose is to examine SREP procedures and decisions, enabling the ECB to recognize common patterns and trends in the operations of different banks, as well as to identify and highlight emerging trends in the industry (Hakkarainen, 2020).
	ECB collects daily data from MTS Market ²⁴ to generate daily yield curves for the euro area. Additionally, the ECB utilizes Google data to evaluate economic indicators in real time.
	To perform volatility and resilience assessments, data from Prisma ²⁵ are specifically utilized. The analysis conducted on specific categories within the product basket primarily centers on commodity prices.
Bank of Mexico	Joint project with Factiva ²⁶ on text mining that enables banks to analyze qualitative data. This includes analysis of various textual sources like news articles, financial contracts, social media content, supervisory reports, market intelligence and other relevant reports.
	Joint project with the UK's Financial Conduct Authority (FCA) on web scraping and text mining audits advertising material and financial advice documents provided by financial institutions.
Bank of Canada	Cutting-edge AI/ML system is developed to create a risk index utilizing sentiment analysis of Twitter messages. This index effectively captures the reactions of Twitter users to positive or negative shocks impacting the Mexican financial sector. Research indicates that when there are shocks affecting the index, there is a positive correlation with an escalation of financial market risk, higher stock market volatility, increased sovereign risk, and greater exchange rate volatility.
Bank of Greece	Using ML techniques, the Bank performs sentiment analysis in surveys and monetary policy reports. The application of this tool aims to improve forecasting capabilities and identify any anomalies in the data.
Bank of Greece	Bank of Greece conducts an analysis of data collected from corporate and small and medium-sized enterprise (SME) loans using data mining algorithms. The primary goal is to reduce data complexity through dimensionality reduction and enhance the accuracy of predicting the future behavior of corporate loans. This approach enables making more informed decisions, gaining deeper insights into lending patterns, and better assessing potential risks associated with corporate borrowers.
Central Bank of Sweden	Sveriges Riksbank uses ML algorithms to build the index, which includes research on fruit and vegetable prices collected daily from the internet. The main objective of this initiative is to assess whether the inclusion of these data can improve the precision of short-term inflation forecasts.
Reserve Bank of New Zealand	The Bank applies ML techniques to analyze vast real-time datasets that consist of around 550 macroeconomic indicators. The primary objective is to enhance the existing forecasting of GDP growth, including predicting the current or near-term state of the economy. Initial findings from

²³ Supervisors assess the risks banks face and check that banks are equipped to manage those risks properly. This activity is called the Supervisory Review and Evaluation Process (SREP) and its purpose is to allow banks' risk profiles to be assessed consistently and decisions about necessary supervisory measures to be made, <https://www.bankingsupervision.europa.eu/>.

²⁴ MTS is one of Europe's leading e-commerce fixed income markets, with over 500 unique counterparties and an average daily volume of over EUR 130 billion, <https://www.mtsmarkets.com/>.

²⁵ Prisma is a server library that helps developers read and write data to the database in an intuitive, efficient and safe way, <https://www.prisma.io/>.

²⁶ Factiva is a business information and research tool owned by Dow Jones & Company. Factiva aggregates content from both licensed and free sources. Providing organizations with search, alert, distribution and other information management capabilities, <https://www.dowjones.com/professional/factiva/>.

Participants in the conduct of monetary policy	Application of AI/ML in conducting monetary policy by central banks
	their ML experiments have shown encouraging outcomes, surpassing the performance of traditional statistical metrics commonly employed for such predictions.
Bank of Italy	An advanced monitoring system is developed to monitor consumer inflation expectations in real time. This system utilizes ML techniques and conducts text analysis on millions of Italian Twitter posts each day. The indicators derived from Twitter data exhibit a robust correlation with conventional statistical measures, indicating their reliability. They outperform other available sources in predicting monthly survey-derived inflation expectations and demonstrate an exceptional ability to accurately forecast consumer expectations.
Bank Indonesia	Bank Indonesia carries out experiments to assess the efficacy of ML techniques in identifying stakeholder expectations concerning the central bank interest rate. This entails collecting and analyzing information from publicly available news articles to gauge the anticipated stance on the interest rate. The objective is to offer valuable insights for the monthly meetings of the Board of Governors, thereby enhancing the decision-making process through better-informed inputs.
Central Bank of Chile	AI/ML system is deployed to generate a daily economic uncertainty index for Chile. This index is built through the analysis of Twitter feeds and quantifies the level of general disagreement among users, acting as a proxy for economic uncertainty regarding economic development and policies. The index displays significant spikes that align with instances of pronounced economic uncertainty arising from both domestic and international factors. This illustrates the promising use of social media data for capturing and monitoring real-time economic uncertainty effectively.
Central Bank of the Netherlands	AI utility is employed to identify liquidity challenges in banks as a preemptive measure against potential deposit withdrawals. The objective is to determine whether AI can efficiently detect early signs of liquidity issues and enhance the bank's capacity to address such problems promptly.
Central Bank of Spain	AI tool is developed to categorize banknotes as fit or unfit for circulation based on their condition. The use of this tool leads to greater efficiency and accuracy in banknote evaluation, ensuring that only suitable and quality banknotes are used in circulation, while unfit ones are dealt with appropriately.
Federal Reserve System	Big Data and ML-based tool is constructed to generate the Week Economic Index (Lewis et al., 2020), which consolidates seven weekly indicators representing the US economy. This tool effectively combines and analyzes these indicators to provide a comprehensive and timely assessment of economic health and performance on a weekly basis. This allows policymakers, businesses and analysts to make informed decisions and gain a deeper understanding of the current state of the US economy.
German Federal Bank	Big data and ML-based tool is developed for modeling the Week Activity Index.
Swiss National Bank	Through the application of ML techniques, a specialized algorithm is developed to examine the correlation between central bank independence and the evolution of inflation.
Bank of Portugal	Bank of Portugal utilizes data from the Portuguese credit register. This source is distinguished by its remarkably extensive and detailed information, comprising over 200 attributes, resulting in a large number of intricate observations.
Central Bank of Ecuador	Development of neural networks, specifically autoencoders, is employed to detect outliers in a vast volume of transactions. The primary objective is to identify unusual transactions that may warrant further investigation by the payment system oversight team. This application has proven to be highly effective in identifying a diverse range of payment transaction anomalies.
Bank of Thailand	The bank implements a ML-based anomaly detection and classification technique for banknote printing. This approach is designed to tackle the challenges of identifying defective banknotes and understanding the reasons behind their issues. The tool is built on a Convolutional Neural Network (ResNet-101), a powerful type of artificial neural network commonly used for image analysis.

SUMMARIES

Lukáš Cibik, León Richvalský

THE ECONOMY OF EU MEMBER COUNTRIES IN 2020 FROM PERSPECTIVE OF MAGIC SQUARE

The aim of our article is to quantify the impacts of COVID-19 disease on four basic aggregate economic indicators, which are set in Kaldor's magic square in EU member countries in the year 2020, as well as to identify changes in the area of the square compared to the five-year average. The result of our article is the finding that, compared to the five-year average, the area of the magic square decreased by more than 15% in 2020 from the point of view of the entire EU. The drop in real GDP in 2020 is particularly significant. There is a general economic decline and economic recession in the EU, with significant disparities between individual countries. However, there is also one member country, Lithuania, which managed to increase the area of the magic square in 2020 compared to its five-year average.

Keywords: EU; COVID-19; magic square; GDP; balance of payments; HICP; unemployment
JEL: E66; F63; O11; O52

Ivan Todorov, Gergana Angelova

ECONOMIC GROWTH, INCOME DISPARITY AND GREENHOUSE GAS EMISSIONS: THE CASE OF BULGARIA

The objective of this research is to perform an empirical analysis of the nexuses between real per capita output growth, income disparity and greenhouse gases in Bulgaria. To accomplish this goal, the original and the environmental Kuznets curves for Bulgaria were constructed. The results from the study indicate that in Bulgaria social resilience declines as economic sustainability increases. This demands tax and income policies for alleviating income disparity. It is advisable that progressive income taxation and tax-free minimum income be installed in order to diminish social instability in Bulgaria. Another inference from the empirical investigation is that Bulgaria ought to have a minimum real per capita output growth of 5.8% so that a decrease in carbon emissions is achieved.

Keywords: Sustainability; Kuznets curves; Bulgaria; income disparity; greenhouse gas emissions
JEL: F63; O20; Q01; Q56

Adriana Elena Porumboiu, Petre Brezeanu

MACROECONOMIC FACTORS THAT GENERATE FISCAL RISK IN ROMANIA

Fiscal risk, under the form of unforeseen increases in public expenditures, can be quantified by the (increasing) government debt level. This study aims to identify the interdependencies between government debt, the number of people active on the labour market (labour force), the level of the average salary in the economy, the harmonized index of consumer prices and the RON-EURO exchange rate. The main objective is thus to assess which ones of the last four variables influence in the short and long run the government debt and constitute a fiscal risk. The analysis is focused on Romania, using quarterly data starting from the 1st quarter of the year 2000 and up to the 2nd quarter of 2021, the applied methodology being VECM. The most important conclusions show that changes in the level of the average salary and active population are significant and influence the government

debt both in the short and long run and they can constitute in this regard fiscal risk determinants, while HICP as an inflation indicator or HICP do not exert significant impact on government debt either on short term or long term. While the average salary constantly exerts a significant and positive influence on the government debt, the change in the active population leads to a change of the same sign in the government debt in the short term, but of the opposite sign in the long term. The main recommendation for the government that derives from the results of the study is to implement measures to increase the active population and increase the degree of employment, in order to decrease the pressure on the government debt and fiscal risks, both in the short term and long-term. This is in line with the results of numerous studies that show that the decrease in the active population, combined with the rise in retired people, lead to increasing indebtedness.

Keywords: fiscal risk; government debt; demographic tendencies; average salary

JEL: H63; J01; H50

Mimoza Luta, Suada Ajdarpašić, Mersiha Kalač-Kačamaković

THE IMPACT OF HUMAN RESOURCE PERFORMANCE MANAGEMENT PROCESS ON THE SUCCESS OF THE ORGANIZATION: CASE STUDY – KOSOVO

It is already known that performance management represents a set of processes and practices of human resource management, i.e. activities that aim to achieve the goals of the organization in the best possible way. In fact, there are numerous studies which are dedicated to the performance management process, showing that this process is now not only applicable in various organizations, but is also the object of analysis to improve it ongoing. Moreover, in organizations in Kosovo, there has been a lack of studies about this process over the years. Previous research has proven that the human factor is one of the key components of a successful organization. As a result, good human resource management with special emphasis on performance management practices and processes can be considered as a successful way to achieve the objectives that the organization aims. Therefore, the main objective of this paper focuses on performance management which is measured through human resource management practices and processes, defining the success or failure of the organizations in Kosovo. Thus, for the realization of this paper, we conducted a survey through a questionnaire that we distributed to employees and managers of organizations throughout the territory of Kosovo. The findings have shown that recruitment and selection, performance appraisal, training, reward system and career development are important factors in the performance of the enterprise. Considering these factors and their importance, the study provides recommendations and suggestions for improving these processes and human resource management practices for the researched organizations and broader.

Keywords: Performance management; human resources; processes; practices; development

JEL: O15; J53

Darko Lazarov, Kiril Simeonovski

MACROECONOMIC STABILITY AND ECONOMIC GROWTH: AN EMPIRICAL ESTIMATION FOR NORTH MACEDONIA

The main aim of the paper is to investigate the effect of macroeconomic stability on economic growth in North Macedonia by applying ARDL econometric model and by using quarterly data for the period from the first quarter of 2007 to the fourth quarter of 2022. We divide the concept of macroeconomic stability into four sub-concepts – output stability, price stability, fiscal stability and financial stability – and find suitable proxies for each of them. In addition, we add a few growth drivers as control

variables. The estimated results indicate that higher GDP volatility has a negative effect on economic growth at one level, but weaker and positive effects at one lag; inflation volatility and budget balance volatility have no effect on GDP growth; and capital adequacy ratio negatively impacts GDP growth. Furthermore, we find that the levels of financial intermediation and indebtedness negatively impact the growth of the Macedonian economy.

Keywords: macroeconomic stability; economic growth; ARDL model

JEL: E31; E32; E44; O40

Sarah Goldman, Virginia Zhelyazkova

DRIVERS OF SHADOW BANKING SYSTEM: A PANEL EMPIRICAL APPROACH FOR DEVELOPED COUNTRIES

In the current paper, we aim to examine the Shadow Banking System (SBS) in a number of developed countries, more precisely nine countries from Europe and the United States for the period 2002-2018. The goal is to define which are the key determinants that drive the SB processes. To this end, we run simple robust panel estimations. As a result of this analysis, we have reached a number of conclusions: 1/ the roles of banks, insurance companies and pension funds are important, 2/ changes in banking variables, such as the capital ratios, lead to an increase in shadow banking activity, 3/ there is a negative relation between banking interest margins and shadow banks, and 4/ developments on the stock market affect shadow banking positively. However, given the limitations in terms of data size and evolving definitions, our findings are not generalizable. Our main recommendation is to develop a more granular and reliable approach to improve the quality of empirical research and reduce the literature gap.

Keywords: Shadow Banking System; Robust panel estimations; macro-prudential policy.

JEL: C1; E5; G2

Slavi Genov

LESSEES' RIGHT-OF-USE ASSETS – CONCEPTS, REQUIREMENTS AND PRACTICES REQUIREMENTS AND PRACTICES

This work is dedicated to the definitions of control introduced by the Conceptual Framework for Financial Reporting which defines assets recognition based on the understanding that assets are an economic resource and as such a bundle of rights. The concept of assets recognition based on the relationship with the provisions of property law is analysed and on this basis, the reporting, presentation and disclosure of the right-of-use assets in the financial statements of Bulgarian companies for 2021 are studied.

Keywords: Conceptual Framework; lease; right-of-use asset; lease liability; presentation and disclosure of leases

JEL: M41

Silviya Georgieva, Maria Vasilka, Kostadin Kolarov

THE USE OF UNIVERSITY RESEARCH PRODUCTS IN ENTREPRENEURIAL PRACTICE: SPECIFICS ACCORDING TO SIZE CLASS OF ENTERPRISES AND SECTORS OF ECONOMIC ACTIVITIES

The partnership between universities and businesses, the transfer of scientific products created in higher education institutions and used in entrepreneurial practice is a source of innovation in a

turbulent and highly unpredictable environment. This cooperation provides indisputable benefits not only for scientific and business organisations, but also for the economy and society as a whole. This, as expected, causes significant interest among researchers, as well as national and international institutions. Despite the scientific activity and the emphasized interest, there is a need for additional knowledge regarding the scope and extent of the use of scientific products created by academia, analysed and evaluated through the prism of entrepreneurs. The aim of this paper is to identify whether enterprises' size and sector affiliation influence the use of university research products in entrepreneurial practice, investigating the companies' perspective. Therefore 904 companies, operating in Bulgaria, were surveyed through a structured questionnaire. The methods for analysing the empirical data combine exploratory data analysis and confirmatory data analysis, in which the tools of diagrammatic images and contingency tables were used. The results show that as the size of enterprises increases, the use of research products does too, while at the same time, entrepreneurs' assessment of the need to establish partnerships with universities has a non-linear relation to the size of the enterprise. In addition, smaller businesses were found to be targeting university research products presented in publicly available forms while bigger ones are looking for interactive ways of knowledge transfer. Along with the size of the enterprises, it was found that their economic sector affiliation affects the intensity of cooperation with the academia highlighting as leading the sectors related to knowledge-based services, contrary to the prevailing perception that manufacturing and ITC sectors occupy leading positions.

Keywords: entrepreneurship, university-business cooperation, scientific products, knowledge transfer, SMEs

JEL: L14, L25, L26, O33, O36

Silvena Yordanova

HOW TO APPLY DIGITIZATION IN THE TOURISM AND HOSPITALITY?

Information and communication technologies have moved us from an industrialized society to an information society, driven and regulated by the information content. The content of the website, the automation and robotisation as technologies used by hospitality organizations have become necessary conditions, providing a warranty that the company will be recognized on one hand. Tourism and hospitality are industries that have been most significantly affected by the information age in which we live. Due to digitization, the tourist has the opportunity to obtain preliminary information about the given destination, to take a virtual tour and to create expectations about the future destination he/she plans to visit. The digital technologies also support and help the tourist in the preplanning, planning stage as well during the trip and after it. In other words, the digitalization of tourism facilitates and contributes to the quality service of tourists. The current paper addresses the essence of digitalization through application of the artificial intelligence in the example of tourism and hospitality. What is more, it discussed how the digitalization can impact on the tourism industry. Best practices for the application of digitization in the sphere of hospitality and tourism have been also presented in the current paper.

Keywords: digitization; robots; artificial intelligence; chatbots; travel blogs; AI; hospitality robots; emotional intelligence; digital maturity

JEL: L83

Sonya Georgieva

**APPLICATION OF ARTIFICIAL INTELLIGENCE AND MACHINE
LEARNING IN THE CONDUCT OF MONETARY POLICY BY CENTRAL
BANKS**

Over the past few years, artificial intelligence (AI) and machine learning (ML) have become increasingly important in central banks' policy-making and monetary policy-making processes. The global financial crisis of 2008-2009, the COVID-19 pandemic, as well as various other episodes of high economic uncertainty since the turn of the millennium have adjusted central banks to a number of serious challenges and have led to the expansion of these mandates and emerging and exploiting new and extensive data. The study briefly notes on this as a big database (big data) and applications of AI/ML-based techniques that can provide support on monetary policy decisions, especially during times of uncertainty in the economy, referring to the latest research in this area. Also, concrete examples based on the creation of big data and AI/ML techniques applied in the activities of the European Central Bank and other central banks in Europe and the rest of the world are considered and analyzed. The analysis reveals that big data and AI/ML methods have demonstrated successful utility in conducting monetary policy by central banks. Although useful as a complement, these tools cannot be regarded as replacements for conventional data and methods due to issues related to statistics, the ability to interpret outcomes and ethical dilemmas.

Keywords: artificial intelligence; big data; machine learning; central banks; monetary policy; economic uncertainty

JEL: E52; E58; D81; C55