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Section I.: Banking and Financial Risk

A Systematic Literature Review of Systemic Risk

Noémi Filičková[1]

Abstract

This study presents a bibliometric analysis of systemic risk in the banking sector, offering insights into publication trends, key research themes, and the most influential countries, institutions, and authors in the field. The analysis draws upon 2,271 publications from the Web of Science database, spanning the period from 2001 to 2024. Notably, over 50 % of these publications were produced within the last four years, reflecting a growing interest in systemic risk. The findings reveal the United Kingdom's prominence in publication volume, while the United States leads in citation impact. Germany, China, and Italy also demonstrate significant contributions in terms of both publication output and citation influence. The analysis of frequently occurring keywords highlights recent focal points in research, including COVID-19, financial stability, performance, determinants, and contagion. These findings underscore the importance of systemic risk as a research domain, providing a comprehensive overview of current scholarship and guiding future research directions.

Keywords: *systemic risk, banking sector, research trends, bibliometric analysis.*

JEL Classification: *C52, G01, G21*

Introduction

The issue of monitoring systemic risk is becoming more relevant due to growing deregulation, the development of financial innovations, and the increasing interconnectedness of banks in the global financial market (Black et al., 2016; Demirer et al., 2018; Härdle et al., 2016; Hué et al., 2019. The importance of this issue is further underscored by the recent collapse of Silicon Valley Bank (SVB), a regional American bank that funded startup companies in the technology and innovation sectors. Despite the efforts of U.S. financial regulators, attempting to mitigate potential damage by promptly ensuring full protection to the bank's depositors, SVB's failure still triggered a wave of global financial instability. This failure also evoked a worldwide decline in bank stock prices. The unrest in financial markets subsequently led to the collapse of the Swiss banking giant Credit Suisse, which was promptly acquired by UBS, a larger financial institution. This acquisition took place after an initial lifeline of $54 billion from the Swiss central bank proved insufficient to save Credit Suisse. The irony is that, just as during the global financial crisis, the solution to these recent financial problems was the acquisition of failed institutions by even larger banks, with bank consolidation itself increasing systemic risk (Bougheas, 2023). These events raise the question: "How could the failure of a relatively small bank like SVB have such widespread effects, leading to global consequences such as the collapse of a 167-year-old institution like Credit Suisse? The answer to this question relates to an understanding of systemic risk, which involves risks associated with the entire financial

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system. Given the importance of this field and the abundance of existing literature in various countries, the aim of this article is to provide a systematic literature review – a bibliometric analysis to determine the main research trends in the field of systemic risk in the banking sector. For the successful achievement of the objective of this article, we formulated the following three research questions:

1. Which of the countries can be considered the most prolific in publishing on this topic?
2. Which organizations and authors can be considered the most influential in this field?
3. What are the main focal points of research in the topic of systemic risk?

The structure of the paper is organized as follows: After the Introduction, Section 1 provides the reader with the theoretical knowledge necessary to understand the issue of systemic risk. Theoretical insights primarily focus on the definition of systemic risk, measuring systemic risk, and the mechanisms for its transmission. Section 2 describes the sample and the empirical methodology. Section 3 presents the results of the analysis, and the last Section offers concluding remarks and possible topics for further research.

1 Theoretical background

Economic entities are constantly exposed to various financial and non-financial risks. Risk, in general, can be defined as a degree of uncertainty associated with future developments (Mejstřík et al., 2015). According to the ECB, the main risk factors affecting the banking sector and increasing its systemic vulnerability can be considered as follows: the increasing liquidity risk arising from the economic slowdown and reduced access to capital markets; the loss of bank revenues caused by regulatory and political responses; and the growing interconnectedness between banks (ECB, 2021). All the aforementioned risks can spread like contagion through interconnected banks, leading to an increase in systemic risk. In the literature (Rodríguez-Moreno and Peña, 2013; Silva et al., 2018), we can find various definitions of systemic risk, with a common feature being the fact that, due to the interconnectedness of banks, the failure of one bank can propagate to others. This can lead to their failure, as well as to negative impacts on the entire financial and banking sector in multiple countries. The issue of monitoring systemic risk is becoming increasingly relevant with deregulation, the development of financial innovations, and the growing interconnectedness of banks in the global financial market (F. Allen and Carletti, 2013; Black et al., 2016; Demirer et al., 2018; Härdle et al., 2016; Hué et al., 2019.

The existing literature on systemic risk can be divided into two groups. The first group consists of studies in which the authors measure and evaluate systemic risk based on banks' sensitivity to systemic risk (Acharya and Steffen, 2013; C. T. Brownlees et al., 2012; Jobst and Gray, 2013; Weiß et al., 2014. The second group comprises studies by Adrian and Brunnermeier, 2011; Billio et al., 2012; Chan-Lau, 2013; León and Murcia, 2013, which assess systemic risk based on the contribution of banks to systemic risk. Systemic risk sensitivity represents the macroeconomic shock that negatively impacts every financial institution. On the other hand, systemic risk contribution refers to an individual shock in one bank that subsequently transmits throughout the entire banking system (Kleinow and Moreira, 2016). The difference between these two terms can be better understood from Figure 1.

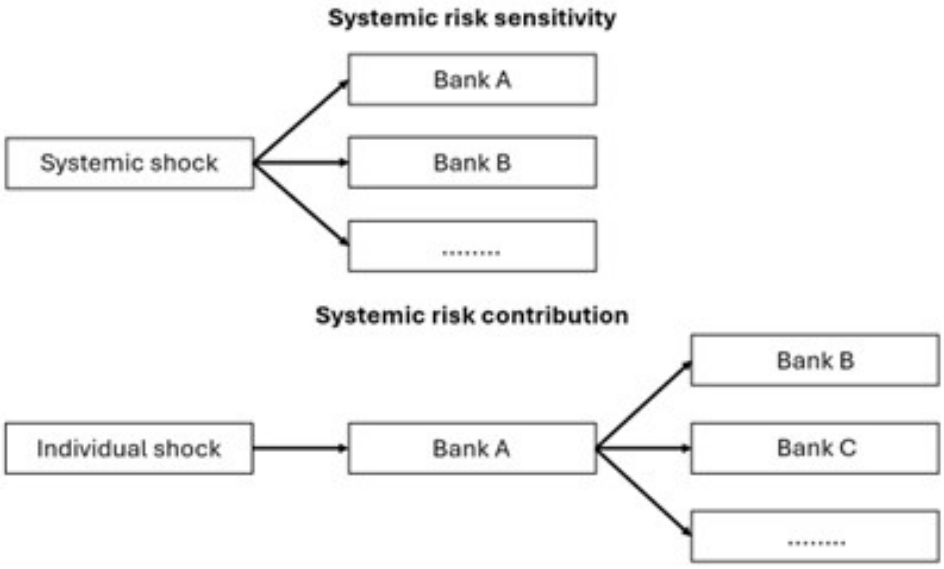

Figure 1: Systemic risk sensitivity and contribution
Source: own elaboration according to Kleinow and Moreira, 2016

In the literature, we can find various methods for assessing systemic risk, such as Co-VaR (Adrian and Brunnermeier, 2011), Principal Component Analysis (Kritzman et al., 2011), CATFIN (L. Allen et al., 2012), Marginal Expected Shortfall (C. T. Brownlees et al., 2012), Degree of Connectivity to an Institution (Billio et al., 2012) Systemic Expected Shortfall (Acharya and Steffen, 2013), Cross-quantilogram Approach (Han et al., 2016), and SRISK (C. Brownlees et al., 2020). We can also find indicators describing the systemic importance of a financial institution, including SIFI, CISS (Hollo et al., 2012), Spillover-To-Others and Spillover-From-Others (Diebold and Yilmaz, 2014). Alongside traditional methods, there has been a growing need in recent years to utilize new methods for assessing systemic risk, such as machine learning methods, network analysis, and graph theory (Baumöhl et al., 2016, 2020; Chen et al., 2019; Kou et al., 2019; Zhang, 2019). In addition to measuring systemic risk, some studies examine the determinants that influence its development, such as competition (Anginer et al., 2014), financial network structure (Acemoglu et al., 2015), diversification (Yang et al., 2020), regulation by central banks, whether through interest rate management or macroprudential policy tools. Additionally, determinants like bank size, capitalization, and net interest income also impact systemic risk (Brunnermeier et al., 2020).

The literature on systemic risk is extensive. This motivated us to analyze academic literature and provide insights into the structure, dynamics, and evolution of this research field through bibliometric analysis. The bibliometric methodology involves applying quantitative techniques, specifically bibliometric analysis, to bibliometric data, such as units of publication and citation (Broadus, 1987; Pritchard, 1969).

2 Research methodology

To answer our research questions, we conducted bibliometric analysis, a method offering insights into publication trends, key research themes, and the most influential countries, institutions, and authors in the field. In the last decade, there has been an increased interest in this method, attributed to the availability and accessibility of bibliometric

software such as Gephi, Leximancer, and VOSviewer. Additionally, scientific databases like Scopus and Web of Science facilitate relatively quick and easy access to the necessary bibliometric data (Donthu et al., 2021). To obtain the necessary data, we worked with the Web of Science database, which we subsequently processed using VOSviewer software. Before downloading the data, we identified the most frequently occurring keywords based on a review of approximately 50 publications focused on the topic of systemic risk. These keywords, along with other parameters (Tab. 1), were used to filter out irrelevant publications, helping us ensure the relevance and accuracy of the conducted analysis. Following the most frequently occurring keywords, we obtained 47,326 articles, which were further filtered. Many of these articles were from categories not directly related to our research, so in the next step, we filtered only categories related to our research, including "Economics", "Business Finance", "Business", "Management", "Mathematics", "Mathematic Applied", and "Law". The majority language of scientific publications is English, which led us to select the next filter focused on English-language articles, including a total of 5,565 articles. In the final step, we applied a filter focused on the type of access to publication, giving preference to articles with open access. This step allowed us to obtain a final set of 2,271 articles, spanning the period from 2001 to 2024, which served as the basis for our further analysis.

Table 1: Filtering criteria

Filter	**Criteria**	**Number of Documents**
Keywords	Systemic risk, Financial crises, Covid-19, Financial network, Financial Stability, European banks, Systemically important banks, Credit default swap, Bank regulation, Macroprudential regulation, Macroprudential policy, Interconnectedness, CoVaR	47,326
WoS Categories	Economics, Business Finance, Business, Management, Mathematics, Mathematic Applied, Law	5,948
Document Type	Article	5,615
Language	English	5,565
Access	Open Access	2,271
Final Sample		**2,271**

Source: Own elaboration

After filtering all relevant publications, we downloaded them as txt. files and used VOSviewer software for data analysis and visualization. We employed two techniques for bibliometric analysis, including performance analysis and science mapping. Performance analysis examines the contributions of research constituents to a research field (Cobo et al., 2011; Ramos-Rodríguez and Ruíz-Navarro, 2004). The most prominent measures for performance analysis are the number of publications and citations per year or per research constituent. Publications serve as a proxy for productivity, while citations measure impact and influence. Other measures, such as citations per publication and the h-index, combine both citations and publications to measure the performance of research constituents. The second technique, social mapping, examines the relationships between research constituents and includes citation analysis, co-citation analysis, bibliographic coupling, co-word analysis, and co-authorship analysis (Baker, Kumar, and Pandey, 2021; Cobo et al., 2011; Ramos-Rodríguez and Ruíz-Navarro, 2004). While citation analysis, co-citation analysis, and bibliographic coupling techniques focus on publications, the co-word analysis is a technique that examines the actual content of the publication itself. The

words in this analysis are often derived from "author keywords", and in its absence, notable words can also be extracted from "article titles", "abstract" and "full text" (Baker, Kumar, and Pattnaik, 2021; Burton et al., 2020; Donthu et al., 2021; Emich et al., 2020; Liu et al., 2019). The analysis of co-words can be used as a supplement to enrich the understanding of the thematic cluster derived from co-citation analysis or bibliographic coupling. This is because the themes formed through the commonalities in publications tend to be relatively general, therefore, the use of co-word analysis can help elaborate on the content of each thematic cluster. Co-word analysis can be also used to forecast future research (Donthu et al., 2021).

3 Results

In the first step of the analysis, we focused on the relevance of the issue of systemic risk. The relevance of the examined issue can be observed in Figure 2, which shows the total number of publications on systemic risk in the Web of Science database from 2001 to 2024.

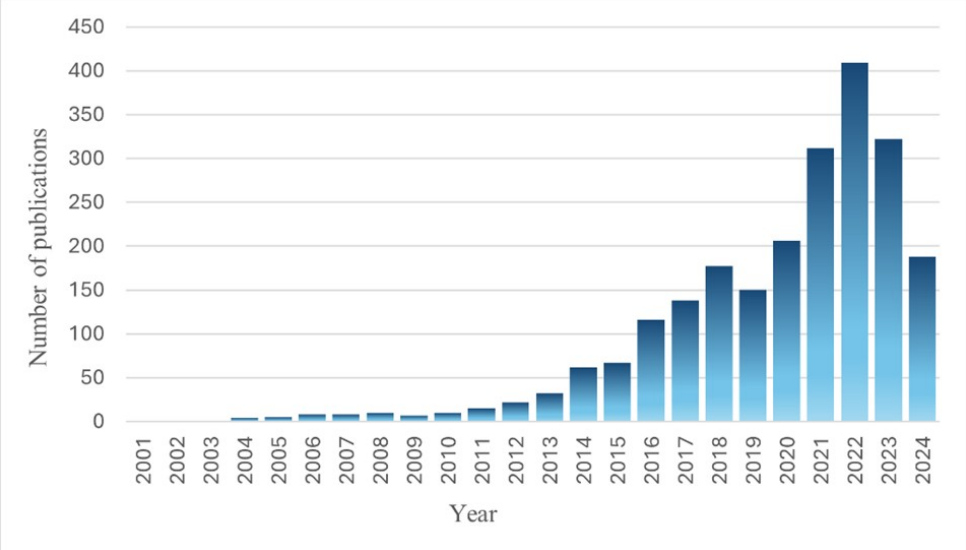

Figure 2: Publications trend
Source: own elaboration according to WoS, 2025

It has been shown that the number of publications has been increasing in recent years, indicating a growing interest in the topic. This rise in publications is not surprising, as systemic risk is closely linked to crises, and recent years have been characterized by the COVID-19 crisis. Over 50 % of all publications were published in the last four years, with the highest number recorded in 2022, totaling 409 publications. Therefore, we can consider systemic risk to be a current and relevant topic. Considering the significance of this issue, let´s take a closer look at the countries that are most influential in researching this area. The impact of each country is assessed based on its total number of publications and citations. Countries are ranked according to their publication count, beginning with the one that has the highest total.

In the ranking of countries contributing most to addressing the issue of systemic risk through their publications in Table 2, the UK secured the top position with 585 publications, representing more than 25 % of the total published studies in this field.

Table 2: TOP 10 most influential countries

No.	Country	No. of Publications	% of Total Publications	No. of Citations	ACPP
1	UK	585	25.76	14,924	26
2	USA	457	20.12	18,414	40
3	Germany	205	9.03	4,035	20
4	China	202	8.89	4,710	23
5	Italy	170	7.49	3,452	20
6	France	150	6.61	3,411	23
7	Spain	118	5.20	2,953	25
8	Australia	112	4.93	1,921	17
9	Netherlands	91	4.01	2,420	27
10	Saudi Arabia	71	3.13	1,597	22
38	Slovakia	25	1.10	307	12

Note: ACPP – Average number of citations per publication.

Source: Own elaboration according to WoS, 2025.

The USA follows in second place with 457 publications, accounting for approximately 20 % of the total publications. When examining the ranking based on citations, the USA leads with 18,414 citations, while the UK holds the second position with 14,924 citations. Countries like Germany, China, Italy, France and Spain can also be considered among the most influential countries in this field. We included Slovakia in this ranking as well, placing it 38th with 25 publications and 307 citations. For enhanced visualization, we have illustrated the ranking of countries in Figure 3, which presents the total number of publications for each country during the analyzed period.

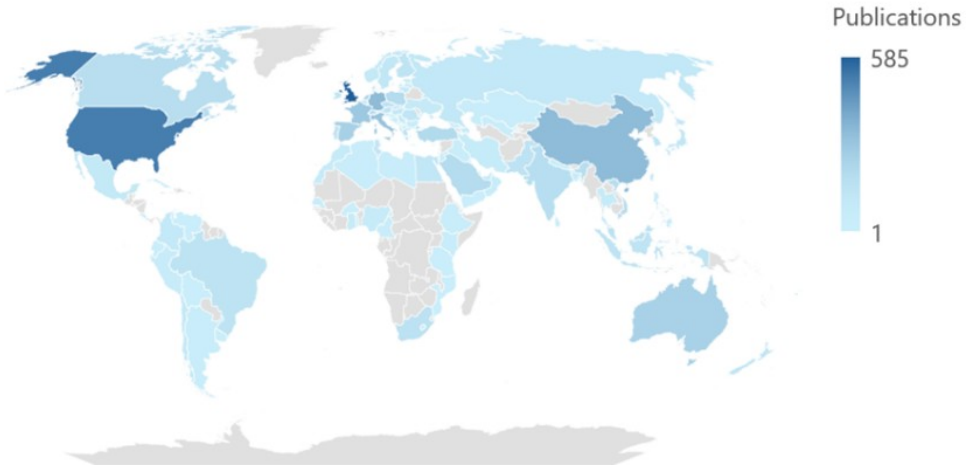

Figure 3: Worldwide publications
Source: own elaboration according to WoS, 2025

As we can see, there is a significant difference in scientific output between leaders such as the UK and the USA and other countries, highlighting geographical and possibly financial inequalities in access to scientific resources and publishing. The leading positions of the UK and the USA are further supported by an overview of the 10 most influential institutions, the majority of which are English and American universities. We assess the

impact of organizations based on the number of citations they receive. The most influential institution is the National Bureau Of Economic Research, which has received 5,868 citations (Table 3). The second place was secured by the Centre for Economic Policy Research with 3,649 citations, while the World Bank ranked third with 3,162 citations. When considering citations in relation to the number of publications, the University of Minnesota Twin Cities holds the top position with an average of 285 citations per publication.

Table 3: TOP 10 most influential institutions

No.	Organization	No. of Citations	No. of Publications	ACPP
1	National Bureau of Economic Research	5,868	57	103
2	Centre for Economic Policy Research	3,649	58	63
3	World Bank	3,162	23	137
4	New York University	1,638	13	126
5	Columbia University in the City of New York	1,502	16	94
6	Bank for International Settlements	1,456	17	86
7	University of Minnesota Twin Cities	1,424	5	285
8	Harvard University	1,288	9	143
9	Tilburg University	1,283	17	75
10	University of Oxford	1,249	24	52

Note: ACPP – Average number of citations per publication.

Source: Own elaboration according to WoS, 2025.

To create a list of the most influential authors, authors like organizations were also ranked based on the total number of citations in all their work. This list is show in Table 4.

Table 4: TOP 10 most influential authors

No.	Author	No. of Citations	No. of Publications	ACPP
1	Viral V. Acharya	1,467	5	293
2	Thorsten Beck	964	6	161
3	Mauro Gallegati	671	8	84
4	Rangan Gupta	670	10	67
5	Jose-Luis Peydro	613	8	77
6	Yong Tan	584	10	58
7	Asli Demirguc-Kunt	518	6	86
8	Elie Bouri	509	5	102
9	Moritz Schularick	485	7	69
10	Joseph E. Stiglitz	410	6	68

Note: ACPP – Average number of citations per publication.

Source: Own elaboration according to WoS, 2025

Viral V. Acharya is the most influential author in the field of systemic risk with 1,467 citations. His number of citations per publication is 293 citations. Thorsten Beck follows with 964 citations and 161 citations per publication. Mauro Gallegati is the third most influential author. The fourth and fifth most influential authors are Rangan Gupta and

Jose-Luis Peydro. Although Elie Bouri ranks seventh in total citations, he holds the third position when considering the average number of citations per publication. This list of the most influential authors can serve as a valuable resource for readers seeking reputable experts and leading authorities on the topic of systemic risk. For readers, it is essential to identify the most frequently occurring themes in the field of systemic risk. To provide a deeper understanding of the thematic structure and the interrelationships among keywords, these keywords have been categorized into 5 clusters (Figure 4).

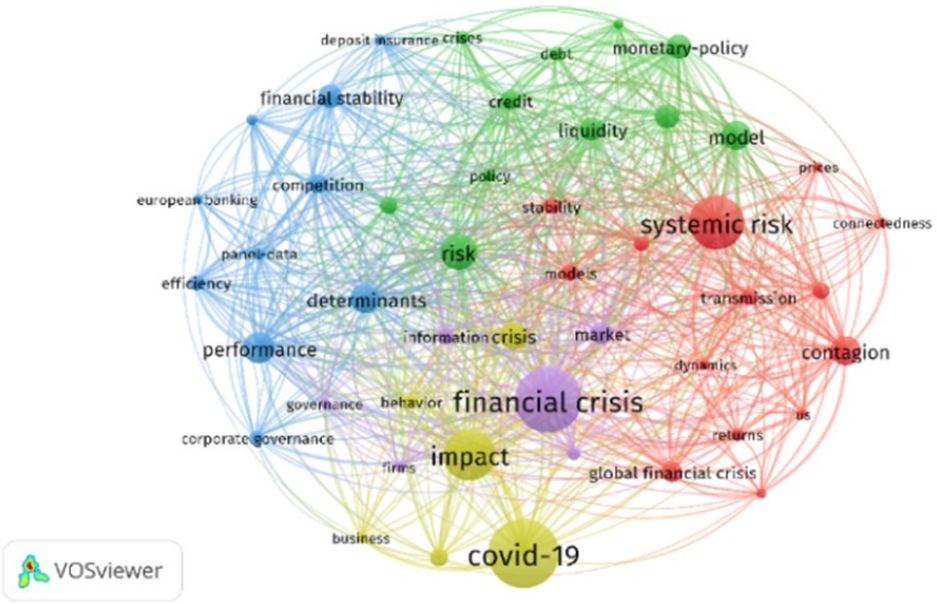

Figure 4: Most frequently occurring keywords
Source: own elaboration in VOSviewer

The first cluster contains 14 keywords primarily focused on transmission of systemic risk. Systemic risk is typically transmitted to the financial sector through bank connectedness, acting as a contagion. The second cluster comprises 11 keywords centered on factors that may influence the level of systemic risk, including monetary policy, bank liquidity, credit (primarily non-performing loan), risk in general, and crises. The third cluster consists of 10 keywords, which, conversely, focus on areas that may be influenced by systemic risk. In this area, we can include performance, financial stability, efficiency, and European banking. Both the fourth and fifth clusters each contain 6 keywords related to the crisis. In relation to the keywords, it is also interesting to analyze their occurrences over time. Some keywords may have occurred more frequently a few years ago, while others have come to prominence more recently. For this purpose, we presented the most frequently occurring keywords for each year in the following Figure 5.

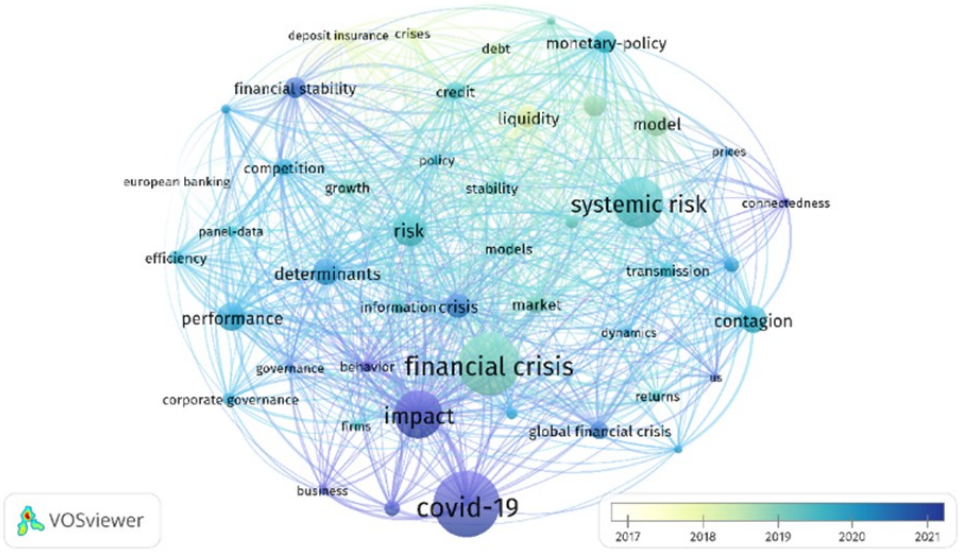

Figure 5: Most frequently occurring keywords over the years
Source: own elaboration in VOSviewer

In 2017, 2018 and 2019, research on systemic risk predominantly focused on themes such as liquidity, debt, model, market, stability, and financial crises. In the following year, the focus shifted toward topics like contagion, monetary policy, efficiency, panel-data, and performance. In recent years, however, the scope of systemic risk research has evolved, bringing areas such as Covid-19, impact, determinants, connectedness, and transmission. This finding may be helpful for readers in understanding which areas are currently being researched in the context of systemic risk.

Conclusions

Based on our research questions, this study provides a comprehensive view of systemic risk research. Our findings highlight the growing importance of systemic risk, as shown by a consistent increase in related publications over recent years, reaching a peak of 409 in 2022. This increase in research activity likely reflects responses to recent global crises, particularly the COVID-19 pandemic, which has emphasized the impact of systemic risk. At the country level, the UK stands out as the most prolific country, contributing over 25 % of all publications, closely followed by the USA, which has a significant impact in both the number of publications and citations. Other influential contributors include Germany, China, Italy, France, and Spain. These findings reveal geographical disparities in research output, which may reflect differences in resources and funding. The leading positions of the UK and the USA are further supported by an overview of the 10 most influential institutions, the majority of which are English and American universities. The national Bureau of Economic research ranks as the most influential, received the highest citations (5,868 citations), followed by the Centre for Economic Policy Research (3,649 citations) and the World Bank (3,162 citations). On an individual level, Viral V. Acharya stands out as the most influential author based on the number of citations, closely followed by Thorsten Beck and Mauro Gallegati. Notably, although Viral V. Acharya ranks highest in influence, he is not among the most published authors, underscoring the fact that authors with fewer publications scan still achieve a significant impact - an observed that

also applies to several other top-citated authors. Additionally, the keyword analysis of systemic risk identifies five clusters, providing insight into the primary areas of study: the transmission of systemic risk, factors influencing systemic risk, impact of systemic risk, and crises-related themes. Research in this area has evolved significantly from 2017 to the present, initially focusing on keywords such as liquidity, stability, and financial crises. Recently, research has expanded to include keywords like COVID-19, impact, connectedness, and transmission, reflecting the current priorities in this field. In conclusion, these findings offer valuable guidance for readers looking to navigate the current landscape of systemic risk research, highlighting the leading countries, institutions, authors, and focal areas within the dynamically evolving field.

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Profiling Typical Bank Clients in Slovakia: A Personality and Demographic Analysis

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Abstract

Financial inclusion is essential for economic development, providing individuals with access to financial services that enhance stability and well-being. This study examines how demographic factors influence banking behavior in Slovakia using survey data from Market Vision Slovakia and a probit regression model. Key variables include age, gender, education, income, urban residency, and the number of banking products used. Findings reveal that the number of banking products is the strongest predictor of bank affiliation. Age, education, and gender also play significant roles, with some banks attracting younger clients, while others serve older or less-educated populations. Urban residency influences bank choice, with certain institutions catering more to urban clients and others focusing on rural areas. The study highlights the importance of tailored banking strategies in promoting financial inclusion. By understanding demographic differences, banks can enhance customer engagement and financial accessibility, ultimately contributing to economic stability and growth.

Keywords: *financial institutions, banking products, banking services, determinants*

JEL Classification: *G20*

Introduction

In today's globalized economy, financial institutions play an irreplaceable role in the financial inclusion of individuals. Their products and services are essential tools that shape the economic landscape of any country. The importance and necessity of financial inclusion for the economy as a whole have been highlighted by numerous authors (e.g., Fungáčová and Weill, 2015; Sarma and Pais, 2011; Tissot and Gadanecz, 2017). It is a key factor in fostering economic, monetary, and financial stability and promoting economic growth and development at both local and global levels. Additionally, financial inclusion contributes to poverty reduction by enabling individuals to save, invest, and plan their finances to achieve their financial goals and thrive in the modern economic environment.

For banks and financial institutions, understanding the typical customer is fundamental. Knowledge of clients' demographic and personal factors allows banks to not only better tailor their products and services but also to effectively support financial inclusion. This study, therefore, focuses on analyzing how personal and demographic characteristics influence client behavior and their relationship with banking products in Slovakia. The goal is to identify factors typical for different customer groups and provide banks with necessary data to better meet their clients' needs, thereby contributing to the economic stability and growth of the country.

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1 Theoretical background

Access to financial services is generally termed as financial inclusion. According to the World Bank, financial inclusion means that "individuals and businesses have access to useful and affordable financial services that meet their needs and are provided in a responsible and sustainable way." These needs include transactions, payments, savings, credit, and insurance. The International Monetary Fund (IMF) defines financial inclusion as "access by households and firms to financial services and their usage." The Bank for International Settlements describes financial inclusion as "the access to and use of a type of financial service that meets the user's needs." Ozili, 2018 states that financial inclusion involves the provision and accessibility of financial services to all residents, particularly the poor or otherwise financially excluded. Doeveren, 2018 notes that financial inclusion ensures free access to appropriate financial services for all residents and businesses at an affordable cost, and it is also about including disadvantaged groups in society on the basis of equal rights and obligations. In a broader sense, financial inclusion is described by Abel, 2018 as a process in which weaker and vulnerable populations are integrated into the organized financial system, thereby gaining access to timely and appropriate credit and other financial products and services at an affordable price.

It is significant for banks to identify the key factors influencing financial inclusion and tailor their products and services to the needs of different customer groups. Such insights are also critical from a competitive advantage standpoint—banks that understand their typical customer and their needs can better target their services and increase client engagement. Research in this area explores various factors affecting the level of financial inclusion, such as economic conditions, demographic factors, education, and access to digital technologies. The following section analyzes studies that address these factors in the context of financial inclusion in different countries. Turkish economist Asli Demirgüc-Kunt and American economist Leora Klapper, in their Demirgüç-Kunt and Klapper, 2012 study, analyzed financial inclusion across 148 economies and identified that account ownership correlates with individual characteristics such as gender, age, education, and urban or rural residency. They found that men are more likely to own bank accounts (55 % compared to 47 % for women) and that account ownership is higher among individuals with higher education levels. High-income economies exhibit the highest rates of account ownership, while gender and educational disparities are most pronounced in developing regions. In 2016, alongside co-authors Martinez Peria and Allen, Demirgüc-Kunt and Klapper (Allen et al., 2016) focused on financially excluded groups in 25 countries and confirmed that higher income, education, urban residency, and employment significantly increase the likelihood of account ownership.

Efobi et al., 2014 in their study in Nigeria confirmed the effect of demographic and socio-economic factors such as income, age, and education on the use of banking services, savings, and cash withdrawals. High financial discipline and a propensity to use information technologies further reinforced the use of banking products. Similar factors were investigated by Fungáčová and Weill, 2015, who compared financial inclusion in China with other BRICS countries. They found that financial inclusion correlates with income and education, with a non-linear relationship concerning age—older individuals use financial services more frequently, but only up to a certain age. Gender and the social status of men within families were also identified as influential factors in account ownership in China.

A study from India by Nandru et al., 2016 highlighted that income level and edu-

cation are key factors in account ownership and savings behavior. In Tanzania, Lotto, 2018 focused on the determinants of financial inclusion and found that higher income and education increase the likelihood of account ownership, with older men being more financially included than younger women with lower education. In Indonesia, Susilowati and Leonnard, 2019 analyzed how government initiatives affected access to accounts, savings, and loans. Men were found to have a higher likelihood of account ownership than women, with higher income and education also increasing the probability of obtaining loans, mainly due to better financial security.

In another study, Zins and Weill, 2016 examined financial inclusion across 37 African countries and identified key factors such as education, income, and employment as correlates of financial inclusion. Their findings were consistent with previous research, also underscoring the importance of technological access to banking services.

A review of the literature shows that most authors approach the issue of financial inclusion by examining its level and influencing factors, with a significant focus on Asian and African countries. However, there is a paucity of studies exploring this topic from the perspective of banks, specifically aimed at identifying the "typical" client of a given bank. Moreover, no studies have been found that conduct such an analysis in Slovakia. This represents an opportunity to contribute to and fill a gap in empirical literature. Using data collected through a survey in Slovakia, we aim to analyze this issue using a probit regression model, in alignment with methodologies applied in prior studies.

2 Research methodology

The data analyzed in this study originates from a database provided by MARKET VISION SLOVAKIA. This company collects data related to customer relationships within the Slovak banking sector as part of evaluations of customer and user experience across bank distribution networks. The database encompasses various areas related to respondents' relationships with financial institutions. Specifically, the database includes information on respondents' familiarity with banking, savings, and insurance institutions. It also details the banking products used by Slovaks and the specific banks or financial institutions where these products are held. Additionally, the database indicates whether respondents have become new clients of a bank within the past 12 months or if they have terminated their relationship with a bank and the reasons for such changes. Furthermore, it notes which banks respondents would consider if they were to transfer their products.

The database also provides insights into the communication methods that Slovaks actively use and their frequency of use, as well as their satisfaction with banking applications. In terms of client satisfaction, the database includes overall satisfaction ratings, assessments of the bank's reputation, and whether respondents would recommend their bank or financial institution to others. Additionally, it presents data on respondents' living and financial conditions, employment status, level of savings, duration of product and service usage, and their trust in financial and non-financial institutions.

Table 1: Definition and descriptive statistics of variables

Variable Name	Definition	Number of Observations	Mean Value	Standard Deviation
Indicator of Banking Products				
Current Account	A dummy variable equals 1 if the respondent uses a current account at any bank; otherwise, it equals 0.	4,861	0.9716	0.1661
Savings Account	A dummy variable equals 1 if the respondent uses a savings account at any bank; otherwise, it equals 0.	4,861	0.4841	0.4998
Credit Card	A dummy variable equals 1 if the respondent uses a credit card at any bank; otherwise, it equals 0.	4,861	0.2545	0.4356
Term Deposit	A dummy variable equals 1 if the respondent uses a term deposit at any bank; otherwise, it equals 0.	4,861	0.1068	0.3098
Passbook Savings	A dummy variable equals 1 if the respondent uses a passbook savings at any bank; otherwise, it equals 0.	4,861	0.0907	0.2872
Consumer Loan	A dummy variable equals 1 if the respondent uses a consumer loan at any bank; otherwise, it equals 0.	4,861	0.1607	0.3673
Mortgage Loan	A dummy variable equals 1 if the respondent uses a mortgage loan at any bank; otherwise, it equals 0.	4,861	0.1083	0.3742
Overdraft	A dummy variable equals 1 if the respondent uses an overdraft at any bank; otherwise, it equals 0.	4,861	0.1625	0.3690
Mutual Funds	A dummy variable equals 1 if the respondent invests in mutual funds at any bank; otherwise, it equals 0.	4,861	0.1222	0.3275
Personal and Demographic Characteristics of Respondents				
Gender	A dummy variable equals 1 if the respondent is female; otherwise, it equals 0.	4,861	0.5262	0.4994
Age	Age given in years.	4,861	43.7616	16.4000
EDU1	A dummy variable equals 1 if the respondent has attained primary education; otherwise, it equals 0.	4,861	0.0125	0.1155
EDU4	A dummy variable equals 1 if the respondent has attained university education; otherwise, it equals 0.	4,861	0.1720	0.3772
Residence	A dummy variable equals 1 if the respondent lives in a municipality with a population over 5,000; otherwise, it equals 0.	4,861	0.5060	0.4948
Income	Income value in EUR.	4,861	576.3225	415.0386
Satisfaction	A dummy variable equals 1 if the respondent is somewhat or very satisfied with banking services; otherwise, it equals 0.	4,861	0.8362	0.3716
Satisfaction5	A dummy variable equals 1 if the respondent is very satisfied with banking services; otherwise, it equals 0.	4,861	0.4487	0.4974
Number of Products	Number of products used at the bank.	4,861	2.5884	1.4751
Bank				
SLSP	A dummy variable equals 1 if Slovenská sporiteľňa is the respondent's main bank; otherwise, it equals 0.	4,861	0.3286	0.4651
VUB	A dummy variable equals 1 if Všeobecná úverová banka is the respondent's main bank; otherwise, it equals 0.	4,861	0.2808	0.4496
TATRA	A dummy variable equals 1 if Tatra banka is the respondent's main bank; otherwise, it equals 0.	4,861	0.1387	0.3458
CSOB	A dummy variable equals 1 if Československá obchodná banka is the respondent's main bank; otherwise, it equals 0.	4,861	0.1370	0.3439
UNICREDIT	A dummy variable equals 1 if UniCredit Bank is the respondent's main bank; otherwise, it equals 0.	4,861	0.0378	0.1908
POSTOVA	A dummy variable equals 1 if Poštová banka is the respondent's main bank; otherwise, it equals 0.	4,861	0.0158	0.1247
RAIFF	A dummy variable equals 1 if Raiffeisen bank is the respondent's main bank; otherwise, it equals 0.	4,861	0.0971	0.2961
PRIMA	A dummy variable equals 1 if Prima banka is the respondent's main bank; otherwise, it equals 0.	4,861	0.1062	0.3083
365BANK	A dummy variable equals 1 if 365.bank is the respondent's main bank; otherwise, it equals 0.	4,861	0.1152	0.3198

Source: Own elaboration

Table 1 presents the descriptive statistics of the variables included in the model. The

first part of the table offers definitions and descriptive statistics of individual banking product indicators. Notably, 97.16 % of respondents reported owning a current account. The second most common banking product was a savings account, held by 48.41 % of respondents. For deposit products, term deposits and passbook savings accounts were also analyzed, with 10.68 % and 9.07 % of respondents using these products, respectively. Regarding credit products, data was collected on the use of credit cards, consumer loans, mortgages, and overdrafts. The findings indicated that 25.45 % of respondents used credit cards, 16.07 % used consumer loans, 16.83 % had mortgages, and 16.25 % utilized overdrafts. The final analyzed product was investment in mutual funds facilitated by banks, with a usage rate of 12.22 %.

The second part of the table describes the descriptive statistics for respondents' demographic and personal characteristics. Women represented 52.62 % of the respondents, with an average age of approximately 44 years. In terms of education, 12.55 % of respondents had only elementary education, while 17.20 % held university degrees. More than half (56.06 %) of the respondents resided in urban areas. The average gross household income per capita, defined at the regional level, was around 576 EUR. Concerning satisfaction with banking services, over 88 % of respondents stated that they were somewhat or very satisfied with their bank's services, with nearly 45 % expressing high satisfaction. The final variable considered was the number of banking products used, showing that, on average, one respondent used approximately 2.5 banking products.

The third part of the table details the statistics on respondents' main bank affiliation. The largest group of respondents were clients of Slovenská sporiteľňa (38.26 %), followed by Všeobecná úverová banka (22.46 %), Tatra banka (20.41 %), Poštová banka (15.86 %), Československá obchodná banka (13.70 %), 365.bank (11.52 %), Prima banka (10.66 %), UniCredit Bank (10.06 %), and Raiffeisen bank (9.71 %). Other banks included in the survey but with a response share below 9 % were excluded from the analysis.

The analysis will be conducted using a binary regression method based on data sourced from Market Vision Slovakia. As noted by Coss, 2015, this method is employed to estimate a model that specifies the relationship between a dependent variable and one or more independent variables, which may be continuous or categorical. This approach seeks to identify dependencies between explanatory variables and the probability of the occurrence of an observed event.

Most categorical dependent variables take on one of two possible values, such as 0 or 1, yes or no, employed or unemployed, or a decision to purchase or not purchase a product. These variables are referred to as binary, dichotomous, or alternative variables. However, categorical dependent variables can also take on more than two values, such as choices among different products, social status, or the number of children in a family, and are described as multicategory or polytomous variables. The following discussion focuses on a model restricted to a binary categorical variable.

We assume a binary variable Y that can take on one of two values, denoted as 1 and 0. The value 1 indicates that the observed event occurred, while 0 indicates that it did not. The binary variable Y follows an alternative probability distribution, conditional on the probability of the event occurring, expressed as:

$$P(Y = 1) = \pi \tag{1}$$

and the probability of the event not occurring is expressed as:

$$P(Y = 0) = 1 - \pi \tag{2}$$

The mean of this probability distribution is:

$$E(Y) = 1 \cdot P(Y = 1) + 0 \cdot P(Y = 0) = 1 \cdot \pi + 0 \cdot (1 - \pi) = \pi \tag{3}$$

and the variance of the probability distribution is:

$$D(Y) = \pi(1 - \pi) \tag{4}$$

The probability value π can vary depending on the change in the value x of the variable X thus, this probability is denoted as $\pi(x)$. Assuming x is a vector of independent variables $X_1, ..., X_k$, the probability of the event occurring is expressed as:

$$\pi(x) = \beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k \tag{5}$$

For the transformation of non-linear probability models, a link function can be applied. Under the assumption of a binomial distribution of the error term, the probit function serves as such a function. Applying a probit transformation to the probability of the event occurring yields a probit regression model. While in the original model the probability values are constrained to the interval (0,1), the probabilities in the probit model, called probits, range from $(-\infty, \infty)$. Probits are continuous variables and can be used as dependent variables in a linear model. The probit regression model is expressed as:

$$\text{probit}(\pi(x)) = \beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k \tag{6}$$

In this equation, probit $(\pi(x))$, represents the probit-transformed probability value. This model establishes a linear relationship between the probit and the explanatory variables. By estimating the regression coefficients, we can determine the influence of the explanatory variables on the probability of the observed event occurring. The probit regression model is applied to identify the personality and demographic characteristics associated with clients of specific banks, aiming to define the typical client profile for each bank. Only banks identified as the primary bank by more than 9 % of respondents were included in the analysis. Banks with a smaller "market share" were excluded from the analysis. As respondents provided binary responses (yes/no or 1/0) regarding their use of specific bank services, the conditions for applying a probit regression model with a binary dependent variable to determine the likelihood of using a particular bank's services based on respondent characteristics were met. The probit regression model equation takes the following form:

$$\begin{aligned} \text{Bank}_i = \beta_0 + \beta_1 \text{Age}_i + \beta_{12} \text{Age}_i^2 + \beta_2 \text{Gender}_i + \beta_3 \text{Education}_i + \\ \beta_4 \text{Urban Residence}_i + \beta_5 \text{Income}_i + \beta_6 \text{Number of Products}_i + \varepsilon_i \end{aligned} \tag{7}$$

In the given equation, the variable Bank represents the dependent variable, indicating the use of services provided by one of the Slovak banks (Slovenská sporiteľňa, VÚB, Tatra banka, ČSOB, UniCredit Bank, Poštová banka, Raiffeisen bank, Prima banka, 365.bank), where i denotes the respondent index. The independent variables in the model include the personality and demographic characteristics of the respondents, specifically age, gender, education, place of residence, income, and the number of products utilized by the respondent. The selection of variables for the probit model was informed by a review of the literature. Numerous authors highlight that the degree of financial inclusion, in terms of various banking products, is influenced by a range of factors. Most of these authors emphasize the effect of sociodemographic factors such as gender, age, education,

income, employment status, and marital status. Therefore, the following variables were included in our regression model:

3 Definition of Variables

- **Bank** – This variable indicates the respondent's affiliation with the selected bank they identified as their primary bank. Through this variable, we aim to determine whether individual effects are present in the model and whether differences exist among respondents regarding their main bank choice.
- **Age** – This is the first personality characteristic and is recorded as the respondent's age in years. Previous studies suggest the potential for a non-linear relationship between age and the use of banking products. Therefore, when testing the probit regression model, we included a quadratic form of this variable. If the quadratic term was found insignificant, only the results representing a linear relationship were presented. This variable helps determine whether the utilization of banking products is related to the respondent's age and whether this relationship is linear.
- **Gender** – A dummy variable representing the respondent's gender, where a value of 1 indicates that the respondent is female, and 0 otherwise. This variable aims to identify whether gender affects the utilization rate of banking products.
- **Education** – The influence of education was analyzed by categorizing respondents into four groups based on their highest level of education attained. EDU1 includes respondents with elementary education, EDU2 covers those with secondary education without graduation, EDU3 represents secondary education with graduation, and EDU4 comprises respondents with higher education degrees. A value of 1 was assigned to respondents in their respective educational group, while the remaining groups had a value of 0. The literature shows that higher education generally has a positive influence on the use of banking products, whereas lower education correlates with a lower rate of banking product usage. After examining multicollinearity using the VIF test, we identified multicollinearity issues among respondents with secondary education. Based on these test results and previous studies, only the first and fourth educational groups were included in the model. These dummy variables help assess whether elementary and higher education levels affect the utilization rate of banking products.
- **Urban Residence** – A dummy variable that takes the value of 1 if the respondent resides in a locality with more than 5,000 inhabitants. According to data from the Statistical Office, the largest rural towns in Slovakia have populations of up to 8,838, while some cities have populations below 5,000. Thus, the threshold for defining urban or rural residence was set at 5,000 inhabitants. This variable helps determine whether banking products are more commonly used by urban or rural residents.
- **Income** – The literature indicates that income is a significant factor influencing the use of financial services. Due to the unavailability of individual income data, this variable was approximated by the gross household income per capita in the respondent's respective region of residence. This variable tests whether the use of banking products is associated with respondents from regions with higher or lower average income levels.

- **Number of Products** – This variable represents the number of banking products a respondent uses at their main bank. The banking products considered include current accounts, savings accounts, credit cards, term deposits, passbook savings accounts, consumer loans, mortgages, overdrafts, and investments in mutual funds.

4 Results and discussion

The results of the model, presented in Table 2, indicate that the model describing clients of Tatra banka has the highest explanatory power, as evidenced by the Pseudo R^2 value of 8.01 %. This is considered an acceptable level of explanatory power in studies employing a probit model with a large number of observations. In this model, the variables Gender and EDU4 (university education) are not statistically significant. This implies that there is no conclusive evidence to suggest that being male or female, or having higher education, increases the probability of being a client of Tatra banka. Conversely, the model shows that respondents from regions with higher income levels or those residing in urban areas are more likely to be clients of Tatra banka. Additionally, an increase in the number of banking products used by a respondent raises the likelihood by 2.69 % that Tatra banka will be their main bank.

The results further reveal that many Tatra banka clients only have elementary education. The probability of being a client of Tatra banka increases by 6.27 % for respondents with only elementary education. This can be attributed to Tatra banka's offering of fee-free accounts for students, which are popular even among secondary school students. This relationship is also supported by the presence of a non-linear, inverted U-shaped relationship between age and affiliation with Tatra banka, indicating that service usage peaks among the youngest respondents and declines slightly during the working-age period, likely due to the discontinuation of student accounts and fee policies. However, after a certain age, the probability begins to increase again, though these changes are not as pronounced, giving the curve a flatter U-shape.

The second most significant model describes clients of Slovenská sporiteľňa. Here, the bank's policy of offering favorable accounts to younger individuals similarly results in an inverted U-shaped relationship between age and the probability of being a client. In this model, an increase in the number of products used by a respondent increases the likelihood of Slovenská sporiteľňa being their main bank by 7.83 %. Differences emerge in the variables Urban Residence and Income, where results suggest that Slovenská sporiteľňa is more associated with clients from smaller towns and regions with lower average income levels. The model also identified Gender as significant, indicating that being female increases the probability of being a client of Slovenská sporiteľňa by 4.07 %.

The third model focuses on clients of 365.bank. Unlike the previous banks, a linear negative relationship between age and affiliation with 365.bank was found. Given that 365.bank is a digital bank primarily targeting young people, these findings confirm that as respondents age, the likelihood of being a client of 365.bank decreases. Gender is also significant for 365.bank, where men are more likely to be clients than women. Additionally, using more banking products increases the probability of a respondent considering 365.bank as their main bank. Income and Urban Residence did not have a statistically significant impact on the usage of 365.bank's products.

Table 2: Descriptive statistics used variables

Variable	**SLSP**	**VUB bank**	**Tatra banka**	**CSOB**	**UniCredit Bank**
Gender	0.1195 ***	0.0135	-0.0181	-0.0377	-0.1322 ***
	(0.0383)	(0.0415)	(0.0438)	(0.0436)	(0.0511)
Age	-0.0242 ***	0.0018	-0.0176 **	-0.0036	-0.0091 **
	(0.0073)	(0.0013)	(0.0072)	(0.0032)	(0.0016)
Age^2	0.0003 ***	0.0006 **	0.0001 **	0.0000 *	-0.0006 ***
EDU1	0.0410	0.0213	0.2410 ***	-0.0655	-0.1211
	(0.0641)	(0.0683)	(0.0631)	(0.0678)	(0.0874)
EDU4	-0.0434	0.0625	0.0337	0.0403	0.2918 ***
	(0.0514)	(0.0541)	(0.0575)	(0.0547)	(0.0620)
Urban Residence	-0.0791 **	-0.0110	0.1251 ***	0.0069	0.2118 ***
	(0.0383)	(0.0416)	(0.0437)	(0.0446)	(0.0523)
Income	0.0003 ***	0.0003	0.0003 ***	0.0004 ***	0.0004 ***
Number of Products	0.2175 ***	0.1683 ***	0.1033 ***	0.1351 ***	0.0764 ***
	(0.0133)	(0.0197)	(0.0145)	(0.0151)	(0.0166)
Pseudo R^2	5.16%	3.29%	8.0%	2.49%	3.67%
VIF test	NO	NO	NO	NO	NO

Variable	**Poštová banka**	**Raiffeisen bank**	**Prima banka**	**365.bank**
Gender	0.1051 **	-0.0782	0.0938 *	-0.2924 ***
	(0.0452)	(0.0509)	(0.0507)	(0.0499)
Age	0.0279 ***	0.0179 *	0.0323 ***	-0.0126 **
	(0.0088)	(0.0098)	(0.0102)	(0.0016)
Age^2	0.0001 **	-0.0002 *	-0.0005 ***	0.0000 *
EDU1	1.1947 ***	2.7042 ***	0.0301	0.2131 **
	(0.0746)	(0.0802)	(0.0868)	(0.0755)
EDU4	-0.1817 ***	-0.1986 ***	0.0778	0.2153 ***
	(0.0641)	(0.0737)	(0.0650)	(0.0662)
Urban Residence	-0.0497	0.0511	0.0561	0.0497
	(0.0449)	(0.0511)	(0.0518)	(0.0497)
Income	0.0003 ***	0.0004	0.0001	-0.0003 ***
Number of Products	0.0494 ***	0.0414 **	0.1142 ***	0.0816 ***
	(0.0152)	(0.0170)	(0.0162)	(0.0210)
Pseudo R^2	3.19%	1.7%	4.56%	4.69%
VIF test	NO	NO	NO	NO

Note: The dependent variable is an indicator defining bank affiliation. The table presents the marginal effects in the first row and the standard errors in the second row for each independent variable. Asterisks indicate the level of significance at the following thresholds: *** 99 percent, ** 95 percent, * 90 percent.

Source: Own elaboration

In the model for Prima banka, an inverted U-shaped relationship between age and the probability of affiliation was found. This suggests that with increasing age, the probability of using Prima banka's products rises until a certain point, after which it begins to decline. This could be explained by Prima banka's focus on promoting loan products, such as mortgages and refinancing, which are typically used by people in middle age. The most significant variable for Prima banka was Urban Residence. If a respondent resides in a locality with more than 5,000 inhabitants, the probability of being a Prima banka client increases by 3.97 %. Similar to other banks, the use of multiple banking products increased the probability of affiliation with Prima banka by 2.53 %. The impact of Education and Income on product usage at Prima banka was not statistically significant in the model.

For UniCredit Bank, Education had the most significant impact on the likelihood of

using the bank's products. Respondents with higher education were 4.96 % more likely to be clients. Age also showed a statistically significant, linear negative effect, indicating that the probability of being a client decreases as age increases. Urban Residence was also a significant factor, with clients more likely to come from larger towns or cities, aligning with UniCredit's branch distribution in more urban areas. Additionally, the usage of more banking products was associated with a higher probability of affiliation with UniCredit Bank.

The model for Všeobecná úverová banka did not show significant results for most characteristics except for the variable Number of Products, which was significant. This suggests that respondents who use more products from the bank are more likely to consider it their main bank. The Poštová banka model showed that all variables except Income were statistically significant. Gender was significant, with the probability of being a client being 2.46 % higher for women. Poštová banka was also associated with respondents from smaller, rural areas and those with only elementary education. The probability of being a client decreased for those with higher education. The Age variable displayed an inverted U-shaped relationship, indicating that the likelihood of using Poštová banka's services increases with age up to a point, after which it stabilizes or decreases. Poštová banka's strategy of transitioning part of its clientele, particularly younger ones, to 365.bank explains why its services are more prevalent among older, less educated populations in smaller communities. This is supported by Poštová banka's network through Slovenská pošta, which maintains branches in almost every village, making it accessible to the older population and those living in small rural areas.

The model for Československá obchodná banka (ČSOB) indicates that only the variables Age and Number of Products are statistically significant. Age has a linear negative effect on the probability of using ČSOB as the main bank, suggesting that as individuals age, the likelihood of choosing ČSOB as their primary bank decreases. Additionally, the model shows that a higher number of utilized products increases the probability of becoming a client of ČSOB.

The model with the lowest explanatory power is the one for Raiffeisen Bank, which accounts for only 1 % of variability. For Raiffeisen Bank clients, a non-linear U-shaped relationship between age and the probability of using the bank's products was identified. This implies that Raiffeisen Bank's clients are generally middle-aged and tend to have lower educational attainment. Specifically, individuals with only elementary education are 4.37 % more likely to be clients of Raiffeisen Bank. The model also confirms that using multiple banking products positively influences the probability of using Raiffeisen Bank as the main bank.

A common statistically significant variable across all bank models is Number of Products. For all banks analyzed, the use of multiple products increases the likelihood of a respondent using that bank as their primary institution. Higher satisfaction with a bank is likely to lead to a higher probability of using its products and services. This finding aligns with the study by Belás et al. (2015), which demonstrated a positive relationship between the use of multiple banking products and overall satisfaction with the bank.

The impact of other variables varies among the models of different banks. Given that Slovak banks operate in a competitive market, they may target different consumer segments and adjust the features of their product offerings accordingly. This variability explains why individual variables in the models have differing impacts on the probability of a respondent using a particular bank as their main institution.

Conclusions

The results demonstrate that individual banks in Slovakia target different market segments, thereby contributing to the financial inclusion of diverse population groups. The most significant variable across all models is the number of products used within the bank—utilizing a greater number of products increases the likelihood of the bank being the client's primary institution. This relationship is confirmed by previous studies that highlight the positive impact of broader product usage on overall client satisfaction with the bank. From the perspective of financial inclusion, it is noteworthy to observe how different banks attract various client segments. Tatra banka, with its focus on young people and students who can take advantage of fee-free accounts, plays a significant role in integrating younger, student customers into the financial system. Slovenská sporiteľňa supports the inclusion of younger clients from smaller towns, contributing to the accessibility of banking services beyond major cities. Conversely, 365.bank, with its digital orientation, targets tech-savvy younger clients who value online access to banking services. Prima banka and Poštová banka, which focus on loan products and clients in middle age or older residents of smaller communities, contribute to the financial inclusion of individuals who might otherwise be excluded from modern banking—particularly those with lower education levels and older individuals who prefer the physical presence of branches. Poštová banka, through its partnership with Slovenská pošta, effectively serves rural areas where access to banking services is often limited. UniCredit Bank, on the other hand, targets university-educated clients in larger cities, enhancing the availability of services for economically active and professionally oriented residents. In summary, the diversified product offerings and varied target groups contribute to the financial inclusion of a broad spectrum of the Slovak population. Different banks provide products and approaches that reflect the specific needs of their clients, thereby supporting the integration of various social and economic groups into the financial system. This approach helps ensure that banking services are accessible to a wider audience, promoting inclusivity and supporting economic stability.

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Bibliometric Study of the Interest Rate Pass-Through

Karina Zhemelko[1]

Abstract

This study conducts a bibliometric analysis to map the structure and key research trends in the field of interest rate pass-through. Utilizing data from the Web of Science (WoS) database, I examine publication and citation patterns, identify the most influential journals and authors, and analyze institutional collaborations within this research domain. Through the application of VOSviewer, I further identify dominant research themes, key academic networks, and leading institutional contributors. By tracing the evolution of research on interest rate pass-through, this study offers insights into emerging trends and provides a foundation for future research directions in monetary policy transmission. The results highlight a significant surge in research following the Global Financial Crisis, with increasing emphasis on the role of unconventional monetary policy tools and asymmetric transmission effects. Additionally, my findings indicate that research on interest rate pass-through is highly concentrated in Q1-ranked journals, with central banks and international financial institutions playing a pivotal role in shaping the discourse on monetary transmission mechanisms.

Keywords: *bank lending channel, bibliometric analysis*

JEL Classification: *E43, E52, G21*

Introduction

The interest rate transmission channel is considered one of the most traditional mechanisms in monetary policy, with its importance growing in recent years as the responsibility for inflation stabilization has increasingly shifted to monetary authorities. This channel plays a particularly crucial role in economies with inflation-targeting regimes, as adjustments in interest rates enable central banks to effectively influence demand pressures and maintain price stability. The literature in this field is extensive, offering numerous findings on the speed and magnitude of pass-through, structural breaks, non-linearities in transmission, and the impact of financial market conditions on the effectiveness of monetary policy transmission. Given the evolving nature of monetary policy and financial market structures, identifying current research trends is essential for improving our understanding of interest rate pass-through dynamics. In this context, bibliometric analysis serves as a valuable tool for mapping key developments, uncovering dominant research themes, and providing insights that can guide future research in this area. The objective of the bibliometric analysis in this study is to uncover key trends in the literature on interest rate pass-through and provide insights into dominant research themes and methodological approaches. By identifying patterns in scholarly contributions, this analysis establishes a foundation for future research directions aimed at enhancing the understanding of the effectiveness and evolution of interest rate pass-through.

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1 Theoretical Framework and Literature Review

The transmission mechanism of monetary policy through interest rates has been a subject of discussion in economic literature for over 90 years and is considered one of the fundamental channels through which central banks influence the real economy. Keynes (1936) described the interest rate channel as a process in which expansionary monetary policy leads to a decline in real interest rates, subsequently reducing the cost of capital, increasing investment expenditures and aggregate demand, ultimately resulting in higher output.

According to Mishkin, 1995, the transmission process can be represented as follows:

$$M_t \rightarrow r_t \rightarrow I_t \rightarrow Y_t \tag{8}$$

where M_t represents monetary policy actions, r_t stands for real interest rates, I_t denotes investment, and Y_t refers to aggregate output. Focusing on the first part of the equation, the interest rate channel operates under the assumption that monetary policy measures directly influence market interest rates and indirectly affect bank lending and deposit rates. The transmission mechanism of monetary policy impulses can be described as a two-phase process. The pass-through of interest rates begins with adjustments to key monetary policy rates. Changes in these rates by the central bank have a direct impact on money market interest rates, significantly influencing market liquidity conditions. Subsequently, changes in money market rates are transmitted to the interest rates on commercial bank products. Short-term interest rates on instruments issued by commercial banks tend to respond relatively quickly, as their financing often depends on money markets. Consequently, there is a rapid increase in interest rates on short-term loans with variable interest rates. Similarly, short-term fixed-rate instruments exhibit a tendency toward rising rates, although this process typically occurs with some time lag due to the rigidity of contractual agreements and pricing structures in financial markets Bundesbank, 2019.

Modern literature Domonkos et al., 2023; Fungáčová et al., 2023; Horvath et al., 2018; Michaelis, 2024 has expanded the traditional analysis of interest rate pass-through, which primarily examines the transmission of monetary policy rates to commercial bank product rates. This expansion incorporates the role of unconventional monetary policy tools, particularly in a low-interest-rate environment where conventional policy rates were constrained by the zero lower bound. In this context, the concept of the shadow rate was developed to capture the effects of unconventional monetary policy instruments such as quantitative easing and forward guidance Geiger and Schupp, 2018; Krippner, 2022; Wu and Xia, 2022. Empirical studies generally employ two methodological approaches to assess the quality of interest rate pass-through. The first group of studies Egan and McQuinn, 2024; Gondwe et al., 2023; Gregor and Melecký, 2018 utilizes Autoregressive Distributed Lag (ARDL) models with advanced specifications to examine the short- and long-term dynamics of pass-through across different monetary regimes. Additionally, other studies Galindo and Steiner, 2022; Herlambang and Purwono, 2023; Holland et al., 2019 investigate the asymmetry in interest rate transmission during periods of expansionary and contractionary monetary policy. The second group of studies Aristei and Gallo, 2014; Hristov et al., 2014; Michaelis, 2024; Von Borstel et al., 2016 increasingly focuses on the evolution of transmission mechanisms from the Global Financial Crisis (GFC) to the recent period of rapidly rising interest rates. These studies analyze structural breaks and dynamic relationships using Vector Autoregression (VAR) models.

2 Data Collection

For this study, I utilized the *Web of Science* database, provided by *Clarivate*. WoS is a widely recognized and trusted resource, frequently used by researchers due to its extensive coverage of scholarly literature across various scientific disciplines. By employing WoS, I filtered a representative sample of studies based on specific keywords, which form the foundation for this bibliometric analysis. To maintain the breadth of the sample and avoid imposing unnecessary restrictions, I opted not to apply additional filters such as author affiliation, research areas, etc. The search was conducted on January 20, 2025. Table 1 provides an overview of the main characteristics of the collected sample.

Table 1: Details of Collected Data

Inclusion criteria	**Results of filtering**
Selected keywords	Bank Lending Channel (All Fields) OR Interest Rate Channel (All Fields) OR Interest Rate Pass-Through (All Fields) OR Interest Rates Pass-Through (All Fields) OR Interest-Rate Pass-Through (All Fields) OR Monetary Transmission Mechanism (All Fields) OR Monetary Transmission Mechanisms (All Fields)
Number of articles	1,127
Document type	Article, Proceeding paper, Early access
Number of articles	1,108
Language	English
Final sample	1,053

Source: own

To gain a more comprehensive understanding of the development of my research topic, data were collected across all available years without imposing restrictions on a specific time period. As a result, the final dataset spans from 1983 to 2024, ensuring the inclusion of a broad spectrum of relevant studies.

Figure 1 illustrates a map chart displaying countries based on the number of publications, represented by varying shades of blue. Dark blue indicates a high number of publications, medium blue represents a moderate count, and light blue signifies a low number of publications. Regions shaded in light grey do not include any publications in our sample. The most significant contributors are authors from the United States, who have produced the largest number of articles in the studied field, with 264 publications. Germany follows with 88 articles, while Italy, China, and France demonstrate similar output, ranging from 55 to 65 articles each.

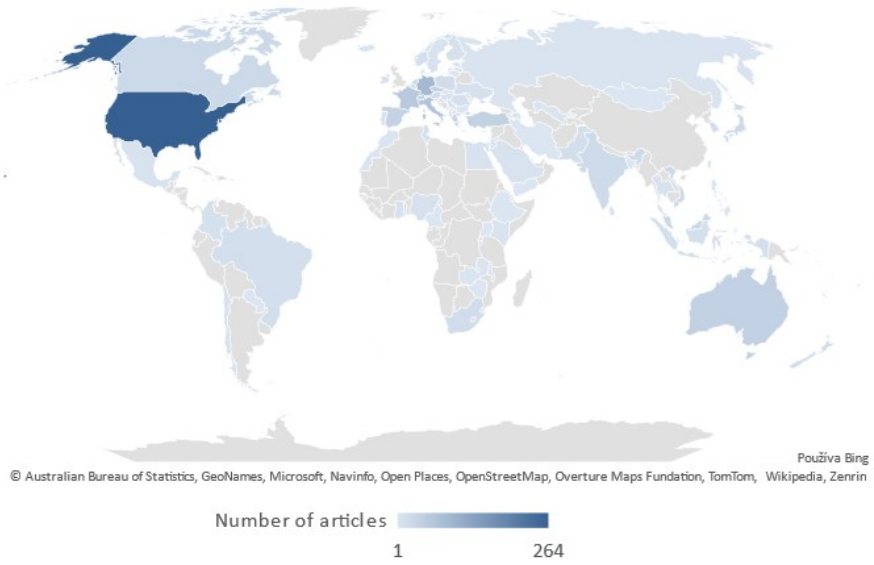

Figure 1: Distribution of the articles across the world
Source: own

3 Methodology

Bibliographic research is a crucial component of scientific inquiry across diverse disciplines, as it entails a systematic review of published resources such as books, articles, and other materials to extract relevant information on a specific subject. By analyzing existing literature, bibliographic studies provide a comprehensive overview of prior research, shedding light on the current state of knowledge within a field. One of its key advantages is the ability to identify gaps in the literature, paving the way for future research opportunities and advancing scholarly understanding Yazdi et al., 2023. Furthermore, it offers a detailed perspective on the historical trajectory of a discipline, encompassing the development of fundamental concepts, theories, and methodologies. In addition, bibliographic research aids in evaluating the credibility and reliability of existing studies by examining the quality of sources, the reputation of authors, and the rigor of their contributions Donthu et al., 2021. References serve as a cornerstone in bibliographic research, as they not only track the temporal evolution of scholarly works but also highlight the interconnectedness of ideas and the extent to which studies have shaped their respective fields. Citation data serves as a valuable tool for researchers, enabling them to pinpoint influential authors and groundbreaking publications within a particular field. It provides insight into how innovative ideas and concepts spread throughout the academic landscape and are embraced by the research community. Additionally, this data offers a framework for exploring the relationships within research networks, uncovering patterns of collaboration, and understanding the interplay between institutions and scholars. By leveraging citation analysis, researchers can also assess the prominence and scholarly contributions of individual academics and organizations, shedding light on their overall impact and influence in shaping their disciplines Lim and Kumar, 2024.

The primary goal of this study is to address the following research questions:

1. What trends can be identified in publication and citation patterns within the Web of Science database?

2. What are the key trends and themes reflected in the keywords of publication patterns within the Web of Science?

3. Which journals are most influential based on publication metrics in the Web of Science?

4. Who are the most impactful authors according to publication metrics in the Web of Science?

5. Which affiliations are most prominent based on publication metrics in the Web of Science?

To conduct bibliographic analyses, the VOSviewer software was utilized. VOSviewer is a freely available tool designed for constructing and visualizing bibliometric networks derived from journals or individual publications. These networks can be created based on citation relationships, bibliographic coupling, co-citation, or co-authorship. Furthermore, VOSviewer includes a text-mining feature that enables the visualization of co-occurrence networks of significant terms extracted from scientific literature. The software employs an association strength normalization technique (default setting) to connect keywords and calculate the strength of links between items. This normalization approach ensures that the relationships between items are accurately represented DeGroote, 2023.

4 Results and Discussion

This section presents the findings of the bibliometric analysis on the research topic of interest rate pass-through. The results are structured to provide insights into the temporal evolution of research activity, key research themes, influential journals, leading authors, and institutional affiliations contributing to this field. The first step in understanding the development of research on interest rate pass-through involves examining the annual distribution of published articles and their citation impact over time. Figure 2 illustrates the temporal trends in the number of publications and citations from 1983 to 2024, providing a broad perspective on the growth of academic interest in this topic.

The global financial crisis of 2008 triggered a significant surge in academic interest in the interest rate pass-through mechanism, driven by the instability in financial markets and the unprecedented monetary policy interventions implemented by central banks to stabilize economies. The peak period in the publication trend was between 2013 and 2022, during which more than 60 articles were published annually. This heightened interest was likely driven by the prolonged low-interest rate environment that followed the financial crisis, as well as the widespread application of unconventional monetary policy tools such as the Targeted Longer-Term Refinancing Operation (TLTRO), Asset Purchase Programme (APP), and other stimulus measures aimed at fostering economic recovery and ensuring financial stability.

Alongside the increase in publications, a sharp rise in citations has been observed since 2010, reflecting the growing academic debate on the effectiveness of these indirect monetary policy tools. The rising number of citations indicates that studies published in this period have played a crucial role in shaping discussions on monetary policy transmission and its implications for financial markets and economic stability.

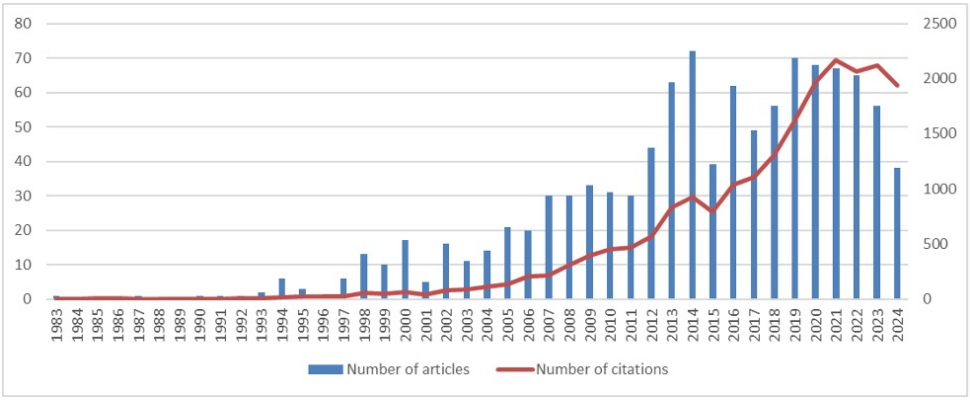

Figure 2: The publication and citation trends
Source: own

Following this intensive research phase, a slight decline in the number of publications has been observed in recent years. However, the recent period of sharply rising interest rates – a response by monetary authorities to combat extremely high inflation – is expected to renew interest in the topic. According to Kerola et al., 2024, the impact of rising policy rates on bank lending and financial conditions will unfold between mid-2023 and 2025, potentially reigniting scholarly discussions on the pass-through of interest rates in a tightening monetary policy environment. Many such publications are already in progress, under review, or awaiting release, signaling an imminent new wave of research on the evolving dynamics of interest rate pass-through.

4.1 Keywords bibliometric analyses

For the co-occurrence analysis by keywords, I extracted author keywords from sample of studies. The total number of keywords was 1,821, with a threshold set at 5 occurrences. A total of 107 keywords met the threshold, of which 10 were removed due to irrelevance, primarily consisting of JEL classifications that are not within the scope of our analysis. The final analysis resulted in nine clusters, representing distinct thematic and methodological areas within the research on interest rate pass-through and monetary policy transmission. Among these, the three largest clusters provide significant insights into the prevailing research themes (Figure 3).

The first cluster consists of econometric models and theoretical frameworks used to analyze interest rate pass-through and the effects of monetary policy. This cluster includes Bayesian estimation, DSGE, FAVAR, SVAR, monetary policy shocks, price puzzle, sticky prices, and monetary transmission mechanisms. These methodologies are commonly employed in empirical research to model the dynamics of interest rate adjustments and the broader impact of monetary policy interventions. The second cluster focuses on monetary policy responses, asymmetric effects of interest rate transmission, and the role of central banks in managing financial crises. It includes keywords such as ARDL model, asymmetry, central bank, financial crisis, global financial crisis, interest rate pass-through, and panel cointegration. This thematic grouping highlights the literature exploring how monetary policy effectiveness varies across different economic environments and financial market conditions. The third cluster is centered on inflation dynamics and transmission mechanisms in monetary policy. It includes keywords such as inflation, inflation targeting, transmission channels, vector autoregression (VAR), VECM, and Taylor rule. This

cluster captures the research dedicated to understanding how inflationary pressures interact with interest rate policies and how central banks utilize transmission channels to influence macroeconomic stability. The analysis of these clusters enabled us to identify the dominant methodological approaches and key research themes that shape the study of interest rate pass-through.

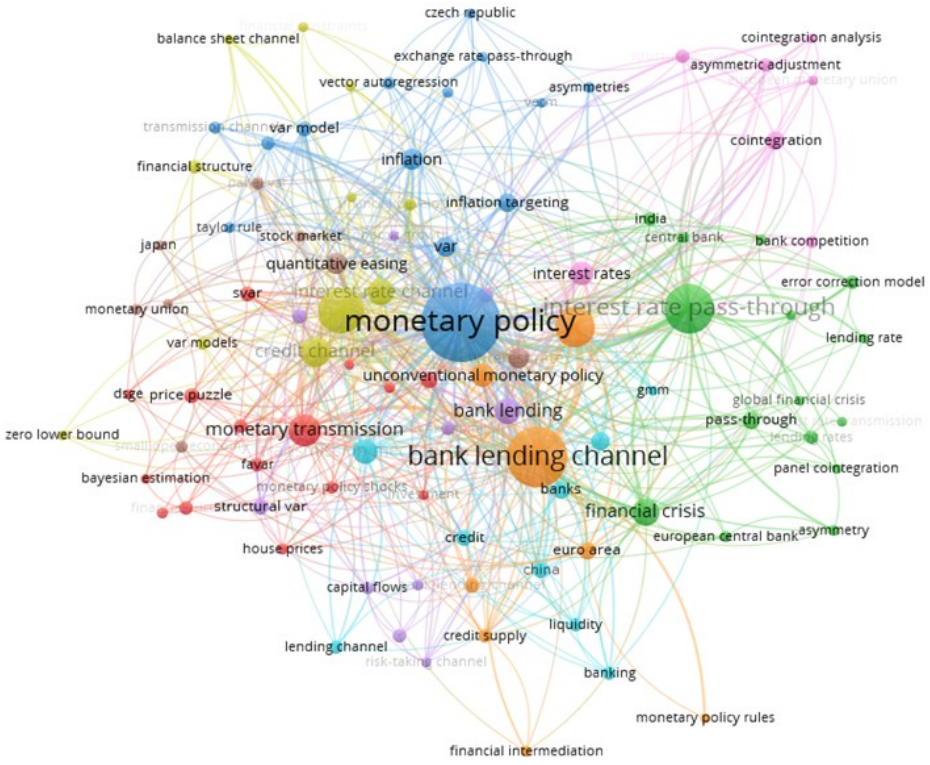

Figure 3: Author's keyword occurrence analysis
Source: own

4.2 Citation and authorship bibliometric analysis

Through co-citation analysis of sources and authors, I identified the most frequently cited journals and scholars contributing to the field of interest rate pass-through. This method allows me to pinpoint the most influential research outlets and individuals shaping the academic discourse on monetary transmission. The citation count serves as an indicator of the impact and relevance of these journals and authors within the research community. Data on impact factors, journal quartiles, and publication counts were extracted from the WoS database.

Among the identified journals, most belong to Q1, indicating their high academic quality and influence (Table 2). Regarding the most cited authors, Ben S. Bernanke stands out as the most influential scholar in this domain, reflecting the significant impact of his research on monetary policy and financial markets. Additionally, other prominent researchers, such as Anil K. Kashyap, Frederic S. Mishkin, and Leonardo Gambacorta, have made substantial contributions to the study of interest rate pass-through, providing a strong theoretical and empirical foundation for further research in this area.

The co-authorship analysis by countries, presented in the first visualization (Fig. 4), illustrates the global research collaboration on interest rate pass-through. The dataset includes studies from 99 countries, with a threshold set at 10 publications per country,

Table 2: Top 10 Most Cited Journals and Authors Ranked by Citation Count

Journal	**Impact Factor / Quartile**	**No. of Citations**	**Author**	**No. of Citations**	**No. of Documents**
American Economic Review	15.3/Q1	2,305	Ben S. Bernanke	1,168	1
Journal of Monetary Economics	5.3/Q1	1,265	Anil K. Kashyap	632	2
Journal of Banking & Finance	4.4/Q1	1,209	Leonardo Gambacorta	373	13
Journal of Money, Credit and Banking	1.9/Q3	1,198	Christopher A. Sims	285	2
Econometrica	8.2/Q1	809	Lawrence J. Christiano	278	3
Quarterly Journal of Economics	20.8/Q1	807	Mark Gertler	277	2
Journal of Finance	10/Q1	684	Allen N. Berg	215	2
Journal of International Money and Finance	3.2/Q2	668	Ravi P. Kishan	198	4
European Economic Review	3.3/Q1	633	Yener Altunbaş	188	2
Journal of Political Economy	11.2/Q1	570	Frederic S. Mishkin	178	1

Source: own based on VosViewer (2025) and WoS (2025)

resulting in 36 countries meeting this criterion. The network analysis identifies eight distinct clusters, with the United States emerging as the most dominant contributor, accounting for 256 studies, followed by the United Kingdom (113 studies) and Germany (87 studies). Additionally, China, Australia and the Czech Republic also form strong research clusters, reflecting their active participation in the field. The observed clustering suggests the global nature of monetary transmission research.

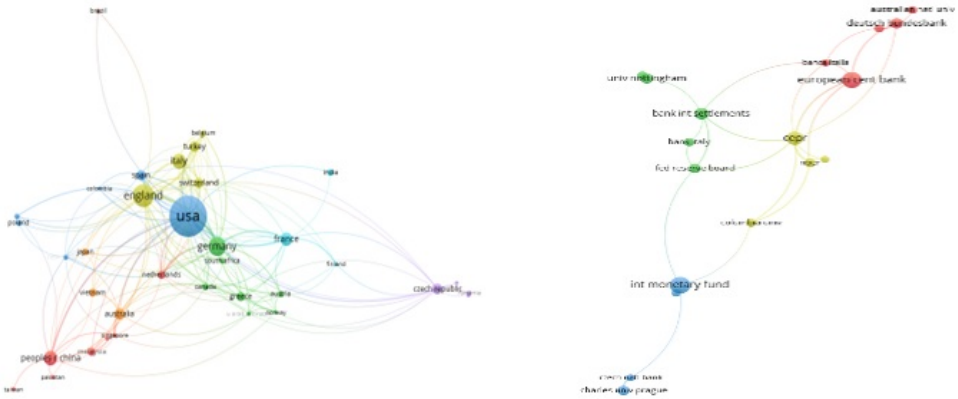

Figure 4: Co-authorship analysis by countries (left) and organizations (right)
Source: own based on VOSviewer, 2025 and WoS, 2025

The second visualization depicts the co-authorship network by organizations, capturing institutional affiliations of researchers in this field (Figure 4). The dataset includes 1,078 organizations, with a threshold set at 8 publications per institution, leading to 18

organizations meeting the criteria. The resulting network consists of four major clusters, with key institutions driving the research agenda, including the Centre for Economic Policy Research (CEPR), the European Central Bank (ECB), the International Monetary Fund (IMF), and the Bank for International Settlements (BIS). Additionally, national central banks play a crucial role in advancing empirical research on interest rate pass-through, reflecting the policy-oriented nature of the field. The institutional collaboration structure underscores the strong linkages between academia and policymaking institutions, highlighting the significant role of central banks and international organizations in shaping the discourse on monetary transmission mechanisms.

Conclusions

This study provides a comprehensive bibliometric analysis of the literature on interest rate pass-through, offering insights into its temporal evolution, key research themes, influential scholars, and institutional contributions. By leveraging the Web of Science database and utilizing VOSviewer for visualization, I identified dominant trends shaping the academic discourse on monetary policy transmission. Findings indicate that interest rate pass-through remains a focal point in monetary policy research, particularly in response to major economic events such as the GFC and the recent period of rapidly rising interest rates. The bibliometric analysis highlights the significant role of high-impact journals in disseminating key research, with most influential publications originating from Q1-ranked journals. Moreover, the co-authorship and institutional collaboration networks reveal strong global research linkages, with central banks and international organizations playing a crucial role in advancing empirical and theoretical studies on this topic. As monetary authorities continue to navigate an evolving economic environment, characterized by inflationary pressures and tightening financial conditions, understanding the efficiency and effectiveness of interest rate transmission remains critical. This bibliometric study provides a foundation for future research by mapping existing knowledge, identifying research gaps, and highlighting emerging trends.

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Session II.: Finance and Innovation

Data-Driven Customer Insights: A Bibliometric Analysis of CRM, Machine Learning, and Customer Behavior

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Abstract

Customer relationship management (CRM) has become an important area of study in recent years, driven by the growing availability of data and advancements in machine learning and artificial intelligence. This study examines the research landscape of CRM and related topics with a specific focus on the intersection of customer-related themes with modern machine learning methods. Using a bibliometric analysis of 1,270 articles indexed in Web of Science (WoS) and Scopus, the research was conducted using the Bibliometrix package, evaluating publication trends, the distribution of publications across sources and countries, and thematic connections through keyword clustering. Our findings reveal a rapidly increasing interest in the topic, with conference proceedings dominating in volume but high-impact journals driving academic influence. Keyword clustering highlights important themes, mainly the prominence of customer churn prediction—particularly in the telecommunications industry—and the widespread use of machine learning techniques for customer segmentation and behavior analysis. We also observe a growing focus on artificial intelligence, primarily for improving customer experience.

Keywords: *bibliometric analysis, customer relationship management, customer behavior, machine learning, data driven*

JEL Classification: *M31, C88, D83, L86*

Introduction

In modern business, data is often referred to as "the new gold," but its true value lies in the ability to transform it into actionable insights. Companies that rely on fact-based decision-making gain a competitive advantage, greater stability, and adaptability compared to those using intuition or estimation (Bjerg, 2024). In today's economy, where mistakes can have severe financial consequences, this approach is vital for long-term growth, while still complementing the roles of intuition and experience (Verstraete et al., 2021).

The primary objective of this article is to conduct a bibliometric analysis to uncover current trends and research directions in the study of online customer behavior using big data and machine learning models. By leveraging renowned academic databases, we aim to compile a dataset of relevant articles to map the entire research landscape, identify leading journals and prominent keyword trends. This work could potentially serve as a valuable resource for researchers, offering a quick understanding of the field, highlighting

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emerging themes, identifying established or declining areas of focus, and pointing out potential opportunities for collaboration.

The structure of the article is as follows: The Theoretical Background chapter provides a concise overview of the significance of data and the application of machine learning in analyzing customer behavior. Chapter 2, Research Methodology, outlines the approach used for bibliometric analysis, including the process of constructing the article corpus and interpreting the results. Finally, the Results and Discussion chapter presents the main findings, explores their implications, and offers analytical insights into the observed patterns and trends.

1 Theoretical background

In today's digital world, the rapid growth of data brings both opportunities and challenges for businesses. Data-driven decision-making has become essential for staying competitive and adapting to fast-changing markets. Szukits and Móricz, 2023 stress that support from leadership and high-quality data are critical for building an analytical culture. In e-commerce, understanding customer behavior is vital for success, with accurate forecasts helping businesses allocate resources more efficiently, especially in unpredictable markets (Wasserbacher and Spindler, 2022).

Data quality plays a crucial role in the success of analytical models, as Gupta and Mishra, 2021 note that poor data leads to flawed results and reduces trust in analyses. Sharma et al., 2017 argue that companies using data-driven approaches across their operations are more efficient and better able to adapt. Without proper analysis, businesses risk missing opportunities to increase loyalty or sales, and errors in inventory planning can cause costly overstocking or shortages (Mouratidis et al., 2023).

The integration of Business Intelligence (BI) and Customer Relationship Management (CRM) systems has proven to be a game changer for e-commerce. Anastasiei and Georgescu, 2021 found that tools like OLAP and data mining help companies improve personalization and decision-making. Alyamani and Alsalem, 2021 also highlighted how BI enhances customer insights and market segmentation, with cluster analysis improving retention and conversion rates.

Predictive analytics is another powerful tool. Shah and Kumar, 2024 used K-means clustering and random forest algorithms to segment customers by income and spending. Similarly, transactional data analysis using RFM features and machine learning models like SVM and neural networks uncovered purchase patterns, supporting better inventory planning and personalized marketing (Dhanushkodi et al., 2025).

De and Prabu, 2022 reviewed churn prediction methods, noting their effectiveness for customer retention but highlighting challenges in generalizing across industries. Finally, Pourmahdi et al., 2025 explored the role of machine learning in promoting sustainable customer behavior, particularly around pricing strategies and price-sensitive consumers.

The incorporation of Artificial Intelligence into Customer Relationship Management within enterprise information systems (EIS) has revolutionized how businesses interact with customers and manage their operations more efficiently (Ozay et al., 2024). By integrating CRM with Decision Support Systems (DSS), companies can streamline customer acquisition and retention strategies, ultimately reducing costs. As highlighted by Demirkan and Delen, 2013, this synergy enables businesses to pinpoint their most valuable customers and strategically focus efforts on sustaining long-term relationships with them.

With the rapid advancement of AI technologies and the digital transformation accelerated by the COVID-19 pandemic, research on AI-driven CRM has grown significantly. However, comprehensive systematic and bibliometric studies in this area remain scarce (Ozay et al., 2024). While some studies provide overviews of CRM research within specific industries, there is limited literature that examines CRM in contrast to data mining or AI based CRM approaches (Pynadath et al., 2023). Several bibliometric studies have explored CRM in different contexts, but they often focus on narrow subdomains rather than offering a broad mapping of the field. For instance, Ferrer-Estévez and Chalmeta, 2023 examine CRM's role in sustainability, while Perez-Vega et al., 2022 explore its social dimensions.

Building on these insights, this study aims to provide a comprehensive overview of CRM-ML related research by mapping its evolution, key themes and areas of growth and future opportunities. While more focused bibliometric studies may examine a specific aspect of CRM, we believe a broad scope is necessary to capture the full research landscape, allowing researchers to identify patterns before narrowing into specialized areas. Therefore, this analysis serves as a foundation for future, more focused research on specific CRM applications.

2 Research methodology

The cornerstone of any bibliometric analysis is building a robust corpus of analyzed articles. For this study, we conducted searches in two leading scientific databases, Web of Science (WoS) and Scopus, to ensure the inclusion of indexed, reliable, and high-quality documents. To minimize irrelevant results and avoid missing key studies, we tested multiple search strategies using Boolean operators (AND, OR, NOT) to query author keywords, titles, or abstracts through advanced search options. Ultimately, we finalized the following search term for WoS: TI=("CRM" OR "Customer Relationship Management" OR "customer churn" OR "customer segmentation" OR "customer clusters" OR "RFM" OR "customer behavior" OR "customer service" OR "customer experience" OR "customer satisfaction" OR "customer retention") AND TI=("classification" OR "prediction" OR "cluster analysis" OR "machine learning" OR "deep learning" OR "artificial intelligence" OR "AI" OR "analytics"), with a similar counterpart for Scopus. Therefore, this query focused on customer-related topics and their management using modern data-driven techniques such as machine learning and AI.

The initial search yielded 710 and 1,580 results from WoS and Scopus, respectively. To refine the dataset, we filtered for English-language articles published between 2010 and 2025 to ensure relevance to recent developments. We narrowed the scope further by including only fields such as computer sciences, business, management, economics, decision sciences, and social sciences, excluding unrelated areas like medicine or mathematics. We also restricted the document types to articles and proceedings papers, excluding book chapters and other formats. While some studies exclude conference papers due to their less rigorous peer-review process (González-Albo and Bordons, 2011), we included them to capture up-to-date research and emerging ideas. These filters reduced the dataset to 680 articles from WoS and 1,133 from Scopus.

To minimize the risk of excluding significant studies indexed in only one database and to create a comprehensive dataset, we merged the results from both databases using R and the biblioshiny library, removing duplicates. This process resulted in a final dataset of 1,270 documents, which we analyzed using the Bibliometrix library in R (Aria and

Cuccurullo, 2017).

3 Results and Discussion

In this chapter we will go through several notable outputs of the bibliometric analysis. Due to the limited article maximum page range, the discussion and descriptions will be kept brief yet precise.

3.1 Yearly publication trend

The interest in the topic has been steadily increasing over the years, as can be seen in Figure 1 This trend is particularly notable around 2020, when a significant surge in the number of publications is observed.

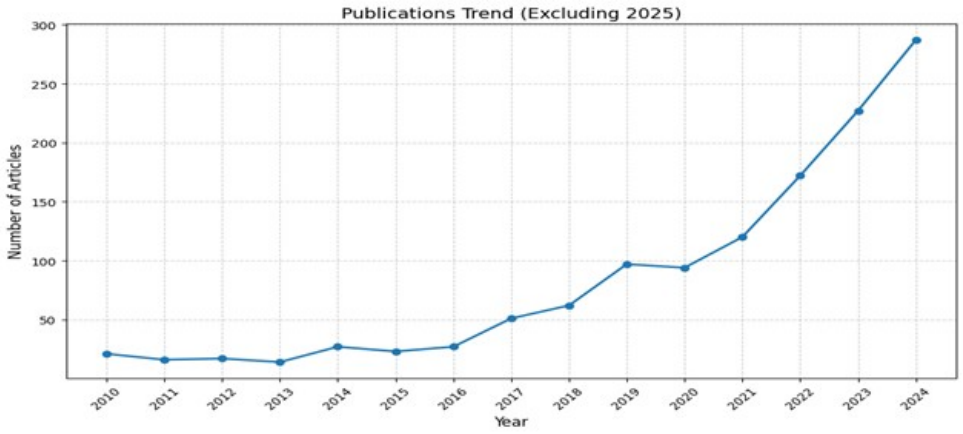

Figure 1: Yearly Publication Trend
Source: own elaboration

In 2024, the total number of publications reached 287. This sharp increase is likely associated with the growing interest in advanced data-driven methodologies, rapid adoption of machine learning techniques and availability of data, as highlighted by Eckart et al., 2021 or Miklosik and Evans, 2020. Across the analyzed period, the publications have been distributed across 879 distinct journals, authored by 3,597 unique contributors. Co-authored publications can greatly enhance innovative studies and academic exchange. Notably, only 87 documents were authored by a single individual, indicating a strong emphasis on collaboration, international co-authorship is at 15 percent.

3.2 Publication distribution

Upon inspection of Table 1, one can see the top five sources based on the number of published articles and total citations. It is interesting to point out that the top three sources with the highest number of publications are conference proceedings, which we believe emphasizes the importance of conferences as venues for disseminating research in the field and as a starting point for emerging ideas, methods and discussions.

Interestingly, the publications are scattered across many sources with no single journal leading in the field, probably indicating the interdisciplinary nature of the research. On the other hand, the top five sources according to their impact measured by total citations

Table 1: Top Sources

Most Relevant Sources	Articles	Most Impactful Sources	Total Citations
ACM International Conference Proceeding Series	27	Expert Systems with Applications	921
Lecture Notes in Networks and Systems	25	Journal of Business Research	485
Lecture Notes in Computer Science	17	Industrial Marketing Management	346
Expert Systems with Applications	16	Journal of Retailing and Consumer Services	333
IEEE Access	14	International Journal of Information Management	287

Source: own elaboration

are well-known journals, with four of them being business and management focused. It is worth noting that all these high-impact sources emerged after 2010 yet have still become the most influential in the field.

3.3 The Three-field Plot

The three-field plot is a useful tool to provide a multidimensional view of the research landscape. This integrated approach in Figure 2 captures thematic connections, leading journals, and geographic contributions in a single view, showing key relationships, that isolated analyses might overlook. It avoids redundancy, conserves space and allows readers to quickly understand the interconnected nature of the research landscape. Analyzing research output by country is a widely used practice in bibliometric research because it provides valuable insights into global research distribution, regional specializations, and collaboration networks. Knowing which regions are leading in publications can indicate where key innovations in AI-driven CRM are emerging.

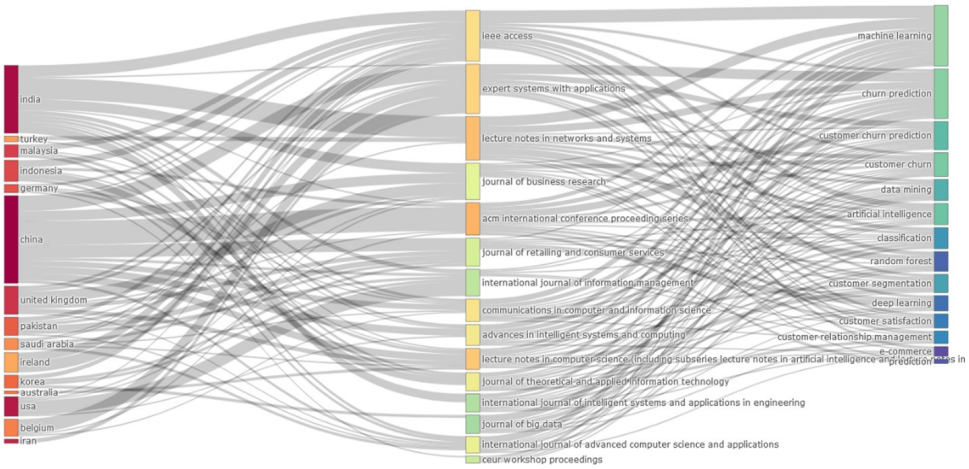

Figure 2: The Three-field Plot
Source: own elaboration using Bibliometrix

A few interesting insights: China and India, the two top countries in terms of numbers of publications, are heavily linked to conference proceedings, indicating high output but

potentially lower impact and relevance. These countries dominate the research area which could correlate with strong investment in AI and digital transformation or government funding programs and their trends can shape the future of CRM applications (Li and Shen, 2025; Vengattil and Mandayam, 2025). In contrast, the United States (in 3rd place in terms of publications) and other advanced countries show stronger ties to well-known journals such as Journal of Business Research or Expert Systems with Applications which may mean higher impact and refined studies. However, number of country citations does not support this idea as China and India are both leading as the most cited countries, followed by the UK, with USA being only in the 8th place.

Furthermore, business-focused journals like Journal of Retailing and Consumer Services and Industrial Marketing Management highlight strong links to practical applications, particularly from U.S. researchers, while technical keywords like "machine learning" and "artificial intelligence" appear frequently tied to China and India. Different regions focus on different aspects of CRM and AI, often influenced by local industry needs. In Europe or the USA, there may be a stronger focus on ethical AI and regulations, while in Asia, research may emphasize automation and scalability (Chen, 2024). The top approach that stands out seems to be churn prediction, being mentioned three times among the top keywords and is distributed quite evenly across journals and countries alike.

3.4 Keywords Clusters

We initially intended to conduct keyword cluster analysis using Bibliometrix but ultimately chose VOS Viewer, as it allows for the clustering of both author keywords and indexed keywords in a single analysis. In contrast, Bibliometrix requires selecting between author keywords and author keywords plus. To enhance readability and interpretability, we applied fractional counting and set a minimum keyword occurrence threshold of 20. Out of 5,525 keywords, 111 met this criterion, resulting in 4,430 links with a total link strength of 3,912.

The results are 5 clusters:

- **Blue Cluster: Sales, Customer Satisfaction, and Artificial Intelligence**
  "Sales" is the central keyword for all clusters, indicating that much of the research revolves around sales-related topics, with "customer satisfaction" playing a key role. This suggests that improving customer satisfaction is crucial for increasing sales and loyalty, which is emphasized by the strong link between this cluster and the purple cluster (customer relationship management). A satisfied customer reduces retention costs, and maintaining an existing customer is often easier than acquiring a new one. Simultaneously, "artificial intelligence" is linked to terms like "chatbots," "customer service," and "sentiment analysis," showing that AI is widely used to enhance customer experience rather than solely for data analysis. This is supported by Adam et al., 2021 and Olujimi and Ade-Ibijola, 2023.

- **Red Cluster: Forecasting and Customer Churn Prediction**
  This cluster revolves around forecasting, with a strong emphasis on predicting customer churn. Studies in this area frequently employ methods like "classification" and "neural networks," while connections to terms such as "telecommunications industry" suggest this sector as a primary application area. The subscription-based nature of the industry, combined with strong competition and low switching costs, makes customer retention directly tied to revenue. AI-driven predictive analytics

helps anticipate churn risks and develop targeted retention strategies Raheem et al., 2024. The ties to the green cluster highlight that machine learning techniques are integral to churn prediction, which appears to be the most studied subject in the analyzed documents.

- **Green Cluster: Machine Learning Techniques**
  This cluster represents the technical foundation of research, emphasizing the reliance on data-driven methods for addressing customer-related challenges. It includes keywords such as "decision trees," "support vector machines," "random forest," and "logistic regression," which are commonly applied to tasks like churn prediction.

- **Yellow Cluster: Customer Behavior and Segmentation**
  The yellow cluster focuses on understanding customer behavior, featuring terms like "commerce," "cluster analysis," and "customer segmentation." The presence of "K-means clustering" and similar techniques indicates efforts to group customers based on shared characteristics to refine targeted marketing strategies. These findings align with Alves Gomes and Meisen, 2023, who identified cluster analysis—especially the K-means algorithm with RFM (recency, frequency, monetary) data—as the most widely used method for customer segmentation. The connection to "sales" and "customer satisfaction" in the blue cluster suggests that these studies aim to personalize offerings and improve business outcomes.

- **Purple Cluster: Customer Relationship Management (CRM)**
  This cluster is less technical but underscores the importance of maintaining long-term customer loyalty and building strong relationships. This aligns with prior discussions by Ndubisi, 2007, which link customer relationship management to increased satisfaction and long-term engagement, tying back to the blue cluster's focus on sales and satisfaction.

As with many bibliometric studies, minor keyword variations (e.g., 'machine learning' vs. 'machine-learning') appear due to differences in database indexing and text processing in bibliometric software. While text preprocessing can improve standardization, the overall keyword clustering results remained quite consistent (except for customer churn appearing in 2 clusters but relatively close to each other), therefore successfully grouping related concepts within the same thematic structures. However future studies could explore additional preprocessing techniques to refine keyword representations, but the impact on high-level trends is expected to be minimal.

Besides the standard keyword clustering, we conducted various analyses on the topic and its trends, including thematic evolution, thematic mapping, factorial analysis, and trend topics. However, due to page limitations and the need to maintain focus, we decided not to include all plots and tables. Instead, we provide key insights:

- In the past two years broad terms like AI or artificial intelligence have been gradually replaced by more specific applications such as AI based CRM, Explainable AI, and its incorporation into customer service automation. Significance of explainability of AI based decisions in enhancing trust and accountability in AI-driven business applications.

- The thematic map analysis identifies customer churn as a motor theme (a well-developed and central topic), customer segmentation as a basic theme, and the integration of AI into customer service as a likely emerging theme.

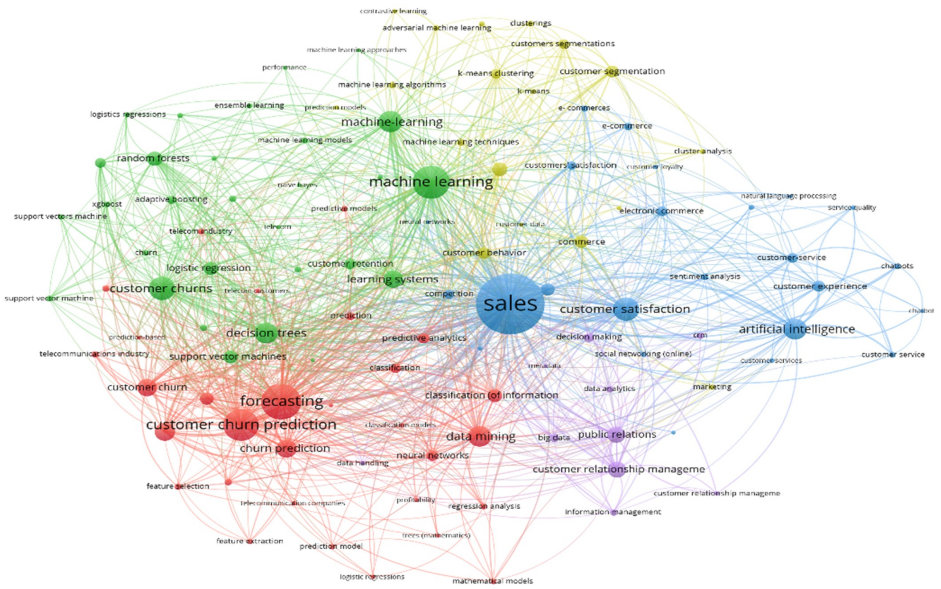

Figure 3: Keyword Clusters
Source: own elaboration using Vos Viewer

- Trend topic analysis of keywords, titles, and abstracts highlights personalization, enhancing customer experience and retention using AI, as well as NLP (Natural Language Processing) and mobile applications as the most recent and relevant research directions (Lokesh and Vasantha, 2024).

- Factorial analysis supports the findings of keyword clustering with grouping common themes similarly.

Implications, Future research Directions and Conclusion

The dominance of churn prediction in contractual or subscription-based business models like telecommunications is natural because churn is clearly defined as contract termination. In such settings, predictive models benefit from readily available data points, making churn identification and intervention more straightforward. However, churn in non-contractual environments, such as e-commerce, remains underexplored despite its strategic importance. In these cases, there is no explicit "yes/no" churn indicator, requiring researchers to develop new methodologies to define and measure churn behavior (Gattermann-Itschert and Thonemann, 2022). Since acquiring new customers is often more expensive than retaining existing ones, understanding churn in non-subscription-based businesses could provide significant value. Future research should focus on advanced behavioral modeling and customer engagement patterns to predict churn where explicit contract data is absent.

Furthermore, the growing use of AI in CRM underscores the need for Explainable AI (XAI), particularly in decision-making processes. It is not sufficient for businesses to know which customers are likely to churn; they must also understand why. Identifying

key influencing factors allows managers to take proactive measures and develop targeted customer retention strategies. Moreover, in industries such as banking and finance, regulatory frameworks often mandate that AI-driven decisions be explainable. For instance, banks utilizing AI for loan approvals must justify why an application was accepted or rejected. As AI continues to shape CRM applications, research should focus on transparent and interpretable models that enhance managerial decision-making while complying with ethical and legal requirements.

Beyond analytics, AI is increasingly used to actively guide customers through their purchasing journey, shifting from a passive analytical tool to an interactive engagement mechanism. AI-powered recommendation engines, chatbots, and virtual assistants influence customer decisions in real time, potentially reshaping consumer behavior and perceptions. For example, the findings of Singh and Singh, 2024 indicate that the quality of AI chatbot services positively impacts customer loyalty through increased satisfaction and trust. And meanwhile AI-driven personalization can enhance user experience, further research is needed to examine its long-term effects on customer trust, brand loyalty, and purchasing habits. Understanding these interactions could help businesses refine AI strategies that not only optimize sales but also maintain ethical and customer-centric engagement.

In this bibliometric analysis we discussed the evolving landscape of customer relationship management and related topics through the lens of modern data-driven methodologies, such as machine learning and artificial intelligence. The interest in the topic is rising rapidly, which is evident from the yearly publication trend. While conference proceedings dominate in terms of volume, high-impact journals in business and management play a key role in shaping the field's academic influence. Our keyword clustering revealed important themes, and their interconnections, including the central role of sales and customer satisfaction, the growing importance of churn prediction which seems to be the most researched topic in the area, especially in industries like telecommunications, and the application of machine learning for customer segmentation and behavior analysis. Additionally, the integration of AI tools is studied particularly in enhancing customer experiences. Despite its limitations, we believe this work provides a solid foundation for understanding the key themes and trends in customer-focused studies, offering valuable direction for future research.

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Microfinance in V4 Countries: A Bibliometric Analysis

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Abstract

Present study explores how microfinance research has evolved in the Visegrád Group (V4) countries—Czech Republic, Hungary, Poland, and Slovakia - through a bibliometric analysis. The goal of the present study was to investigate and evaluate key research trends, influential studies, and how academic interest in microfinance has developed in this region. Using data from the Web of Science database, publications from 1993 to 2025 were observed (analyzing citation patterns, co-authorship networks, and frequently used keywords). As a result of performed analysis were determined that financial inclusion, microfinance institutions, and digital finance are the most widely studied topics, with Poland and Hungary leading in research output. We also found strong academic collaboration within and beyond the V4 region, particularly in studies focused on fintech applications, financial accessibility, and small business financing. However, there are still gaps in research, especially in comparing microfinance models in developed economies and evaluating their long-term impact. Our findings highlight the need for more studies on governance structures, digital microfinance innovations, and financial literacy programs to improve financial inclusion in Central Europe. This research contributes to the broader discussion on microfinance and provides valuable insights for practitioners and stakeholders working to enhance financial accessibility and sustainability in the region.

Keywords: *microfinance, bibliometric analysis, V4 countries*

JEL Classification: *G21, O16, P34*

Introduction

Microfinance refers to the provision of financial services such as microloans, microcredit, microinsurance, and micro savings to individuals and small businesses that lack access to traditional banking services. Microfinance institutions (MFIs) play a vital role in ensuring financial access for vulnerable groups, promoting their economic development and financial sustainability. In the context of the Visegrád Group (V4) countries, microfinance is an important tool for supporting small businesses and increasing financial inclusion, particularly in transition economies. Social lending and peer-to-peer (P2P) lending are also seen as part of microfinance, as they offer alternative financing solutions to individuals and small businesses that may not qualify for traditional bank loans. These models facilitate direct financial relationships between lenders and borrowers, often using digital platforms to provide greater accessibility and efficiency.

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The study by Ali et al., 2023 shows that microfinancing has been contributing to financial inclusion and sustainable development by offering access to financial services to those outside the traditional banking system. The study, published in the International Journal of Finance and Economics, highlights that Microfinance plays an important role in ensuring financial inclusion and stimulating economic growth, especially in transition economies. The Visegrád Group (V4), which includes the Czech Republic, Hungary, Poland, and Slovakia, represents a unique region for analyzing the development of the microfinance sector. Despite relatively developed financial systems, a significant portion of the population in these countries remains outside the traditional banking system, making microfinance an essential tool for supporting small businesses and socially vulnerable groups.

In addition, research by Bauer et al., 2012 also demonstrates that microfinance plays an instrumental role in raising economic conditions and living standards in rural areas. In the article published in the American Economic Review, the authors examine the behavioral issues of microcredit and its impact on economic growth.

The goal of the present study was to perform a bibliometric analysis of scientific publications on microfinance in the V4 countries. Using the Web of Science database, the study allowed to identify key research areas, the most influential publications, authors, and institutional connections, as well as analyze trends in publication activity (Gora et al., 2023). Bibliometric analysis allowed us to determine major thematic trends, regions with the highest concentration of research, and gaps that require further study.

The structure of the paper is as follows: Section 1 presents a review of the existing literature on microfinance in the V4 countries, Section 2 describes the research methods, Section 3 discusses the results of the bibliometric analysis, and the last Section provides conclusion and recommendations for future research.

1 Literature review

Visegrád Group (V4) countries, encompassing the Czech Republic, Hungary, Poland, and Slovakia. A comprehensive study by Pattnaik et al., 2024 examined global microfinance literature, identifying key themes such as the impact of microfinance, its management, and performance efficiency. While this study offers a broad perspective, it also highlights the need for more region-specific analyses, particularly concerning the V4 nations. Microfinance: A bibliometric exploration of the knowledge landscape. (Pattnaik et al., 2024)

In the context of the Czech Republic and Slovakia, recent research has delved into the challenges faced by microentrepreneurs in accessing financing. A study by Hudakova et al., 2018 explored barriers in financing microenterprises from the perspective of Czech and Slovak entrepreneurs, shedding light on the specific obstacles within these countries. This research emphasizes the importance of understanding local contexts to enhance financial inclusion and the effectiveness of microfinance initiatives. (Hudakova et al., 2018)

Furthermore, a bibliometric analysis investigated global research trends on world issues, including economic dimensions relevant to microfinance. Although not exclusively focused on the V4 countries, this study provides a framework for understanding how microfinance research in these nations aligns with broader global trends. These studies collectively underscore the evolving landscape of microfinance research in the V4 countries. They highlight the significance of localized studies to address unique socio-economic

challenges and the value of bibliometric analyses in mapping research trajectories and identifying gaps within the field.

This aspect is particularly relevant in the V4 context, where diverse economic and institutional environments influence microfinance operations. The literature also suggests that understanding the governance dynamics can help identify key trends and emerging areas of research, enabling institutions to adapt to evolving market conditions. Consequently, future studies could benefit from focusing on operational challenges and opportunities within financial institutions to enhance the impact of microfinance in these countries.

2 Data analysis and research methods

Table 1 provides a descriptive analysis of the published articles related to microfinance, based on refined search criteria.

The dataset was retrieved from a structured search within the Web of Science database, incorporating the following Keyword Plus® terms: microfinancing, microcredit, microloans, financial inclusion, microfinance institutions (MFIs), microfinance sustainability, microfinance, and microlending. Additionally, a broader topic-based search included terms such as Microfinance Institutions, Microcredit, Financial Inclusion, and Microfinance Sustainability.

The analysis was further restricted to publications focusing on Slovakia, the Czech Republic, Poland, and Hungary, ensuring a regional perspective. Only articles (as a document type) were considered in this dataset.

Table 1: Analysis of Research Papers

Description	**Results**
Sources (Journals)	144
Keywords Plus (ID)	306
Author's Keywords (DE)	500
Period	1993–2025
Average citations per document	14.17
Authors	396
Author Appearances	453
Authors of single-authored documents	24
Authors of multi-authored documents	120
Documents per Author	0.36
Authors per Document	3.15
Co-Authors per Document	2.15
Collaboration Index	3.15

Source: Own processing based on WoS results.

The search resulted in 144 sources, covering the period from 1993 to 2025. A total of 306 Keywords Plus (ID) and 500 Author's Keywords (DE) were identified. The average number of citations per document is 14.17, reflecting the academic impact of the selected research.

Regarding authorship, the dataset includes 396 authors with 453 author appearances. 24 documents were written by a single author, while 120 were multi-authored. The dataset

reveals a collaborative nature of research in the field, with an average of 3.15 authors per document and 2.15 co-authors per document. The Collaboration Index is 3.15, indicating strong institutional and cross-border academic cooperation.

This bibliometric overview highlights the significant research attention dedicated to microfinance and financial inclusion in the selected Central European countries, providing a valuable foundation for further academic exploration.

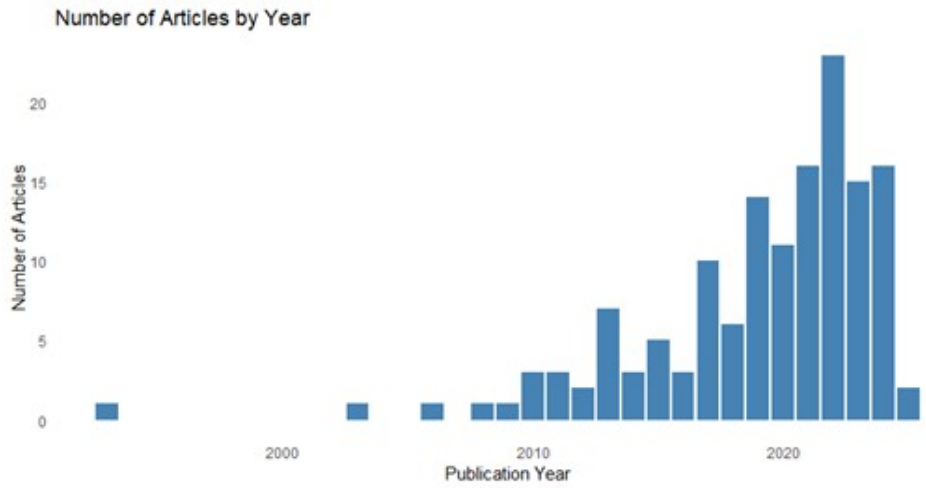

Figure 1: Number of articles published each year
Source: Own processing based on WoS results

Figure 1 shows changes in the number of publications from 1993 to 2025, which allows us to identify the main trends in scientific activity. The first publication in the studied array dates back to 1993. It was written by BRZICA, D and is called "THEORETICAL ISSUES OF ENTERPRISES FINANCIAL MANAGEMENT" in Slovakia. The largest number of publications was recorded in one of the last years 2023 (23 articles), while the minimum value (1 article) was observed in the initial stages of the study. The average number of publications is 6.86 articles per year, the median value is 3 publications.

Data analysis allows us to make a conclusion about the dynamics of research interest in the topic, as well as predict possible changes in the future. Additional studies, including citation analysis and the impact of individual works, will help to understand better the mechanisms of scientific trends formation.

Furthermore, key authors and institutions contributing to this research field studying can provide valuable insights into the main drivers of scientific progress. Identifying collaborations between research organizations and trends in funding sources can reveal how external factors influence the growth and development of academic interests in the subject.

Another important aspect of scientific activity analysis is the evolution of thematic priorities. Over time, certain subfields within the broader topic may gain or lose relevance, reflecting shifts in global economic and technological landscapes. By assessing keyword trends and the thematic focus of high-impact papers, we can determine which research directions are currently at the forefront and which may emerge in the near future (García-Pérez et al., 2020).

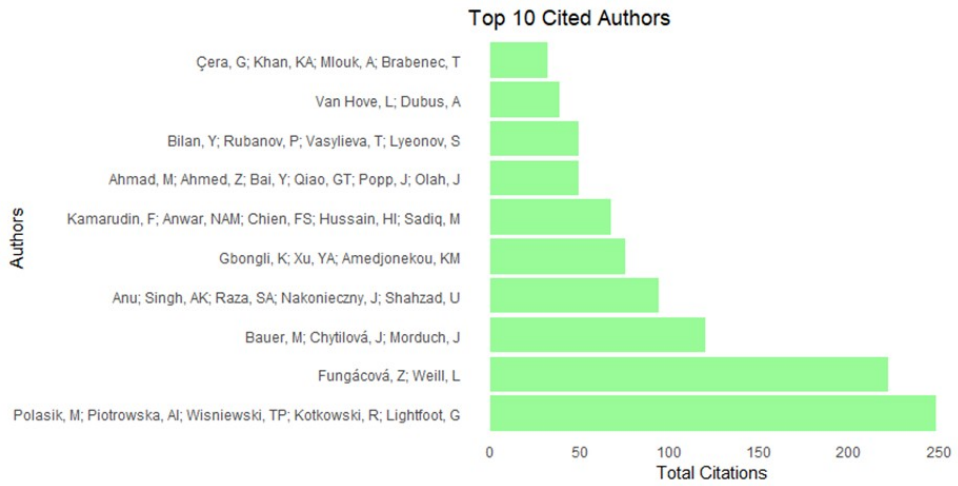

Figure 2: Top 10 Cited Articles
Source: Own processing based on WoS results

The analysis in Figure 2 identifies the top 10 most cited authors whose research has greatly influenced the development of scientific discourse in this field. The diagram presents the names of the authors, ranked by the number of citations of their works.

The leader of the ranking is Polasik, M; Piotrowska, AI; Wisniewski, TP; Kotkowski, R; Lightfoot, G, whose article "Price Fluctuations and the Use of Bitcoin: An Empirical Inquiry" has 248 citations. In their study, the authors analyze Bitcoin price fluctuations and their impact on its use in transactions. (Polasik et al., 2015) In second place are Fungácová, Z; Weill, L, with 222 citations. Their work, "," focuses on the factors affecting access to banking services in China and analyzes the level of financial inclusion in the country. (Fungáčová and Weill, 2015)

The third position is held by Bauer, M; Chytilová, J; Morduch, J, whose study "Behavioral Foundations of Microcredit: Experimental and Survey Evidence from Rural India" has been cited 120 times. This research researching the behavioral aspects of microcredit, based on experimental and survey data from rural regions of India. (Bauer et al., 2012)

Fourth place belongs to Anu, Singh, Raza, Nakonieczny, Shahzad, whose article "Role of Financial Inclusion, Green Innovation, and Energy Efficiency for Environmental Performance?" which has 94 citations. The study studies the relationship between financial inclusion, green innovations, and energy efficiency in developed and developing countries. (Singh et al., 2023)

Closing the top five are Gbongli, Xu, Amedjonekou, with 75 citations. Their work, "Extended Technology Acceptance Model to Predict Mobile-Based Money Acceptance and Sustainability," examines the factors influencing the adoption of mobile financial technologies using structural modeling methods. (Gbongli et al., 2019)

And Other researchers in the top 10 whose studies focus on the efficiency of microfinance institutions, digital financial technologies, Industry 4.0, and mobile payments.

The analysis shows that the most attention in the scientific community is drawn to research related to financial inclusion, digital finance, sustainable development, and microfinance. Interest is seen in topics such as cryptocurrencies, mobile payments, and their impact on the economy, emphasizing the importance of these areas for further research. (Dahal and Fiala, 2020)

While the global interest in microfinance is vast, the V4 countries—Czech Republic, Hungary, Poland, and Slovakia—demonstrate distinctive trends in this area. Research

indicates that these nations are increasingly focusing on microfinance performance and its correlation with sustainable economic development (Akter et al., 2021). Collaborative efforts in these countries highlight a growing emphasis on improving institutional efficiency, which is critical for enhancing financial inclusion. Moreover, the bibliometric analysis reveals that Poland, in particular, shows a significant increase in research output, reflecting a robust academic engagement with microfinance strategies. This regional focus is essential for understanding how microfinance can be tailored to meet the unique socio-economic needs of the V4 countries, thereby contributing to a more inclusive financial system.

Table 2: Most Frequently Used Keywords

Author Keywords	**No**	**Keywords-Plus (ID)**	**No**
Financial inclusion	41	Impact	23
Microfinance	24	Growth	17
Fintech	12	Determinants	11
Microfinance institutions	12	Services	11
Microcredit	9	Performance	10
Financial exclusion	7	Credit	9
Financial efficiency	7	Literacy	9
Social efficiency	7	Access	8
Financial literacy	7	Adoption	8
Poverty	6	Microfinance	8

Source: Own processing based on WoS results.

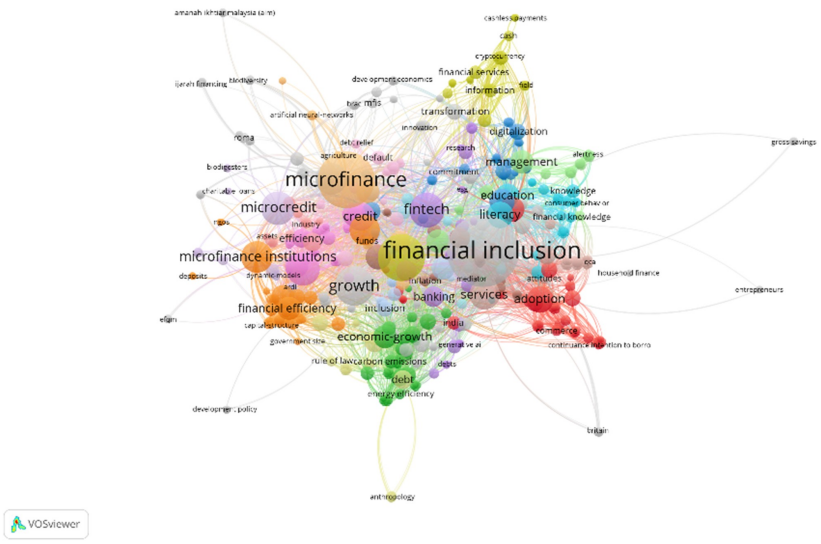

Figure 3: Analysis of the occurrence of all Keywords
Source: Own processing based on WoS results

Based on the bibliographic data analysis from WOS, the most frequently occurring terms were identified. Table 2 presents a list of key terms most used in scientific articles on financial inclusion and microfinance.

The results indicate that in terms of all keywords, Table 2 shows that Financial inclusion is the most popular research topic, confirming its relevance in the scientific community. There is also an elevated level of interest in Microfinance, Fintech, and Financial literacy, highlighting key aspects of this field. Additionally, Figure 3 illustrates the relationships between these keywords used by authors, confirming the strong connections between financial inclusion, microfinance, and banking services.

Regarding the analysis of Keywords Plus (Table 2), a different trend emerges, revealing additional interconnections between research directions, including Impact, Growth, and Determinants. This highlights the importance of financial accessibility for low-income populations, microfinance tools, and their impact on consumption levels and poverty reduction.

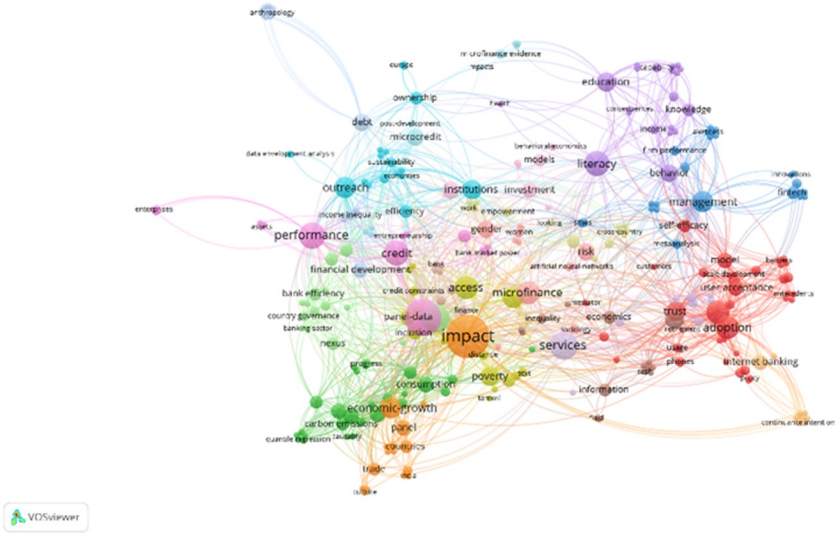

Figure 4: Analysis of the occurrence of Keywords Plus
Source: Own processing based on WoS results

Figure 4 further illustrates that research in financial inclusion focuses on the impact of microfinance, macroeconomic factors, digital technologies, financial literacy, and credit systems. Particular attention is given to internet banking, user trust, and the sustainability of financial institutions, reaffirming the interdisciplinary nature of this field.

3 Results and Discussion

The bibliometric analysis of microfinance research in the V4 countries (Czech Republic, Hungary, Poland, and Slovakia) provides insights into the evolution and scope of academic interest in financial inclusion and microfinance.

3.1 Results

By means of publications (indexed in the Web of Science (WoS) database) review, this study highlights research trends over the past two decades. The findings reveal that microfinance research in the V4 region is largely focused on poverty alleviation, financial accessibility, digital financial services, and SME financing (Ali et al., 2023).

A significant portion of microfinance studies in the V4 countries is concentrated in Poland and Hungary. At the same time Slovakia and the Czech Republic emerging as growing contributors (Pattnaik et al., 2024). Research outputs from these nations demonstrate strong collaboration between academic institutions, with co-authorship patterns indicating cross-border partnerships. However, the research landscape is still dominated by case studies from developing economies, particularly in Asia and Africa, which raises the need for comparative studies involving developed economies.

The most frequently studied topics in the V4 region include microfinance institutions (MFIs), financial inclusion, digital lending, and fintech applications (Singh et al., 2023). Additionally, Islamic microfinance and its role in financial sustainability have gained traction in the literature, reflecting the global trend towards ethical financial solutions. The term co-occurrence analysis suggests that research on financial performance, sustainability, social capital, and gender empowerment has been particularly prominent in recent years.

Despite identifying study research gaps and future research directions, the study highlights the existence of thematic gaps and suggests potential avenues for further research. These findings contribute to the current discussion on financial inclusion and underline the importance of extending research beyond the V4 region to provide a more complete understanding of microfinance trends.

3.2 Discussion

Our analysis revealed and underscored the interdisciplinary nature of microfinance research in the V4 countries, which integrates perspectives from economics, finance, and social sciences. Despite the progress in academic contributions, several gaps and challenges remain unaddressed. One of the primary challenges is the limited focus on developed economies. While microfinance has been widely studied in the context of low-income populations in developing countries, there is a growing need to examine its application in wealthier economies, where financial exclusion also exists but takes different forms. Furthermore, the impact assessments of microfinance programs show mixed results, requiring further studies on the long-term effects of microfinance interventions on economic and social performance (Bauer et al., 2012).

Future research should prioritize comparative analyses between different models of microfinance institutions, exploring the effectiveness of diverse lending mechanisms, governance structures, and risk management strategies. Investigating the funding landscape, product development, and pricing strategies of MFIs can offer valuable insights for both academics and practitioners. Moreover, the rise of fintech and digital microfinance solutions presents an opportunity for researchers to assess their impact on financial accessibility, cost efficiency, and client outreach.

While the results highlight critical aspects of microfinance in the V4 countries, their direct application remains a challenge. Without a broader comparative approach, it is difficult to determine whether the identified trends and challenges are unique to the V4 or part of a larger global pattern. A more extensive evaluation incorporating diverse economic contexts would strengthen the study's practical implications, offering more actionable insights for financial institutions.

Conclusions

Microfinance research in the V4 countries is expanding — and there is a strong focus on financial inclusion, digital finance, and socio-economic development. However, future research should include comparative studies on loan lending models, governance structures, and the impact of fintech on financial accessibility. Future researchers, in order to enhance academic discourse and provide relevant recommendations for improving financial inclusion strategies in the region, should include diverse financial models, developed economies, and emerging trends in digital microfinance. Expanding the research to include developed economies, diverse financial models, and emerging trends in digital microfinance will enhance academic discourse and provide relevant recommendations for improving financial inclusion strategies in the region.

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Evaluating the Effect of Investment Incentives in the Czech Republic

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Abstract

This study examines the role of investment incentives in the Czech Republic, focusing on their impact on regional unemployment. The research analyzes a dataset spanning from 2000 to 2022, covering the total number of supported projects, their financial value, and the number of newly created jobs in various NUTS III regions. The data were sourced from the Ministry of Industry and Trade of the Czech Republic, CzechInvest, and the Czech Statistical Office. The study aims to determine whether the development of unemployment correlates with the number and value of investment-supported projects. Using statistical and mathematical methods, the findings reveal a positive but weak correlation between investment incentives and the unemployment rate. The results indicate that job creation predominantly occurs in regions with already low unemployment rates, suggesting that the current allocation of investment incentives may not be optimally structured to support economically lagging regions. These findings highlight the need for a more targeted approach to investment incentive policies to enhance regional economic balance.

Keywords: investment incentives, foreign direct investment, Czech Republic
JEL Classification: H25, R58, O16

Introduction

Investment incentives are measures implemented by governments or organizations to encourage businesses and individuals to invest in specific sectors or regions. These incentives aim to stimulate economic growth, promote job creation, and attract foreign and domestic investment. Czech Republic had already left the concept of traditional investment incentives before the long period of the economic policy of traditional investment incentives implementation was stopped in 1998. To be eligible for investment incentives in Czech Republic, companies must meet the requirements set out in Act No 72/2000 on investment incentives incentives, as amended by Act No. 426/2023 Coll., subject to the Czech government's approval and a commitment by the Ministry of Industry and Trade to provide the investment incentives. Some of the key incentives include the following Investment Incentive Programs that government has implemented several incentive programs aimed at promoting investment in specific sectors and regions. These programs often offer financial support in the form of grants, subsidies, or tax incentives to eligible investors. Tax Incentives to encourage investment may include reduced corporate income tax rates for eligible businesses, tax credits for research and development activities, and tax deductions for qualifying investments in certain sectors or regions. As a member of the European Union (EU), the Czech Republic has access to EU structural funds aimed at promoting

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regional development, innovation, and competitiveness. These funds can be utilized for various investment projects, particularly in less developed regions. The Czech Republic has established special economic zones (SEZs) in certain regions to attract investment and stimulate economic development. Investors operating within these zones may benefit from tax incentives, simplified administrative procedures, and access to infrastructure and support services. Investment incentives have been investigated by many authors and there are many studies that have investigated the impact of investment incentives on employment and productivity. By providing investment incentives, the government tries to increase economic growth and thus create new job opportunities and increase productivity. Investment incentives are "targeted measures designed to influence the size, location, impact behavior, or sector of an investment project." (Tavares-Lehmann, 2017) Generally speaking, to be considered an 'incentive,' they must be tailored to specific investors or types of investors for specific investment projects. (Blaschke, 2022) Location has a great influence on the placement of investments. Localization factors can be divided into 1. concentration of investments in economically developed regions with lower unemployment, 2. deconcentration factors (mainly cost savings). (Yanikkaya and Karaboga, 2017)

1 Theoretical background

The role of investment incentives, i.e. public interventions in regional policy, is to counteract the concentration of investments in economically more robust regions and to support economically lagging regions. Several authors dealt with this issue, whose studies pointed to the effectiveness, but also the inefficiency, of investment incentives. Damborský, 2023 confirmed with an analysis that the setting of the system of investment incentives could not sufficiently protect economically lagging regions. Belkhodja et al., 2017 showed that investment incentives and the environment have different effects on investors according to their background. Schalk and Untiedt, 2000 reported that investment incentives have a positive effect in the short term. However, investment incentives do not positively affect regional productivity and competitiveness over time. Fox and Murray, 2004 assessed investment incentives very similarly. The effectiveness of investment incentives depends on the period in which they are implemented. Bronzini and de Blasio, 2006 conclude from a survey of investors supported by the Italian government that investment incentives are limited. Aniello and Bertsch, 2023 examine the effects of investment incentives on the growth of investment volume and report insignificant effects on the sectoral investment. Atiyas and Bakis, 2013 claim that improvements in labour productivity is achieved through the reallocation of employment from low to high productivity industries. Investment incentives can take various forms:

Tax incentives: Governments may offer tax breaks such as tax credits, deductions, or exemptions to businesses or individuals who invest in certain sectors or geographical areas. These tax incentives can reduce the overall tax burden on investors, making investment more attractive. (Abeler and Jäger, 2015)

Financial incentives: Governments may provide financial support in the form of grants, loans, or subsidies to encourage investment. These funds can help cover the initial costs of investment or provide capital at favorable terms to support business growth. (Noor and Hassan, 2022)

Regulatory incentives: Governments may streamline regulations or provide exemptions from certain regulatory requirements for investors in specific industries. This can reduce compliance costs and bureaucratic hurdles, making investment more efficient.

(Aniello and Bertsch, 2023)

Infrastructure incentives: Governments may invest in infrastructure projects such as transportation networks, utilities, or telecommunications to support economic development and attract investment to regions. (de Rus and Socorro, 2010)

Training and workforce development incentives: Governments may offer incentives to businesses to invest in training programs or workforce development initiatives to ensure they have access to a skilled labor force. (Mawer and Jackson, 2005) Investment incentives are legislative measures aimed at stimulating investment. In most countries these are coordinated by a dedicated Investment Promotion Agency.

Regarding Central and Eastern European countries, factors such as production costs (Gauselmann et al., 2011), market size, trade openness and other macroeconomic variables were most often investigated (Bobenič Hintošová et al., 2021). Another stream of literature also includes institutional factors such as infrastructure, corruption, government spending and the rule of law (Bilan et al., 2019; Chanegriha et al., 2017). According to Fabuš and Csabay, 2018 in Slovakia, investment incentives are considered as a basic tool to support foreign investment activities. In Czech Republic, it is generally stated that the provision of investment incentives is in most cases effective (Cedidlova, 2013) and positively related to the development of regions but only in specific areas. (Hlaváček and Janáček, 2019). Johnson and Toledano, 2022 said that in the EU, some incentives are considered "State Aid," which is defined under EU law as: 1. aid in any form whatsoever, 2. which confers an advantage or benefit for the recipient; 3. granted by a member state or through state resources; 4. distorts or threatens to distort competition by favoring certain undertakings or the production of certain goods; 5. affects or is likely to affect trade between member states. Governments have long used incentives to shape the behavior of economic actors. The use of incentives is key to promoting public goals and correcting market failures caused by information asymmetry, externalities, and other circumstances. Incentives can help produce positive outcomes that the market alone cannot achieve by supporting the private sector. Governments use investment incentives for a variety of reasons, including:

- to convince investors to create jobs, increase competitiveness, create exports and build tax bases.
- to deepen local ties, for example, these are incentives to increase the number of local employees, procure goods and services from local providers and invest in education and training.
- to encourage domestic companies to grow abroad. (Hinkley and Weber, 2021)

Musil and Hedija, 2020 analyzed the relationship between investment incentives and the economic cycle and determined that investment incentives are procyclical. Hlaváček and Janáček, 2019 examined the impact of investment incentives and foreign investments on socio-economic development in the Czech Republic. The system of investment incentives is generally perceived as an advantage by which governments may influence the localisation decisions of companies in favour of targeted regions to attract and accumulate capital in their territory to support their economic growth. Táncošová, 2019 drew attention to the problem of uneven territorial distribution and higher investments directed to economically stronger regions. Authors Fabuš and Csabay, 2018 evaluate investment incentives as a still necessary tool for stimulating job creation. The analysis of the impact of investment incentives and the growth of supported companies in the Czech Republic

was also investigated by Bolcha and Zemplinerová, 2012, who pointed out the very low efficiency of the incentives. In his research, Dinga, 2011 focused on the influence of investment incentives on the placement of foreign direct investments in the Czech Republic. He concluded that the number of allocated incentives was relatively higher in districts with high unemployment, but the positive effect of investment incentives was minimal. Viturka, 2007 claims that the biggest benefit of investment incentives is their impact on employment growth. Investment incentives are usually conditional on the creation of a certain minimum number of new jobs, which contributes to improving the situation on the labor market and increasing the number of jobs.

Blaschke, 2022 concluded that the impact of investment incentives on economic development is positive but statistically insignificant. According to Johnson and Toledano, 2022 governments provide incentives to attract investments to have a positive impact on the economy, but it is difficult to measure them. Yanikkaya and Karaboga, 2017 demonstrated a negative impact on macroeconomic indicators of the economy. The positive impact of investment incentives on employment was also demonstrated by Schalk and Untiedt, 2000. Several independent authors in Poland (Ambroziak and Hartwell, 2018; Ślusarczyk, 2018) have shown in their studies that investment incentives attract foreign investments, which have proven to be a successful tool in the employment of lagging regions. The collective of researchers Schwarz et al., 2007 concluded that the relative maturity of the region has no influence on the amount of investment incentives, and thus the incentives are not aimed at less developed regions. The amount of promised investment incentives does not proportionally correspond to the number of promised jobs. The investment incentive will thus support only the given segment of the economy but will not start the growth of the entire region. Several studies suggest that the role of incentives in influencing investment location decisions is often limited. This is a consequence of the fact that tax incentives cannot compensate for an unattractive investment environment. The World Bank's investment climate surveys found that investors do not see incentives as key to their investment decisions. Other studies that examined the factors most important to their investment decisions concluded that incentives are a secondary factor in firms' investment decisions. (Jensen, 2018; Johnson and Toledano, 2022) Research by several authors (Antaloczy and Sass, 2001; Bevan and Estrin, 2000; Bevan et al., 2004; Clausing and Dorobantu, 2005; Garibaldi et al., 2001) did not demonstrate the importance of investment incentives. By observing investment promotion agencies in transition and developing countries, Morisset, 2003 found that the effects of investment incentives can even be negative.

The Czech Republic offers a comprehensive range of investment incentives aimed at fostering economic growth, technological advancement, and regional development. By providing tax relief, cash grants, and other benefits, the country seeks to attract and retain investors in key sectors, thereby enhancing its competitiveness and economic resilience. Investment incentives are available in the following forms:

- Corporate Income Tax Relief: Investors can benefit from corporate income tax relief for up to ten years, depending on the type of investment and its location.
- Cash Grants: Available for job creation and training new employees.
- Job Creation and Training Grants: Support creating new jobs range from CZK 100,000 to CZK 300,000 per job. Training grants can cover up to 50 % of training costs for new employees.

- Property Tax Relief: Local property tax relief may be available for investments in specific regions or for certain types of projects.
- Investment in Technology Centers and Business Support Services: Business support services centers, including shared services centers, can also receive financial support.
- Special Incentives for Strategic Projects: Support for large-scale, strategic investment projects (extra grants, tax relief, or other benefits).
- Support for Renewable Energy and Environmental Projects: Investments in renewable energy, energy efficiency, and environmentally friendly technologies can qualify for specific grants and subsidies.
- Research and Development (R&D) Incentives: Tax deductions, grants and subsidies for collaborative research projects with universities and research institutions.

The primary government agency CzechInvest is responsible for attracting foreign investment and administering investment incentives. It provides support and information to investors, including guidance on available incentives and assistance with the application process. A program supporting innovation, competitiveness and the development of business infrastructure will also play an important role. The Operational Program Entrepreneurship and Innovation for Competitiveness (OP PIK) is co-financed from the European Structural and Investment Funds (ESIF).

2 Research methodology

To achieve the goal, an analysis was used at the territorial level of districts and regions of the NUTS III of the Czech Republic. The reason why we excluded Prague from our dataset is that it is a completely different environment with different structures. The dataset contains information on the region that received investment incentives between 2000 and 2022, the number of supported projects, the amount of incentives and the number of newly created jobs. The analyzed data were collected from project databases created by the Ministry of Industry and Trade of the Czech Republic with the support of the Agency for Business and Investment Support - CzechInvest. These data represent independent variables. Macroeconomic data of the region collected by the Czech Statistical Office are used as dependent variables. The main statistical tool used for data processing is a correlation analysis. The correlation coefficient between two variables (x&y) is calculated using the Pearson correlation coefficient r, which is defined as:

$$r = \sum (x_i -$$

(9)

Where
r Pearson correlation coefficient,
x_i value of variable x,
y_i value of variable y,

The research aimed to find answer to main research question:

Does the development of unemployment depend on the number of supported projects and their value?

To answer the question, the following hypotheses were tested:

H1: Unemployment development depends on the number of supported projects.

H2: Unemployment development depends on the value of the supported projects.

The analysis contains indicators a) the number of supported projects, b) the value of the incentives, c) the number of newly created jobs, d) unemployment rate at the NUTS III.

3 Results and discussion

In the analysis of regional data from the Czech Republic, a correlation analysis was conducted to examine the relationship between unemployment development and investment incentives, including the number of supported projects and the value of these projects. The following subsections will present the results of this analysis in detail.

3.1 Results

In total, 755 investment projects were supported in Czech Republic from 2000 to 2022 in the total value of 15.41 billion euros, as a result of which 68,121 jobs were created. The most of them was in 2014, up to 142 in the total value of 2.75 billion euros and the creation of 12,922 jobs.

Table 1 summarizes the basic data of investment incentives and average value of unemployment rate in individual NUTS III regions. Unemployment rates represent macroeconomic indicator which is used for statistical analysis.

The largest number of projects were supported in the Moravia-Silesia in the total number of 117, where the largest number of jobs were created, namely 9,524. However, the largest number of investment incentives was provided to the Central Bohemia in the total value of 2.32 billion euros. The smallest number of projects was supported in the capital city, Prague. Only one project was supported during the entire monitored period. The value of the project was 48 million euros with the total of 500 created jobs. Here it is necessary to mention that "new jobs created" means the creation of a new job. It does not mean that the same number of unemployed people are employed. Newly created jobs will also attract workers from other companies. In terms of unemployment, the most problematic regions are Moravia-Silesia and Usti ($u > 8\%$). The main goal is to increase investments especially in these regions. The highest employment is in the capital city ($u > 2.8\%$).

Table 1: Investment Incentives and Average Unemployment Rates by NUTS III (2000–2022)

Region	**Supported Projects**	**Value of Supported Project (mil EUR)**	**New Jobs Created**	**u (%)**
Prague	1	48	500	2.8
Central Bohemia	96	2323	7904	4.0
South Bohemia	46	735	2224	4.4
Plzeň	69	1109	6576	4.2
Karlovy Vary	13	187	819	7.9
Ústí nad Labem	87	2116	6502	9.1
Liberec	35	783	3482	5.3
Hradec Králové	52	1388	7356	4.9
Pardubice	48	872	6133	5.1
Vysočina	45	795	4742	4.7
South Moravia	102	1028	4576	5.6
Olomouc	67	1013	4500	7.0
Zlín	57	880	3283	5.7
Moravia-Silesia	117	2129	9524	9.1

Source: own elaboration using data of CzechInvest and the Czech Statistical Office

If we look at Figure 1, we can say that in most regions of the Czech Republic, the number of projects is proportional to the number of newly created jobs.

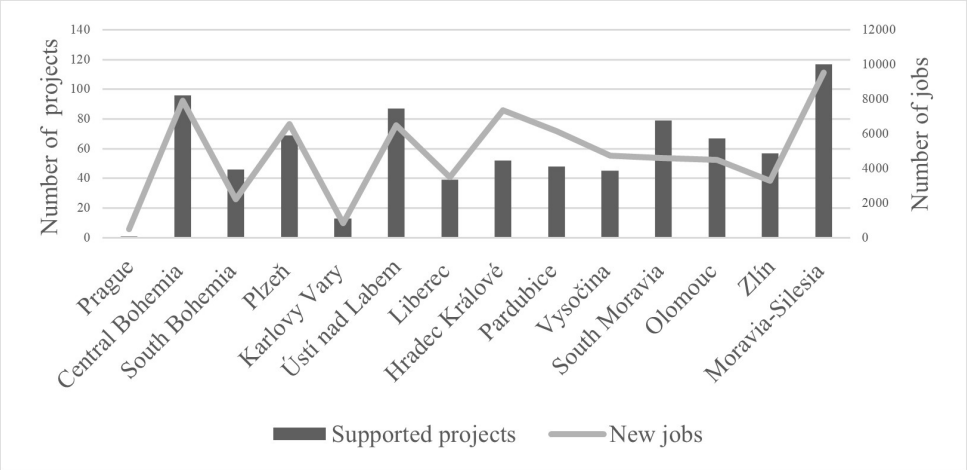

Figure 1: Top 10 Cited Articles
Source: Own processing based on WoS results

In the region of the capital city of Prague, only one project was supported during the entire monitored period, but it created up to 500 jobs. Based on the ratio of created jobs and supported projects, Hradec Kralove was the second-best region with a total of 52 supported projects and 7,356 jobs. On the contrary, the region of South Bohemia fared the worst, with a total of 2,224 jobs and 46 supported projects.

We try to find the relationship between unemployment and investment incentives expressed as supported projects (P), investment value (I), jobs created (J). The results

Table 2: Correlation coefficients (all regions)

	Unemployment (U)
Supported projects (P)	0.39786
Value of Investment (I)	0.44015
Jobs created (J)	0.61259

Source: Own elaboration

are presented in Table 2 we could see that there is a moderate correlation between these variables at the aggregate level.

Table 3: Correlation coefficients (individual region)

Region	**Supported projects (P)**	**Value of Investment (I)**	**Jobs created (J)**
Central Bohemia	-0.09269	-0.26136	0.23415
South Bohemia	-0.11996	0.04150	-0.01443
Plzeň	-0.00153	-0.36201	-0.10989
Karlovy Vary	0.60153	0.75749	0.72855
Ústí	-0.19113	-0.11582	-0.18053
Liberec	0.19265	-0.33542	-0.04239
Hradec Králové	-0.09565	0.15879	0.20460
Pardubice	0.17402	0.07188	-0.02531
Vysočina	-0.67141	-0.49945	-0.03963
South Moravia	-0.26065	-0.10077	0.08333
Olomouc	-0.18654	-0.28229	0.06487
Zlín	-0.11916	-0.02867	-0.03315
Moravia-Silesia	-0.22178	-0.18326	-0.08190

Source: Own elaboration

We also calculate correlation coefficients at the individual level for each region, the results are shown in Table 3. In Karlovy Vary region, there is a strong unemployment-investments and unemployment-jobs correlation.

3.2 Discussion

The correlation coefficients between unemployment (U) and the other variables provide valuable insights into the relationships between different factors. The correlation between unemployment and the number of supported projects (P) is 0.39786, indicating a moderate positive relationship. This suggests that as the number of supported projects increases, there tends to be a slight increase in the unemployment rate, although the relationship is not very strong. The correlation between unemployment and the value of investment (I) is slightly stronger at 0.44015, implying a moderate positive relationship as well. Higher investment values tend to be associated with higher unemployment, which could reflect a time lag in the creation of jobs or regional disparities in the distribution of investment. The strongest correlation is between unemployment and the number of jobs created (J), with a coefficient of 0.61259. This indicates a moderate to strong positive relationship, meaning that as more jobs are created, unemployment tends to decrease, as expected.

However, the correlation does not suggest a perfect inverse relationship, implying that there are other factors at play in influencing unemployment beyond job creation.

The correlation coefficients between unemployment and the other variables across different regions of the Czech Republic reveal varying patterns in how supported projects, investment values, and job creation relate to unemployment rates. For instance, in regions like Karlovy Vary, there is a strong positive correlation between unemployment and the number of supported projects (0.60153), value of investment (0.75749), and jobs created (0.72855), suggesting that these factors are closely linked to higher unemployment in this region. On the other hand, regions like Vysočina show a strong negative correlation with unemployment (-0.67141) and also exhibit negative correlations with the number of supported projects (-0.49945), indicating that investment and job creation are somewhat effective in reducing unemployment there.

In Central Bohemia, South Moravia, and Olomouc, the correlations are more mixed, with relatively weak relationships between unemployment and the other variables, suggesting that these regions may experience other influences on unemployment beyond the support provided by investment incentives. For example, while Central Bohemia shows a weak positive correlation between unemployment and jobs created (0.23415), it has a negative correlation with the number of supported projects (-0.26136), which could indicate that other factors might be influencing the unemployment rate despite the presence of investment projects. Similarly, in regions like Plzeň and South Bohemia, both the value of investment and the creation of jobs seem to have minimal impact on reducing unemployment. Overall, the variation in the correlation coefficients across the regions highlights the complexity of the relationship between investment support, job creation, and unemployment, suggesting that while investment incentives may have a positive effect in some areas, other structural factors, such as economic composition and regional disparities, also play significant roles in influencing unemployment outcomes.

Conclusions

This study aimed to analyze the relationship between investment incentives and unemployment in the Czech Republic at the regional level. By examining data from 2000 to 2022, we sought to determine whether the number of supported projects and their financial value had a measurable effect on unemployment trends across different NUTS III regions. The findings revealed a positive but relatively weak correlation between investment incentives and unemployment reduction. This suggests that while investment incentives contribute to job creation, their impact is not substantial enough to significantly alter unemployment rates across regions.

A key observation from our research is that investment incentives have been disproportionately allocated to regions with lower unemployment rates, while economically lagging areas have received comparatively fewer incentives. This misalignment raises concerns about the effectiveness of the Czech Republic's investment incentive framework in addressing regional economic disparities. The results indicate that, in many cases, job creation through investment incentives does not directly benefit the unemployed population within the region but instead attracts workers from other sectors or geographical areas. As a result, the potential for these incentives to serve as a tool for reducing unemployment in the most affected regions remains limited.

Our findings align with previous research (Damborský, 2023; Karaalp, 2014; Yanikkaya and Karaboga, 2017), which also highlighted the limited efficiency of investment incentives

in reducing unemployment in targeted regions. The study by Damborský, 2023 particularly supports the argument that the current system of investment incentives in the Czech Republic does not sufficiently protect or uplift economically weaker regions. While some regions benefit from increased investment and job creation, the overall economic impact appears to be concentrated in already developed areas with robust labor markets.

These insights have important policy implications. To enhance the effectiveness of investment incentives, policymakers should consider revising their allocation criteria. A more strategic approach would involve prioritizing investment projects in regions with persistently high unemployment rates and ensuring that the incentives contribute to sustainable job creation for local populations. Additionally, incentives should be linked to broader regional development policies that include workforce training, infrastructure improvements, and industry diversification. Such an integrated approach would increase the long-term economic resilience of disadvantaged regions.

While this study provides valuable insights into the effects of investment incentives on regional unemployment, it is important to acknowledge its limitations. The research focuses solely on one country, which may limit the generalizability of the findings to other contexts. Future studies could expand this analysis by comparing investment incentive strategies across multiple countries or by incorporating additional economic indicators such as GDP growth, productivity, or regional income levels. Moreover, further research could explore the long-term effects of investment incentives on employment stability, wage levels, and sectoral development.

In conclusion, investment incentives play a role in regional economic development, but their effectiveness in addressing unemployment remains questionable. The results suggest that current policies may need to be adjusted to ensure that investment incentives better serve the regions and populations that need them the most. A more targeted, data-driven approach could help optimize the distribution of incentives, thereby maximizing their economic and social benefits.

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A Decade of Innovation in Slovakia: Analyzing EIS Indicators from 2015 to 2024

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Abstract

Innovation is a key driver in fostering economic growth, competitiveness, and sustainable development. The European Innovation Scoreboard (EIS) serves as a crucial analytical tool for measuring and comparing the innovation performance of EU member states and selected non-EU countries. This article examines the evolution of selected EIS indicators for Slovakia from 2015 to 2024, identifying key trends, strengths, weaknesses, and areas for improvement within the country's innovation ecosystem. The study employs a longitudinal data analysis based on EIS reports from 2015 to 2024, focusing on key innovation dimensions. By analysing changes in these indicators over time, the research provides valuable insights into Slovakia's innovation performance and its position relative to the EU average. Slovakia has consistently ranked among the Emerging Innovators, with innovation performance below the EU average. While some indicators, such as intellectual assets (patents, trademarks) and knowledge-intensive expenditure, show positive trends, others—such as investment in research and development, venture capital funding, and collaboration between SMEs and research institutions—remain underdeveloped. The analysis also highlights a persistent trend in employment within knowledge-intensive activities, which may pose challenges for the country's future innovation capacity. Our research concludes that, to enhance its innovation performance, Slovakia should focus on increasing private sector investment in research and development, strengthening collaboration between industry and academia, fostering the development of the startup ecosystem, and addressing the issue of brain drain. These findings provide recommendations for policymakers to support a stronger and more competitive innovation environment in Slovakia.

Keywords: *innovation performance, R&D investments, intellectual assets, innovation policy, economic development*

JEL Classification: *O31, O32, O33, O38, O40*

Introduction

Innovation is a key driving force behind economic growth and competitiveness, playing a crucial role in shaping the development of modern economies. A country's ability to innovate determines its capacity to create new industries, enhance productivity, and sustain long-term economic prosperity. Measuring a nation's innovation performance is therefore essential for understanding its strengths and weaknesses in this area and for the design of effective policies that support research, development and the knowledge-based economy.

The European Innovation Scoreboard (EIS) serves as a comparative analytical tool that assesses the innovation performance of EU member states and selected non-EU countries. Slovakia has consistently been classified among the Emerging Innovators, with an

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innovation performance below the EU average. The aim of this article is to analyse the development of selected EIS indicators in Slovakia from 2015 to 2024. Based on this analysis, we seek to evaluate innovation performance trends in Slovakia over the past decade and identify key strengths and weaknesses across various dimensions of innovation. Subsequently, we will propose recommendations that could enhance Slovakia's innovation ecosystem.

To achieve these objectives, this article employs a longitudinal data analysis using EIS reports from 2015 to 2024. Based on the analysis, we will provide recommendations for policymakers, businesses, and researchers seeking to increase Slovakia's innovation potential and global competitiveness.

1 Theoretical background

1.1 Innovations

Innovation is a key factor in economic and social progress, shaping industrial development, increasing productivity and strengthening the competitiveness of nations. The first mentions of the term "innovation" date back to the late 19th century, where it referred to something new or unusual.

One of the first economists to systematically study innovation was Joseph Schumpeter. He defined innovation as "new combinations of production factors that lead to economic change." (Schumpeter, 1911) He later expanded this concept, characterising innovation as "a structural change in industry" and emphasising the "principle of creative destruction, where old technologies and processes give way to new and more efficient ones." (Schumpeter, 1939) The author Damanpour, 1996 understands innovation "as a means of changing an organization, either as a reaction to changes in the external environment or as a preventive action to influence the environment." Another author, Van de Ven, 1986, states that "as long as an idea is perceived as new to the people involved, it is an "innovation", even though to others it may appear to others to be an "imitation" of something that exists elsewhere."

In the modern definition, innovation is defined according to the Oslo manual, which describes it as "a new or significantly improved product, process, or business model that has been introduced to the market or implemented within an organisation." (OECD, 2018) This definition emphasises that innovation is not limited to technological advancements but also includes managerial and organisational improvements.

According to Hudáková, 2019, innovation is "the main driving force of regional development, contributing to overall growth and international competitiveness."

1.2 The importance of innovation for the competitiveness of countries

The ability to innovate is one of the most important factors for the long-term competitiveness of countries. OECD, 2013 defines competitiveness as "the degree of advantage or disadvantage a country has in selling its products in international markets."

According to Porter, 1990 "companies achieve competitive advantage through innovation", with the advantage arising either from the development of new products and services or from improvements in production processes.

According to Hudáková, 2019 innovation represents "a source of competitive advantage, particularly in the area of new and innovative products, services, and production processes." The authors Poltarykhin, 2021 argue that one of the main factors in increasing competitiveness is the innovative development of economic entities. Insufficient progress in innovation hinders the emergence of technological industries and limits the socio-economic development of the national economic system."

Countries that invest in research, development, and technological progress are better able to adapt to global changes, increase exports, and attract foreign investments, which strengthens their long-term economic growth.

1.3 The European Innovation Scoreboard (EIS)

The annual European Innovation Scoreboard (EIS) is a composite indicator, which "provides a comparative assessment of the research and innovation performance of the EU Member States and the relative strengths and weaknesses of their research and innovation systems." (European Commission, 2024c) It has been published since 2001. Its composition has changed several times over the years. The EIS helps "stakeholders assess areas in which they need to concentrate their efforts to boost innovation performance, considering the national socio-economic context (which is captured by a complementary set of structural indicators to help interpret the results). The EIS results can help reveal which dimensions of national innovation systems are especially weak or strong and thus should be the subject of attention from policymakers." (European Commission, 2024a) The EIS is "a useful tool for policymakers, but also for scientists, academics, innovators, and the general public. It helps policymakers identify strengths and weaknesses, guiding strategic interventions and policy formulation. Overall, the EIS serves as an evidence base for making informed decisions." (European Commission, 2024b)

European Innovation Scoreboard categorises member states in four innovation groups based on their scores: Innovation Leaders (performance is above 125 % of the EU average), Strong Innovators (between 100 % and 125 % of the EU average), Moderate Innovators (between 70 % and 100 % of the EU average) and Emerging Innovators (below 70 % of the EU average). (European Commission, 2024b)

The methodology of the EIS has evolved and changed over the years. The latest edition, European Commission, 2024a, distinguishes "between four main types of activities – Framework conditions, Investments, Innovation activities, and Impacts – and 12 innovation dimensions, capturing in total 32 indicators." (European Commission, 2024c) Each main category contains the same number of indicators and has an equal weight in the Summary innovation index. A detailed description can be found in Figure 3.

2 Research methodology

As part of the methodology, we decided to use a longitudinal analysis, which serves to study the development of selected variables over time. Given that the composition of the Aggregate Innovation Index has changed several times over the years, with the last revision of the measurement framework occurring in 2021, we selected for our research only those innovation dimensions and their indicators that were consistently included in the Aggregate Innovation Index from 2015 to 2024. In some cases, the indicators underwent minor name changes, while retaining their original essence. The selected innovation dimensions and their indicators are as follows:

- HUMAN RESOURCES: New doctorate graduates, Population completed tertiary education
- ATTRACTIVE RESEARCH SYSTEMS: International scientific co-publications, Most cited scientific publications, Foreign doctorate students
- FINANCE AND SUPPORT: Public R&D expenditures, Venture capital
- FIRM INVESTMENTS: Business R&D expenditures, Non-R&D innovation expenditures
- LINKAGES: Innovative SMEs collaborating with others, Public-private scientific co-publications
- INTELLECTUAL ASSETS: PCT patent applications, Community trademarks, Community designs
- INNOVATORS: SMEs introducing product or process innovations, SMEs introducing marketing or organisational innovations, Employment in Knowledge-Intensive Activities, Medium and High-tech manufacturing exports, Knowledge-Intensive Services exports, Sales share of new innovations.

The EIS uses the latest statistics from Eurostat and other internationally recognised sources available at the time of the analysis. Data for our analysis was drawn from EIS reports for the years 2015 to 2024:

- Innovation Union Scoreboard 2015 (European Union, 2015)
- European Innovation Scoreboard 2016 (European Union, 2016)
- European Innovation Scoreboard 2017 (European Union, 2017)
- European Innovation Scoreboard 2018 (European Union, 2018)
- European Innovation Scoreboard 2019 (European Union, 2019)
- European Innovation Scoreboard 2020 (European Union, 2020)
- European Innovation Scoreboard 2021 (European Union, 2021)
- European Innovation Scoreboard 2022 (European Commission, 2022)
- European Innovation Scoreboard 2023 (European Commission, 2023)
- European Innovation Scoreboard 2024 (European Commission, 2024a)

3 Results and Discussion

3.1 Results

The innovation performance of the Slovak Republic has consistently remained below the European Union average. The blue line in Figure 1. As we can see, the Summary innovation index exhibits significant fluctuations. Slovakia achieved a particularly strong result in 2017, when the country's innovation performance reached 70 % of the EU 2016 benchmark. However, in the following year, 2018, there was a sharp decline of 6 %. A similar pattern was observed in 2020 (66.6 %) and 2021 (63.1 %). Based on these results, Slovakia is classified as an Emerging Innovator with an innovation performance of 60-70 % of the EU average. Using commands in RStudio, we visualised the linear trend on the graph through linear regression, represented by a black dashed line. This trend line indicates the overall direction of the Summary innovation index. Although the graph shows slight growth in recent years, the trend line suggests a slight decline in Slovakia's innovation performance.

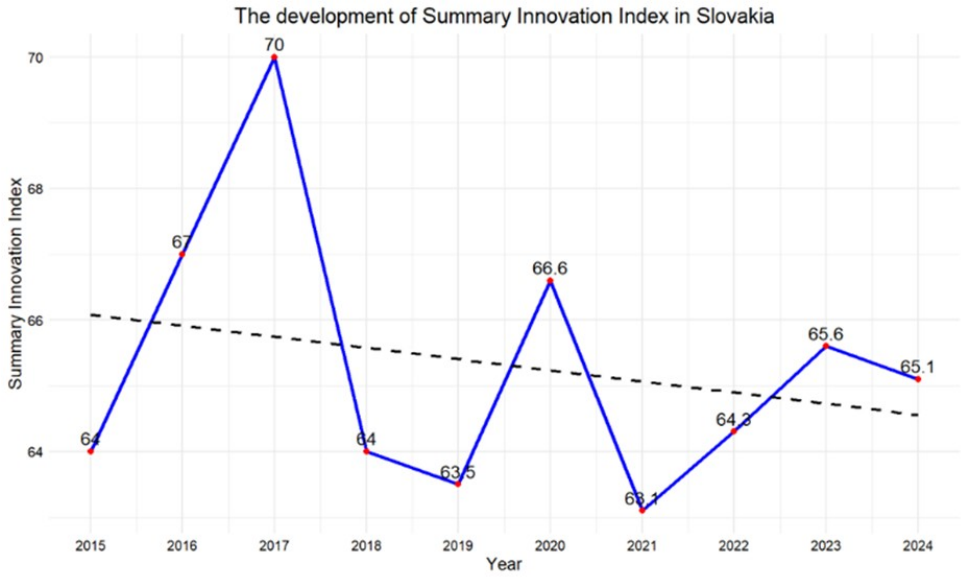

Figure 1: The development of Summary innovation index in Slovakia
Source: own based on European Innovation Scoreboards

Figure 2 shows that the trends in the innovation dimensions we examined have varying impacts on the overall Summary innovation index. While some areas, such as human resources and firm investments, may be crucial for the long-term sustainability of innovation in Slovakia. The significant decline in Human Resources in recent years could serve as a warning signal for future innovation development, as a skilled workforce is a key driver of innovation. Additionally, Finance and support remain unstable, which may affect the country's long-term innovation capacity. To stabilise and improve Slovakia's innovation performance, it would be beneficial to focus on sustainable research funding, stronger support for businesses, and the development of a highly skilled workforce.

As mentioned in the theoretical background, EIS 2024 distinguishes four main types of activities. The innovation dimensions and indicators we examined, which fall under framework conditions according to the EIS 2024 methodology, are presented in Figure 4

compared to the Summary innovation index. The graph illustrates the gradual development of various dimensions related to innovation potential. While some indicators (such as Population completed tertiary education) show significant fluctuations, others, like Foreign doctorate students and International scientific co-publications, exhibit consistent growth over time. Overall, innovation performance is stabilising, but disparities between different indicators—such as Most cited scientific publications and the overall Attractive research systems—highlight areas with potential for improvement.

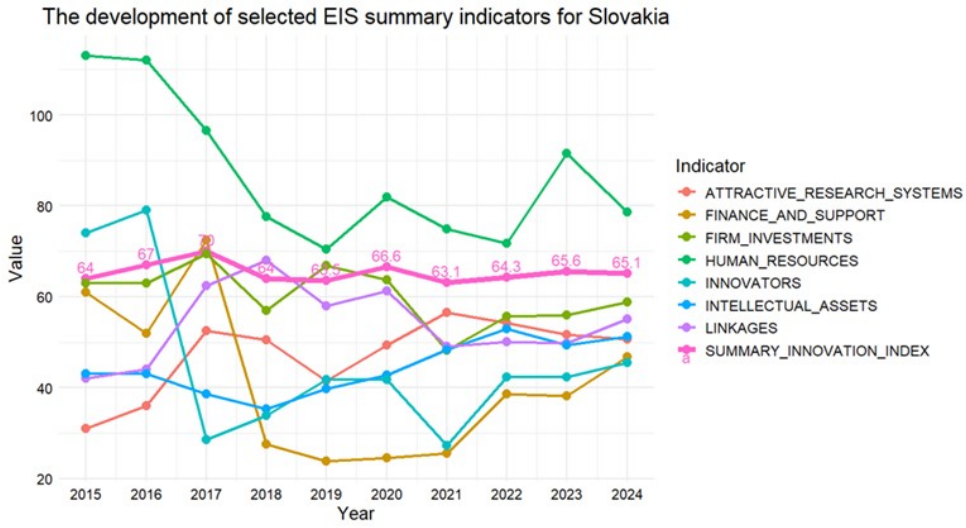

Figure 2: The development of selected EIS summary indicators for Slovakia
Source: own based on European Innovation Scoreboards

Figure 5 indicators compared to the Summary innovation index illustrates the trends of selected dimensions and indicators within the Investments category. This area has undergone dynamic changes, with some indicators (such as Public R&D expenditures and Venture capital) experienced significant fluctuations. Slovakia has consistently shown the weakest results in Business R&D expenditures and Venture capital, as well as in the broader dimension of Finance and Support, where there is substantial room for improvement.

The trends of selected dimensions and indicators from 2015 to 2024 under Innovation activities are depicted in Figure 6. The Intellectual assets dimension has shown steady growth, particularly in the PCT Patent Applications indicator. However, the performance of indicators such as innovative SMEs collaborating with others and aspects of SMEs introducing product or process innovations highlight the need to strengthen business collaboration in Slovakia.

The final category, Impacts and its selected indicators are illustrated in Figure 7. The sharp decline in exports of knowledge-intensive services after 2020 highlights the sector's vulnerability to external shocks, such as the pandemic. Both export indicators are on a recovery path but remain below pre-crisis levels. Despite overall stability, there is a slight decline in employment in knowledge-intensive activities, which could affect future innovation potential. The Impacts category presents a mixed picture of the long-term effects of innovation. While some indicators, such as turnover from innovation, show slight improvement, others—particularly exports of knowledge-intensive services—face significant challenges. Overall, greater support is needed to enhance the efficiency and impact of innovation.

The development of all selected indicators for Slovakia from 2015 to 2024 is illustrated in Figure 8. As we can see, Slovakia performs the best in the indicators Medium and high-tech product exports and Sales share of new innovations. However, both have shown a significant decline since 2020. On the other hand, Slovakia has consistently recorded the lowest values in Venture capital and Business R&D expenditures, highlighting critical weaknesses in the country's innovation ecosystem.

3.2 Discussion

The development of innovation indicators in Slovakia over the past ten years shows that the country is classified as an Emerging Innovator, with its innovation performance oscillating between 60-70 % of the European Union average. This development may be influenced, for example, by unstable funding for research and development. Expenditure from both private and public sources has long been below the EU average, with Business R&D expenditures and Venture capital investments being particularly weak. Another factor influencing this development is declining human capital, because despite good results in education indicators such as New doctorate graduates and Population completed tertiary education, there is a decline in the qualified workforce for innovation, which may be caused by the outflow of talent abroad. The weak connection between the academic and business sectors, which also affects the country's insufficient innovation performance, is demonstrated by the Innovative SMEs collaborating with others and Public-private scientific co-publications indicators. Cooperation between research institutions and businesses is still insufficient in Slovakia.

Based on the analysis of the development of selected indicators that affect the country's innovation performance, we can identify some of Slovakia's strengths and weaknesses in the field of innovation. The stable growth of Intellectual Assets, especially PCT patent applications and Community trademarks, indicates the country's ability to create intellectual property. We can also consider the relatively strong Medium and high-tech product exports and Knowledge-Intensive Services exports as strengths, although they have experienced fluctuations after 2020. A problem in the field of innovation in Slovakia may be the long-term underfinancing of innovations from the private sector, which hinders the development of the business ecosystem. On the contrary, the low level of Venture capital investments signals weak support for startups and innovative companies. Employment in knowledge-intensive activities has decreased in recent years, which may also have a negative impact on the country's long-term competitiveness.

In an effort to increase Slovakia's innovation performance and get closer to the EU average, we propose taking several steps. Policymakers should focus on increasing R&D financing from private sources. The government should support investment in innovation through tax incentives and grant schemes for companies. Improving programs to support technology transfer and applied research would lead to stronger cooperation between academia and businesses. In order to reduce the brain drain from the country, it is necessary to create attractive conditions for R&D experts, including higher salaries and better infrastructure. Support for startups and venture capital is also key, by motivating investors to be more active in the field of Venture capital investments and providing mentorship for emerging technology companies.

Achieving an overall improvement in the innovation ecosystem in Slovakia would require a coordinated approach by the state, companies and academic institutions, while the ability to respond to global trends and technological changes will also be an important

factor.

Conclusions

Based on the analysis of the development of Slovakia's innovation indicators from the European Innovation Scoreboard (EIS) from 2015 to 2024, it can be concluded that Slovakia has long been classified as an Emerging Innovator, with innovation performance below the EU average. Although some indicators have shown positive development, the overall trend of innovation performance in Slovakia indicates a slight decline.

Based on our analysis, Slovakia's strengths include stable results in the area of Intellectual Assets, particularly in PCT patent applications and Community trademarks, as well as a relatively strong export of technologically advanced products and services. The weaknesses include low levels of private investment in research and development, weak connections between the academic and business sectors, and stagnation in employment in knowledge-intensive industries.

To improve Slovakia's innovation performance, we suggest increasing R&D funding from the private sector, fostering collaboration between research institutions and businesses, strengthening the startup ecosystem, and addressing the brain drain. Without these measures, Slovakia will struggle to move up to higher categories of innovative countries.

The results of our analysis suggest that while Slovakia has made progress in certain areas, it still faces challenges that require systematic political and economic interventions. Future studies could focus on a more detailed analysis of specific policies and their impact on the country's innovative environment.

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Appendix

Figure 1 Indicators included in the EIS 2023 measurement framework

Figure 3: Indicators included in the EIS 2023 measurement framework
Source: own based on European Commission, 2024

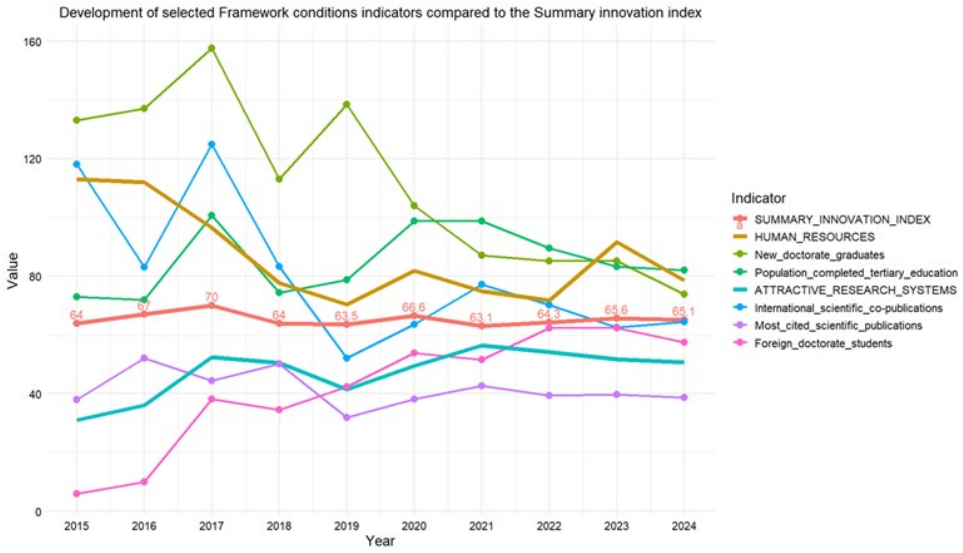


Figure 4: Development of selected Framework conditions indicators compared to the Summary innovation index

Source: own based on European Innovation Scoreboards

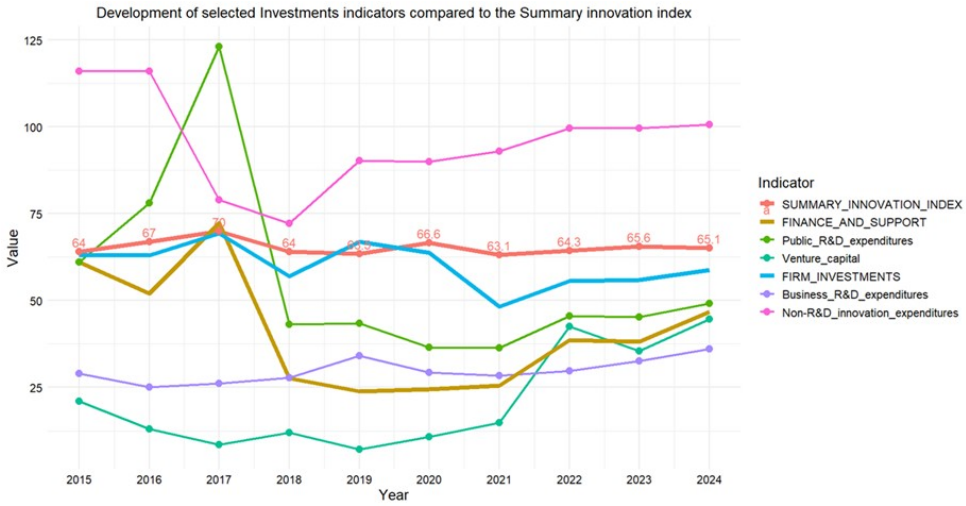


Figure 5: Development of selected Investments indicators compared to the Summary innovation index

Source: own based on European Innovation Scoreboards

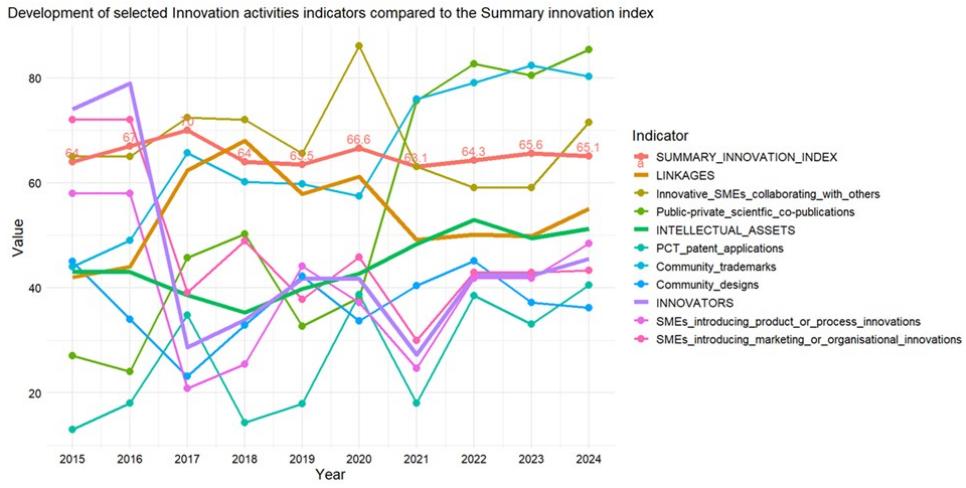


Figure 6: Development of selected Innovation activities indicators compared to the Summary innovation index

Source: own based on European Innovation Scoreboards

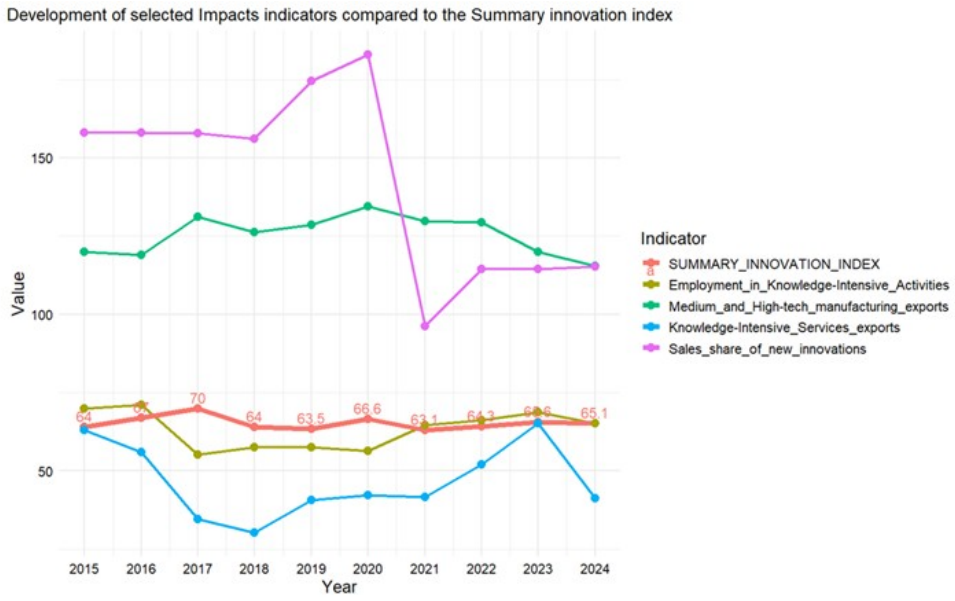
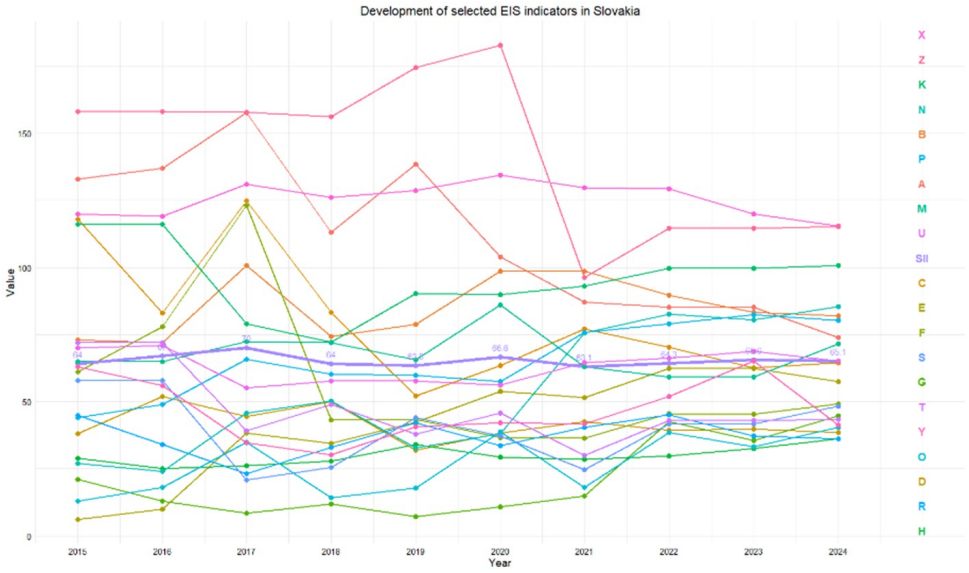


Figure 7: Development of selected Impacts indicators compared to the Summary innovation index

Source: own based on European Innovation Scoreboards



Note: Indicators: A: New doctorate graduates, B: Population completed tertiary education, C: International scientific co-publications, D: Most cited scientific publications, E: Foreign doctorate students, F: Public R&D expenditures, G: Venture capital, H: Business R&D expenditures, K: Non-R&D innovation expenditures, M: Innovative SMEs collaborating with others, N: Public-private scientific co-publications, O: PCT patent applications, P: Community trademarks, R: Community designs, S: SMEs introducing product or process innovations, T: SMEs introducing marketing or organisational innovations, U: Employment in Knowledge-Intensive Activities, X: Medium and high tech product exports, Y: Knowledge-Intensive Services exports, Z: Sales share of new innovations, SII: SUMMARY INNOVATION INDEX

Figure 8: Development of selected EIS indicators in Slovakia
Source: own based on European Innovation Scoreboards

Session III.: Taxation and Innovation

Public Debt Determinants: Trends and Insights from a Bibliometric Analysis

Dominika Jusková[1], Lenka Maličká[2]

Abstract

Public debt has become a critical issue in economic research, given its implications for fiscal stability, economic growth, and governance. Understanding the key determinants of public debt is essential for developing effective debt management strategies and informing economic policies. This study employs a bibliometric analysis to examine research trends on public debt determinants, using data from the Web of Science (WoS) database spanning 1986 to 2024.The findings reveal a growing academic interest in this topic, particularly in response to global financial crises, sovereign debt issues, and shifts in economic policies. A co-occurrence network analysis identifies three dominant research clusters. The first cluster focuses on macroeconomic and fiscal policy aspects, including government spending, taxation, and monetary policy. The second cluster examines corporate finance and capital structure, highlighting the interaction between private and public sector borrowing. The third cluster explores governance, institutional quality, and sustainability, emphasizing the role of political institutions and regulatory frameworks in debt dynamics. By mapping citation patterns, thematic developments, and academic collaborations, this study provides insights into the intellectual structure of public debt research. The results underscore the interdisciplinary nature of this field, reflecting an increasing emphasis on policy-oriented approaches that integrate economic, financial, and political perspectives. Given the complexity of public debt dynamics, future research could benefit from meta-analytical approaches that synthesize empirical findings and assess causal relationships among key determinants. Furthermore, integrating machine learning techniques and big data analytics may enhance predictive modelling and risk assessment in public debt management. These insights contribute to a deeper understanding of public debt determinants and offer a valuable foundation for evidence-based policymaking, supporting governments and institutions in designing more effective debt management strategies.

Keywords: *public debt determinants, bibliometric analysis, Web of Science*

JEL Classification: *A12, C89, E62, H62, H63*

Introduction

Public debt has become a critical area of study in economic research, particularly considering its implications for fiscal policy, economic growth, and financial stability. As countries grapple with rising debt levels, understanding the determinants of public debt has gained prominence among scholars and policymakers alike. This article aims to conduct a bibliometric analysis of the determinants of public debt, providing insights into

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the trends, patterns, and influential factors that have shaped this field of research over the years. Bibliometric analysis serves as a powerful tool for assessing publication trends and research outputs across various domains. By systematically analysing the metadata of published works, researchers can identify key themes, influential authors, and the evolution of knowledge in a specific area. The increasing use of bibliometric methods in economic research highlights the importance of quantitative approaches in understanding complex phenomena such as public debt (Razinkova, 2024).

Previous studies have underscored the significance of various economic factors, including economic growth and interest rates, as primary determinants of public debt. However, it is essential to recognize that these economic variables only partially explain the observed changes in public debt, suggesting the presence of other influential elements, such as institutional and political factors (Abubakar, 2020; Cifuentes-Faura and Simionescu, 2023; Eberhardt and Presbitero, 2015; Panizza and Presbitero, 2014). This multifaceted nature of public debt necessitates a comprehensive analysis that encompasses a wide range of determinants and their interrelationships.

In this context, the current bibliometric analysis will explore the literature surrounding public debt determinants, focusing on the contributions made by various researchers and the implications of their findings. By mapping the landscape of public debt research, this study aims to provide a nuanced understanding of the challenges associated with public debt management and the evolving dynamics that influence it (Filatova et al., 2023; Razinkova, 2024). Through this analysis, we hope to shed light on the critical determinants of public debt and offer valuable insights for future research and policy formulation in this vital area of economic study.

1 Theoretical background

The study of public debt determinants has been a central focus of economic research, particularly regarding its impact on economic growth. Over the past few decades, the theoretical discourse surrounding this topic has evolved significantly, reflecting a broad spectrum of empirical studies and theoretical frameworks. This evolution can be categorized into three key themes: the relationship between public debt and economic growth, the role of institutional quality, and the implications of fiscal policies.

A large body of literature has examined the interplay between public debt and economic growth, revealing a complex and non-linear relationship. Kourtellos et al., 2013 argue that while public debt can have positive short-term effects, particularly through counter-cyclical fiscal policies, it may also lead to negative long-term growth effects when debt levels become unsustainable. Similarly, Dafermos, 2015 challenges the assumption that high debt levels inherently hinder economic performance, arguing instead that no direct causal link exists between public debt and growth. Conversely, Sobczak and Radziewicz, 2021 provide empirical evidence that excessive debt can limit public investment and slow economic expansion through the crowding-out effect. Panizza and Presbitero, 2014 further emphasize that the impact of public debt varies significantly depending on economic conditions and debt levels.

The role of institutional quality in shaping public debt dynamics has garnered increasing attention. Nguyen and Luong, 2021 argue that strong institutional frameworks can mitigate the adverse effects of public debt, highlighting the importance of governance in achieving sustainable debt levels. In developing economies, where much of public debt is external, institutional weaknesses amplify its negative effects (Panizza and Presbitero,

2014). Simultaneously, fiscal policies play a critical role in shaping debt outcomes. Baldacci et al., 2013 suggest that gradual fiscal adjustments that protect public investment can support growth while reducing debt burdens, while An et al., 2020 demonstrate that in middle-income countries, the negative impact of debt on growth becomes significant when debt exceeds critical thresholds.

The 1980s and 1990s marked the beginning of detailed investigations into public debt dynamics, particularly in developing countries. The neo-classical perspective suggested that public debt could stimulate growth by facilitating capital mobilization (Listiyani, 2023). However, empirical evidence remained inconclusive, prompting further research into the conditions under which public debt is beneficial or detrimental (Bilan and Ihnatov, 2015; Rathnasiri and Soysa, 2020). This debate intensified during the global financial crises of the late 2000s, which shifted research focus on public debt sustainability. Researchers emphasized the risks of fiscal imbalances, particularly their role in fuelling inflationary pressures (Cecchetti et al., 2010) and highlighted the growing importance of institutional quality and governance in debt management (Aman-Ullah et al., 2024).

Following the Great Recession of 2008, concerns over rising public debt levels and fiscal deficits led to extensive academic debate. Studies such as Abubakar, 2020 and Güzel and Çetin, 2016 stress that fiscal tightening and efficient public spending are crucial for debt stabilization. Eberhardt and Presbitero, 2015 emphasize the heterogeneity and nonlinearity of the debt-growth relationship, showing that debt effects vary across different national contexts (Loo and He, 2018). The 2010s saw the rise of advanced econometric models to analyse this relationship, including threshold models, which identified critical debt-to-GDP ratios beyond which debt negatively impacts growth (Guerini et al., 2018; Šuliková and Tykhonenko, 2017; Teles and Mussolini, 2014).

More recently, research has explored the socioeconomic effects of public debt, including its influence on poverty and inequality. While debt can finance development projects, its long-term impact depends on the efficiency of public investment and governance structures (Akram, 2016). Furthermore, studies indicate that debt-growth dynamics vary significantly based on region and income level, highlighting the need for tailored policy approaches (Busato, 2024). As we approach 2024, rising global public debt—particularly in the wake of the COVID-19 pandemic—has reignited debates on debt sustainability and long-term economic stability (Busato, 2024). Researchers are increasingly focusing on the political economy of debt management, acknowledging that governance and institutional quality are key determinants of debt outcomes (Aman-Ullah et al., 2024).

Furthermore, digital technologies and big data analytics are opening new pathways for understanding public debt dynamics. The ability to analyse large datasets and apply machine learning techniques allows for more precise policy recommendations (Guerini et al., 2018), improving debt management strategies. The determinants of public debt and its implications for economic growth are multifaceted and highly context dependent. The interplay between public debt, institutional quality, and fiscal policies remains a crucial research area, particularly considering global economic challenges. As the field continues to evolve, future research should refine methodologies, incorporate interdisciplinary perspectives, and consider country-specific conditions to develop effective debt management strategies.

2 Research methodology

This study utilizes the bibliometric method, with all data for the analysis sourced from the Web of Science database. Bibliometric analysis is a well-established approach used to examine scientific literature quantitatively and is closely linked to the field of scientometrics. It encompasses various analytical techniques, including co-citation analysis, co-author analysis, and cluster analysis, which help to identify patterns, trends, and relationships within academic research (Chen and Xiao, 2016).

The analysis was conducted using R Studio software, a widely used tool for statistical computing and data visualization. Prior to conducting the analysis, it was necessary to install several specialized packages, such as "bibliometrix" and "shiny" (Ramadhan et al., 2023). These preparatory steps were essential for enabling a systematic and structured bibliometric analysis, allowing for the processing of scientific publication data and the generation of descriptive statistics. The results of the bibliometric analysis consist of a set of descriptive statistics, providing fundamental insights into the dataset, including the total number of articles analysed, authorship details, document counts, and the frequency of author-assigned keywords. Furthermore, bibliometric analysis offers a broad spectrum of insights, such as the evolution of research topics over time, the geographical distribution of publications within the Web of Science database, identification of the most influential authors, citation patterns, and the distribution of key terms across documents. These findings are systematically presented in the "Data" and "Results" sections of this study. Additionally, bibliometric analysis can uncover relationships between research themes, identify emerging trends, and even highlight international collaborations in scientific publications. While this study does not explicitly explore these aspects, it lays the groundwork for further research into such connections, providing a foundation for future studies to delve deeper into the interconnectedness of research domains and the global scholarly landscape.

2.1 Data

All data used in this article originate from the Web of Science (WoS) database, a reputable source for academic publications. The dataset was compiled using the keyword "public debt determinants" to ensure a comprehensive selection of relevant studies. The analysis covers the period from 1986 to 2024, reflecting nearly four decades of research on this topic, with the earliest study meeting the selection criteria published in 1986. If we used only the keyword "public debt" as the search criterion in the Web of Science (WoS) database, the time span would expand to cover the years 1901 to 2024. Over these 38 years, the number of publications has steadily increased, reflecting the rising academic and policy interest in public debt determinants. Early research in this area was limited, but as economic globalization progressed and sovereign debt crises emerged, scholarly attention intensified. By the most recent decade, publication volume had grown significantly, highlighting the ongoing relevance of this issue. As of 2024, a total of 1,192 documents on this subject have been indexed in WoS, including journal articles, conference proceedings, and review papers. These studies explore various factors influencing public debt, such as macroeconomic policies, fiscal sustainability, institutional governance, and external shocks.

To ensure transparency, Table 1 below presents all fundamental details regarding the input data, including publication trends, document types, citation metrics, and authorship

characteristics, providing a solid foundation for further bibliometric analysis. The dataset spans 1986 to 2024, during which 1,192 documents were indexed in WoS database across 586 sources. The annual growth rate of publications has been 13.37 % on average, with the most significant increase occurring between 2006 and 2015 (17.51 %). This increase in research output may have been driven by the growing interest in public debt management, which emerged as a key policy concern following the Great Recession, highlighting the need for sustainable fiscal strategies in response to the global economic crisis.

To capture shifts in research focus, the analysis also considers four sub-periods (1986-1995, 1996-2005, 2006-2015, and 2016-2024). In the initial decade (1986-1995), research output was relatively low, with only 21 documents published, whereas in the most recent decade (2016-2024), publication volume surged to 795 documents. This significant increase suggests a growing academic interest in public debt determinants, likely driven by economic crises, evolving fiscal policies, and global financial challenges. Authorship trends indicate a shift toward collaborative research, as the average number of co-authors per document increased from 1.86 in 1986-1995 to 3.1 in 2016-2024. Additionally, the proportion of international co-authorships rose from 4.76 % in the earliest period to 26.04 % in the most recent decade, reflecting the increasing globalization of research in this field. The total number of references cited in the dataset reached 45,661, with a significant rise in the latest period, demonstrating the expanding knowledge base of public debt research. These findings suggest that academic interest in public debt determinants is likely to continue growing, with research becoming more collaborative, international, and methodologically diverse. The increasing number of author keywords (3,015 in total) indicates a broadening scope of investigation, reflecting the evolving nature of public debt studies and their interdisciplinary connections with governance, fiscal policy, and financial stability.

Table 1: Main information about data

Description	**1986:2024**	**1986:1995**	**1996:2005**	**2006:2015**	**2016:2024**
Sources (Journals, etc.)	586	17	38	227	434
Documents	1,192	21	60	316	795
Annual Growth Rate %	13.37	24.14	2.05	17.51	11.17
References	45,661	998	1,806	11,598	34,491
Author's Keywords	3,015	10	64	857	2,447
Authors	3,067	39	119	679	2,289
Single-authored docs	246	7	15	87	137
Co-authors per Doc	2.83	1.86	2.18	2.32	3.10
International co-authorships %	24.33	4.76	13.33	23.42	26.04
Article	1,077	17	48	283	729

Source: own processing from Bibliometrix environment

3 Results

This section presents the findings of the bibliometric analysis on public debt determinants, based on data from the Web of Science (WoS) database covering the period 1986–2024. Figure 1 below illustrates the annual publication trends, showing a steady rise in research activity. While early studies on this topic were scarce, interest has grown significantly

in recent decades, reflecting the increasing relevance of public debt in economic and policy discussions. The surge in publications highlights the interdisciplinary nature of this research, integrating perspectives from economics, finance, and public policy.

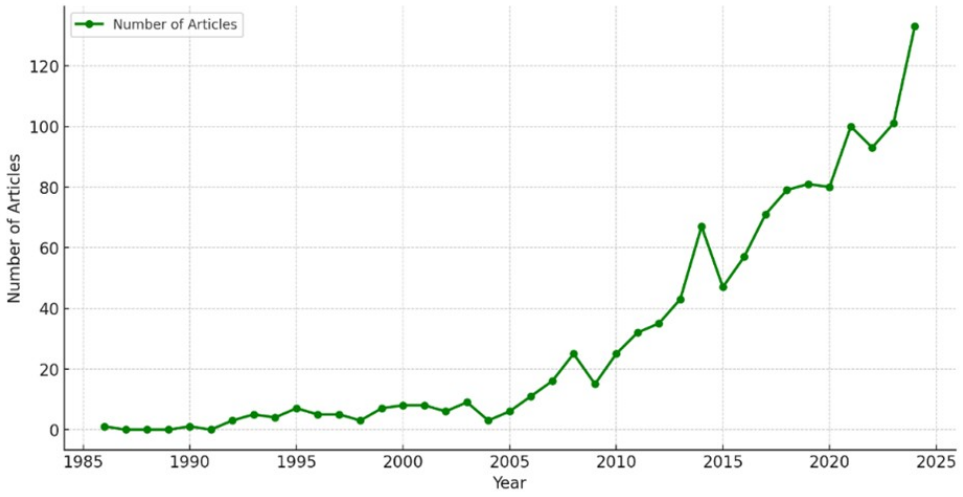

Figure 1: Annual Scientific Production (Number of publications)
Source: own processing from Bibliometrix environment

The map below (Figure 2) illustrates the scientific production by country in the Web of Science (WoS) database during the examined period.

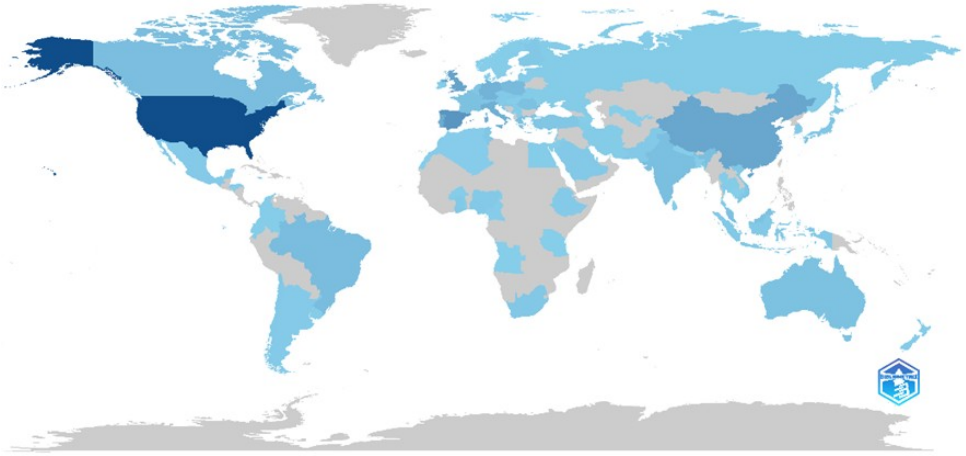

Figure 2: Countries' Scientific Production
Source: own processing from Bibliometrix environment

According to the data, the United States ranks as the leading contributor, with 780 publications on the subject. Following closely, Spain and the United Kingdom have also demonstrated significant academic output, producing 328 and 243 articles, respectively. Beyond these top contributors, several other countries have made notable contributions. Italy (220 articles), Germany (203 articles), Canada (194 articles), India (184 articles), and Australia (176 articles) also feature among the most active nations in this research field.

The analysis of the most relevant authors in public debt research highlights the top 10 contributors based on the number of articles published in the Web of Science (WoS)

database. This ranking identifies key researchers who have significantly shaped discussions on sovereign debt, fiscal policies, and financial sustainability, with a notable presence of researchers from Spain and other European countries, indicating strong regional interest in the topic. While the number of publications provides insight into research productivity, a more compelling perspective emerges when examining the most cited authors, as citations reflect the academic influence and impact of specific studies within the research community. Figure 3 below presents the top 10 most cited authors in public debt research, ranked by the total number of citations recorded in the WoS database. Rajan RG leads with 2,740 citations, demonstrating the far-reaching influence of their work on financial and economic studies. Baker M and Djankov S follow closely, with 1,403 and 1,296 citations, respectively. Other key contributors, including Faulkender M and Louzis DP, have also garnered over 600 citations, reflecting their impact on public debt and financial policy research.

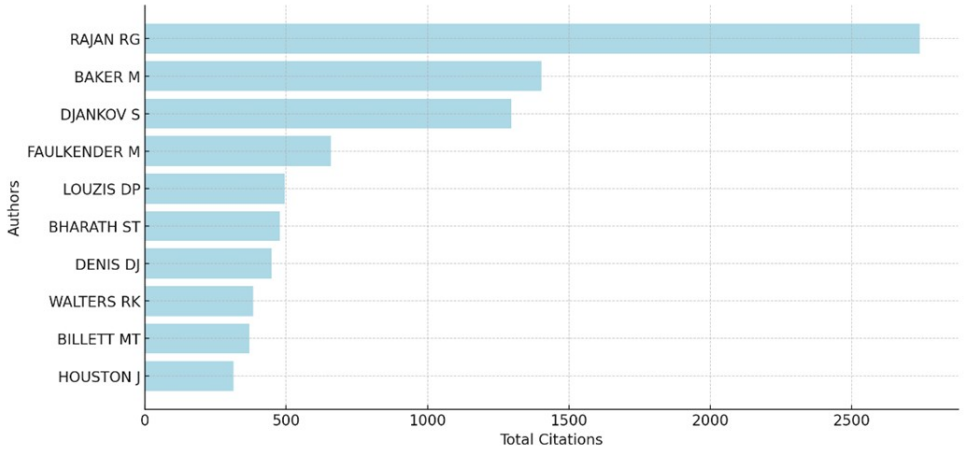

Figure 3: Most Global Cited Documents
Source: own processing from Bibliometrix environment

The high citation count of these publications underscores their role in shaping theoretical frameworks and empirical methodologies in the field. While publication volume highlights the breadth of research activity, citation metrics provide deeper insights into the lasting influence and recognition of specific studies. The next section will further explore citation networks and thematic connections, offering a more detailed perspective on the most influential research in public debt determinants.

The words cloud below (Figure 4) illustrates the most frequently used author keywords in studies related to public debt determinants. Since the core focus of this bibliometric analysis was on public debt, it is expected that the keyword "public debt" occupies the largest share, accounting for 29 % of the dataset. Similarly, other major keywords such as "capital structure" (8 %), "local government" (5 %), "economic growth" (4 %), and "fiscal policy" (4 %) indicate key research themes explored by scholars in this field. The visualization also highlights a diverse range of secondary research topics that have gained scholarly attention. Keywords such as "determinants" (3 %), "corruption" (3 %), and "sustainability" (2 %) suggest that research has expanded beyond macroeconomic aspects to include institutional and governance-related factors influencing public debt. Additionally, terms like "sovereign risk" (2 %), "credit risk" (2 %), and "debt maturity" (2 %) point to financial market implications and risk assessment frameworks within the discourse on public debt.

Figure 4: WordCloud
Source: own processing from Bibliometrix environment

To analyse how the focus of research has evolved over time, the dataset was also divided into four decades: 1986-1995, 1996-2005, 2006-2015, and 2016-2024. Some keywords, such as "economic growth" and "investment", appear consistently across all periods, reflecting their long-standing relevance in public debt studies. However, other terms, like "sovereign risk" and "governance", emerged only in later periods, indicating a shift in scholarly attention toward institutional and policy-related aspects of debt management. Moreover, in the most recent studies, new topics such as "emerging markets," "renewable energy," and "environmental regulation" have started appearing more frequently. This trend suggests a growing interest in the intersection of public debt and sustainable development, likely influenced by global discussions on climate finance, green bonds, and fiscal sustainability. The increasing complexity and diversification of keywords over time highlight how the study of public debt determinants has evolved into a multidisciplinary field, incorporating insights from economics, finance, governance, and sustainability studies. The following sections will further explore citation trends and thematic clusters, providing deeper insights into the academic landscape of public debt research.

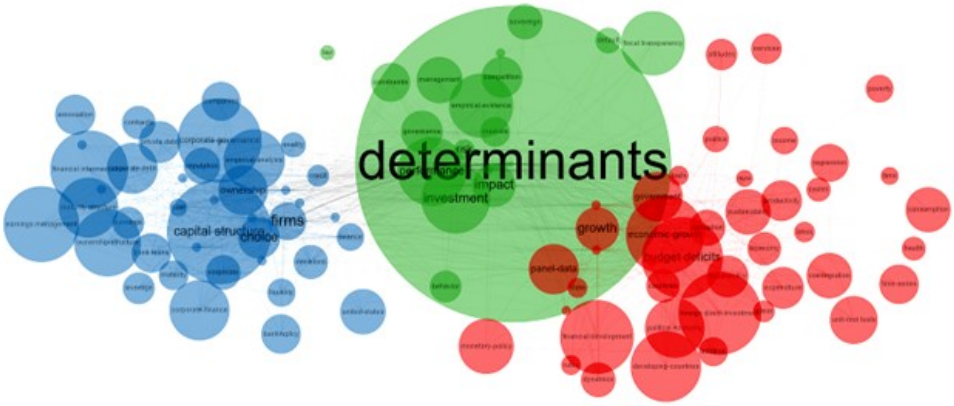

Figure 5: Co-occurrence Network
Source: own processing from Bibliometrix environment

The co-occurrence network above (Figure 5) visualizes the relationships between key terms found in academic publications related to "public debt determinants." The network consists of three main clusters, each representing a different aspect of public debt research.

At the centre of the network, the green cluster, with the dominant node "determinants," represents the general factors influencing public debt. This cluster includes concepts such as investment, performance, risk, and governance, indicating that public debt is analysed not just in economic terms but also through the lens of financial performance and institutional governance.

To the left, the blue cluster focuses on corporate finance and capital structure. Terms like "capital structure," "corporate governance," "ownership," and "firms" suggest that

public debt research overlaps with studies on private sector financial management. The presence of terms related to corporate debt, financial intermediaries, and bank loans indicates that corporate financial decisions play a role in shaping broader debt dynamics.

On the right side, the red cluster highlights macroeconomic factors related to public debt. Nodes such as "budget deficits," "government," "fiscal policy," and "monetary policy" emphasize the role of government policies in determining public debt levels. This cluster also connects to terms such as "inflation," "economic growth," "foreign direct investment," and "developing countries," indicating a strong focus on fiscal sustainability, economic cycles, and global financial flows.

The interconnections between these clusters reveal that public debt determinants are influenced by both private financial structures and macroeconomic policies. The links between the blue and green clusters suggest that corporate finance and governance impact public debt, while the connections between the red and green clusters show that fiscal and monetary policies are critical drivers of debt levels. Additionally, the presence of terms like "corruption," "sustainability," and "political economy" highlights the role of institutional quality in debt accumulation and management.

Overall, this network provides a comprehensive view of how public debt is studied in academic research, showing that it is shaped by government policies, corporate financial structures, investment decisions, and broader economic conditions. The visualization underscores the complexity of debt determinants, illustrating that public debt is not solely a governmental issue but also a reflection of financial market behaviours, economic performance, and institutional frameworks.

Conclusions

This bibliometric analysis provides a comprehensive examination of the research landscape on public debt determinants, uncovering key trends, influential contributors, and evolving thematic areas. Over nearly four decades, academic interest in public debt has steadily increased, reflecting the topic's growing importance in economic and policy discussions. The co-occurrence network analysis identifies three primary research clusters—one focused on macroeconomic and fiscal policy aspects, another on corporate finance and capital structure, and a third on governance, institutional quality, and sustainability—demonstrating the interdisciplinary nature of public debt studies. Emerging themes such as sovereign risk, sustainability, and institutional governance indicate a shift toward a more integrated and policy-oriented approach to public debt research.

The findings underscore the need for a multifaceted perspective on public debt determinants, considering both economic and financial factors alongside institutional and political dynamics. As global economic challenges evolve, research continues to explore new methodologies and interdisciplinary frameworks, emphasizing governance, financial stability, and policy effectiveness. While bibliometric analysis offers valuable insights into research patterns and thematic structures, future studies could enhance understanding by incorporating meta-analytical approaches to synthesize empirical findings and assess causal relationships. Such efforts would improve the comparability and generalizability of existing research, strengthening the foundation for evidence-based policymaking in public debt management.

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Corporate Effective Tax Rate in Slovakia

Zuzana Bobček[1], Alena Andrejovská[2]

Abstract

Effective tax rates are indicators of the actual tax burden on businesses, designed to account for the impact of all legislative measures outlined in legal regulations. This article addresses the issue of effective taxation through effective average tax rates (EATR) and effective marginal tax rates (EMTR), focusing on Slovakia. Effective taxation was analyzed for tangible (buildings, machinery and land) and intangible assets in 2021. The analysis included indicators of the tax depreciation shield, the economic rent of the project with taxation, and the relative tax burden on investment. Depreciation tax shield is the amount of tax savings on capital investment amd the project´s economic rent, with taxation reflecting the magnitude of the project´s financial benefit with an aspect of taxation. In this paper, the 2022 ZEW database is used for analysis. The results showed that machinery, despite achieving the highest tax savings of €17,740 from a €100,000 investment, also had the highest average tax burden among all assets, amounting to 47.12 %. As the most profitable investments in 2021 were considered to be investments in lands (22.79 %), buildings (33.74 %) and intangible assets (37.78 %). The effective marginal tax rate (EMTR) revealed that debt financing allows investors to achieve tax advantages, in contrast to equity financing. For investors, this is the option to optimize their tax burden. In terms of additional investment, the most efficient investments were found to be buildings, machinery, and land. Their tax burden on the additional investment is lower than the tax burden on their total investment.

Keywords: *effective average tax rate, effective marginal tax rate, depreciation tax shield, assets.*

JEL Classification: *H21, H25*

Introduction

The market economy, capital mobility, and the efficiency of corporate taxation are interconnected concepts that significantly influence the decision-making of both investors and government officials regarding investment allocation. Globalization and the digitalization of the economy have brought fundamental changes to the tax systems of EU countries, significantly increasing the geographical mobility of taxes. This development has created a competitive environment among tax systems, raising concerns about the fairness and level of global tax policies. From the perspective of economic efficiency, tax systems should ideally be "neutral," particularly in terms of economic decisions. Differences in corporate taxation between countries may reflect disparities in social security costs, production costs, or preferential treatment for certain types of producers. Therefore, it is

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crucial to monitor effective tax rates, which provide detailed insights into tax bases and offer valuable information not only to investors when deciding on the location and scale of investments but also to policymakers when designing and adjusting tax legislation and the structure of tax systems.

1 Theoretical background

The determination of corporate tax rates plays a significant role in investors' decisions regarding the location of their investments and business activities. The statutory tax rate (STR), set by legislation for all business entities, is considered the most important factor. It is the primary and most accessible information when assessing tax conditions in an economy. However, many authors consider it insufficient. Within the context of statutory tax rates, they are often compared to effective tax rates, which are more significant for corporate taxation and have greater explanatory power Baker and McKenzie, 1999; Barrios et al., 2014; McKenzie et al., 1997. It has been confirmed that the difference between statutory and effective tax rates is substantial, with effective tax rates being significantly lower than statutory rates. This indicates that companies engage in intensive tax planning and shift their profits to jurisdictions with lower tax rates (Saidin et al., 2023). The level of tax rates, which significantly influences tax burden in the form of statutory, effective, and average rates, is essential information not only for investors but also for policymakers and economists (Banociova, 2014). Researchers in the field of taxation therefore focus primarily on effective tax rates, as they provide deeper insights into actual tax liabilities. They are used as a tool to evaluate and compare tax obligations among firms over time. Low effective tax rates (ETR) suggest deliberate tax planning (Drake et al., 2020). According to other studies, it is more important to monitor the overall tax burden, which represents the size of taxation as a proportion of a company's total income/profit in a given country (Gupta and Newberry, 1997 Bird, 2000). The statutory tax rate thus provides only an indicative overview of actual taxation in an economy. On the other hand, the use of effective tax rates or other indicators offers stakeholders more necessary information. Together, they form an essential part of the tax system. Due to globalization and countries' efforts to attract new investors, significant changes have occurred in this area. Corporate tax systems have undergone dramatic changes in recent decades due to declines in both statutory and effective tax rates, as well as significant expansions of tax bases through depreciation (Egger and Raff, 2015, M. P. Devereux et al., 2002). Countries have acted strategically, responding to tax reductions in competing countries, which served primarily to attract foreign investors. To establish effective taxation, several methods and calculation approaches are used, including the backward-looking macro perspective, backward-looking micro perspective, and forward-looking micro perspective. As noted by M. Devereux and Griffith, 1998, Sørensen, 2004, and M. P. Devereux et al., 2008, the use of these methods depends on the data available, the time frame (past/future), and the area under study. All three methods assume that the market for production factors is competitive and that the production function has standard properties. In such cases, decisions on where and how much to invest are influenced not only by the level of capital taxation but also by other production factors (wages, energy, and land). Numerous empirical studies, such as Barrios et al., 2014; M. Devereux and Griffith, 1998; M. P. Devereux and Griffith, 2003; M. P. Devereux et al., 2004; Kubátová and Říhová, 2009; McKenzie et al., 1997; Šimkova, 2016, examine the effects of effective corporate tax rates on companies' economic behavior, including their

location, investment choices, profit shifting, and strategies. Meanwhile, other studies, such as Arnold et al., 2011; Gordon and Slemrod, 1998; Schwellnus and Arnold, 2008; Vartia, 2008 use these rates to address issues of tax competition. Suzuki, 2014, in his study on Asian countries, examined tax holidays as a means of attracting foreign capital and their impact on effective tax rates, which varied depending on the level of capital contribution to individual systems. Tax holidays for typical investments can increase not only the effective average tax rate (EATR) but also the effective marginal tax rate (assuming a 10 % excess profit margin), as some Asian countries have exceptionally generous depreciation policies. In addition to tax holidays, the size of the country and investment tax relief in the form of capital contributions provided by governments are decisive factors. Small countries with nearly zero effective tax rates can attract the most foreign capital. This finding aligns with the simple theoretical model of tax competition, where the optimal behavior of small countries involves "reducing to an absolute minimum" the taxation of income at the source (Gordon, 1986; Zodrow and Mieszkowski, 1986). Larger countries, on the other hand, can maintain relatively high effective tax rates. This is supported by the theory of asymmetric tax competition (Bucovetsky, 1991) and the "new trade theory" (Baldwin and Krugman, 2004; Haufler and Stähler, 2013). The theory of asymmetric tax competition explores differences in capital elasticity between large and small countries, where setting higher tax rates is more balanced. The new trade theory suggests that countries with large domestic markets can maintain higher tax rates. It is important to note that when analyzing tax competition, which is often influenced by the level of effective tax rates, the scale and location of investments must be considered. Analyzing such tax competition remains a challenge for the future.

2 Research methodology

The methodology for calculating the *Effective Average Tax Rate* (EATR) for capital was proposed by King and Fullerton, which was refined and extended by Devereux and Griffith M. Devereux and Griffith, 1998. It is the ratio of the actual pre-tax rate of return required to achieve a zero after-tax economic rent (where the cost of capital is the initial investment) to the actual after-tax rate of return to the shareholder. The main source in calculating the effective average tax rate on capital was the *ZEW Corporate Taxation Database* ZEW, 2022, which provides estimates of effective average tax rates (EATRs) for all European countries and other countries, broken down by asset type and their sources of financing, for the period 1998 to 2021.

The aim of the paper was to analyse and evaluate the efficiency of taxation of selected types of intangible and tangible assets of agricultural enterprises based on the accounting and tax legislation of the Slovak Republic using the construction of the EATR model. The monitoring compares the period of 2004 (Slovakia's accession to the EU) and the year 2021. For assets, two main categories were considered: intangible assets and tangible assets. Among tangible assets, buildings, machinery, and land were analysed. The construction of the EATR model takes into account the discounted value of the product of the variability of tax discrimination and the difference between the revenues and the costs of the project. Revenues are taxed at the required rate of return and accounting depreciation, excluding the impact of inflation. Costs reflect the shareholder discount rate, accounting depreciation, and inflation. Furthermore, they include an expression $(1 - \text{NPV tax depreciation shield})$ that reflects the tax savings from depreciation.

Sources for capital financing were divided into three groups, weighted by OECD (2011) weights compiled from long-run statistical averages of OECD countries: Retained earnings (55%), New equity (10%), Debt (35%).

Input data:

- (r): A real rate of return determined at 5% on the alternative investment.
- (p): A required pre-tax rate of return determined at 20%.
- (π): An inflation rate of 2%.
- (δ): The accounting depreciation rate determined according to ZEW, 2022.
- (τ): Effective statutory tax rate (2021 - 21%).
- (e): The effective property tax rate determined from the statutory property rate (n) of 0.25% less the corporate tax rate (21%). Since the ZEW, 2022 model considers a market value that is not identical in all countries with the acquisition price, it determines a uniform and most optimal base to capture the market value of 0.36%.
- ($\emptyset$): Tax depreciation for tangible assets will be applied in a straight-line or accelerated manner within the meaning of Act No. 595/2003 Coll. on Income Tax. Intangible assets are depreciated under this Act for a maximum period of 5 years up to the amount of their entry price.
- (i): A nominal interest rate that would rise with inflation and with an increase in the real interest rate.
- (ρ): Discounted shareholder rate.
- (γ): The variability of the shareholder's tax discrimination, which reflects the ratio of the funds from a given investment to the funds from an alternative investment. Eliminating the personal income tax at this value sets the value to 1, since the shareholder will not be discriminated against in the decision for the investment but for the option of depositing his funds in the bank.
- (A): The depreciation tax shield is determined by multiplying the net present value by the tax coefficient.
- (F): The net present value of cash flows that arise when an investment is financed respectively by new equity or debt.
- (τ): Tax savings, as depreciation is an expense item that reduces the company's tax base. If the corporate tax rate rises or the nominal interest rate falls, this saving will increase.

$$A = \tau\varphi \left(\left(\frac{1}{1+\rho} \right) + \left(\frac{1}{1+\rho} \right)^2 + \cdots + \left(\frac{1}{1+\rho} \right)^T \right) \tag{10}$$

The Effective Average Tax Rate (EATR) is defined as the ratio of the present value of taxes paid to the net present value of revenue streams, net of the initial cost of investment. The procedure for determining the EATR is to reduce proportionally the economic rent

generated by a given investment as a result of taxation EATR = $\frac{R^*-R}{R^*}$. This procedure does not define the EATR for investment projects that are marginal without taxation, i.e., when $R^* = 0$. A different procedure that tracks the difference between returns relative to the pre-tax net present value of investment return $\frac{p}{1+r}$ has been proposed by Devereux and Griffith M. Devereux and Griffith, 1998. This relationship takes into account the impact of marginal personal effective tax rates on the capital gains accruing to investors from this investment, which reduces the after-tax economic rent.

A variable of the form:

$$\text{EATR} = \frac{R^* - R}{\frac{p}{(1+r)'}} \tag{11}$$

R^* represents the economic rent that accrues from the project net of tax. It interprets the difference between the required pre-tax rate of return and the real interest rate on the next investment. To find the present value of the profit from the project, it is necessary to discount it at the real interest rate.

$$R^* = \frac{p - r}{1 + r} \tag{12}$$

In the assessment, different assets are tracked and the equation is adjusted (reduced or increased) by the individual indicators. Intangible assets and machinery were calculated using the equation in its basic form:

$$R_{1,3} = \frac{\gamma}{1+\rho} \cdot \{[(p+\delta)(1+\pi)(1-\tau)] - [\rho + \delta(1+\pi) - \pi] \cdot (1-A)\} \tag{13}$$

For buildings, equation (13) was reduced by property tax (on buildings: tax rate + (number of floors * floor allowance) * building area) and (on land: tax rate * land area * land value), this tax is a direct cost that will be incurred on this type of asset.

$$R_2 = \frac{\gamma}{1+\rho} \cdot \{[(p+\delta)(1+\pi)(1-\tau)] - [\rho + \delta(1+\pi) - \pi] \cdot (1-A)\} - e \tag{14}$$

For land, book and tax depreciation are removed from equation (14), i.e. $\delta = 0, (1 - A) = 0$ (land is a specific group of non-depreciable assets).

$$R_4 = \frac{\gamma}{1+\rho} \cdot \{[p(1+\pi)(1-\tau)] - [\rho - \pi]\} - e \tag{15}$$

The financing of the investment was made from own resources (retained earnings and new deposits) and from external resources (debt). In the absence of personal taxes $\gamma = 1$, the last indicator will always be zero and the cost of capital for investments financed with new capital and investments financed with retained earnings will be equal. The only difference will be for debt financing. In order to keep the cost of financing as low as possible, companies seek to optimise their capital structure. Corporation tax is a cost of equity financing and often exceeds other costs, e.g. interest, which is a tax deductible item, thereby reducing the tax base, the so-called tax shield. The economic rent of the project with taxation must therefore be increased by the ratio of the discounted value of the difference between the shareholder discount rate and the nominal interest rate and by the interest tax shield. We must not forget the effective property tax rate paid during the period of direct investment activity.

Effective marginal tax rates is defined as the amount of tax arising from the decision of a firm to undertake one more unit of an economic activity. The variable of the form:

$$\text{EMTR} = \frac{\tilde{p} - s}{\tilde{p}} \tag{16}$$

Where s is the post-tax real rate of return from lending:

$$s = \frac{(1 - m^i)i - \pi}{1 + \pi} \tag{17}$$

The general form of the cost of capital is defined as:

$$\tilde{p} = \frac{(1 - A)\left[p + \delta(1 + \pi) - \pi\right] + v\tau\pi + (1 + p)e}{(1 + \pi)(1 - \tau)} - \frac{F(1 + p)}{\gamma(1 + \pi)(1 - \tau)} - \delta \tag{18}$$

The equation for debt financing takes the form:

$$F^{DE} = \frac{\gamma(1 + e)\left(\rho - i + i\tau\right)}{1 + \rho} \tag{19}$$

The equation for financing through a new deposit takes the form:

$$F^{NE} = -\frac{\rho(1 - \gamma)(1 + e)}{1 + \rho} \tag{20}$$

3 Results and discussion

The chapter presents the results of the effective taxation in Slovakia. The result are focus on the development of the statutory and effective corporate tax rate and real estate tax. Furthermore, the chapter includes indicators of the tax depreciation shield, the effective average tax rate, the effective marginal tax rate, and their share.

3.1 EATR, EMTR

The effective corporate tax rate was monitored in 2021,when the base tax rate was 21 %. Table 1 reflects the development since 1991, which is linked to the establishment of the Slovak Republic. Between the years statutory tax rate decrease from 40 % on 21 %. The statutory tax rate and the effective tax rate have developed in the same way since 1998.

Table 1: Evolution of corporate tax rates

Year Period	**Statutory Tax Rate (%)**	**Effective Tax Rate (%)**
1998–1999	40	40
2000–2001	29	29
2002–2003	25	25
2004–2012	19	19
2013	23	23
2014–2016	22	22
2017–2021	21	21

Source: ZEW, 2022

The land tax was determined by multiplying the area of land in m^2 and the corresponding value per $1m^2$. The tax on buildings was determined by the area of the built-up area in m^2 and the tax rate specified in the general binding regulations. ZEW, 2022

calculates the tax on invested capital (real estate) in buildings using the indirect method. Figure 1 shows the development of property tax from 1998 to 2021. Unlike the corporate tax rate, the statutory and effective tax rates differ in amount. However, their development exhibits a uniform pattern. While from 1998 to 2004, the property tax rate was at most 0.11% , from 2005 to 2021, the statutory tax rate reached 0.44%. Throughout the observed period, the effective tax rate remained lower than the statutory tax rate. This suggests that adjustments to the tax base occur in the case of property tax.

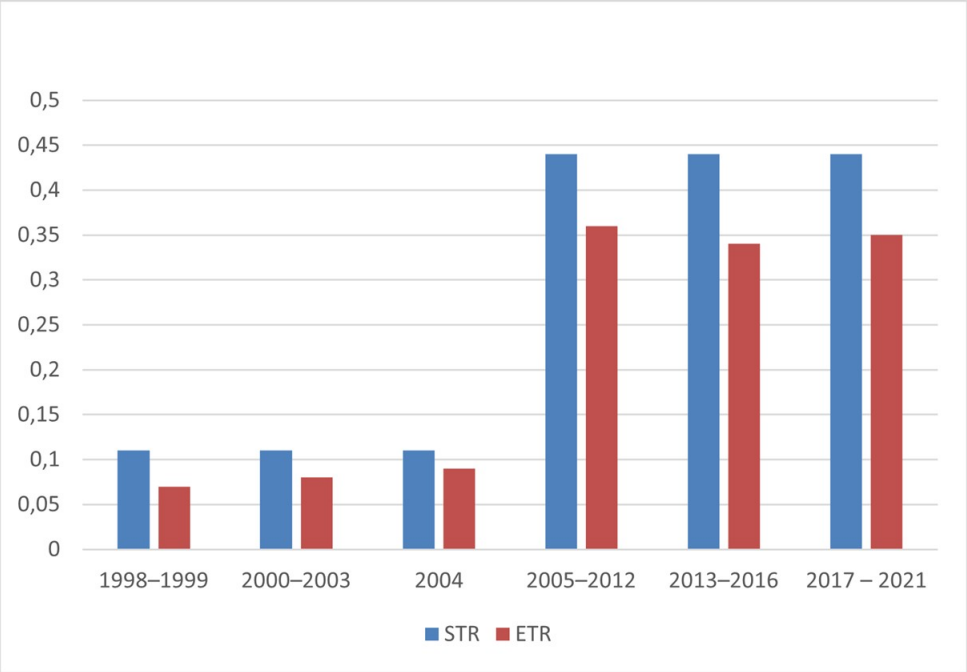

Figure 1: Development of real estate taxes in Slovakia
Source: own based on ZEW, 2022

The analysis identified the effective average rate, effective marginal tax rate, the tax shield - expressing the tax saving and the economic rent of the project with taxation, which means the financial benefit of the project. Table 2.

The highest annual tax savings were achieved in 2021 for machinery. With an investment of €100,000, the investor saves an estimated €17,740 per year in taxes. The second highest savings achieved from investment in intangible assets, which estimated €17,170 per year in taxes. On the other hand, the lowest tax savings comes from buildings. One of reasons may be their long depreciation period (40 years). Other reason may be the least possibility to reduce the tax base through tax depreciation. The annual average tax saving from analysed assets would be €15,313.33. Depreciation tax shield values are not provide for lands, because it is exempt from depreciation under legislation.

Another indicator tracked as part of the EATR is the project's economic rent with taxation, which captures the magnitude of the project's financial benefit with an aspect on taxation. The highest value of the indicator (R) belongs to the lowest level of the EATR. When investor decided to invest in lands and buildings comes out as the most profitable investment. Investing in land can yield up to €9,960 with the lowest achieved tax rate of 22.79 % at financing form as retained earnings and new equity. In the debt financing investor in 2021 can yield €11,420 with 24.18 % effective average tax rate. On the other hand the second option for investors are buildings. Buildings, with their long

Table 2: Results

Assets	Rate of tax depreciation	Rate of accounting depreciation	Depreciation tax shield (A)
		2021	
Intangible assets	20%	15.35%	0.1717
Buildings	5%	3.1%	0.1103
Machinery	25%	17.5%	0.1774
Lands	–	–	–
		Economic rent of the project including taxes (R)	
Assets	**Retained earnings**	**New equity**	**Debt**
Intangible assets	0.0709	0.0709	0.0849
Buildings	0.0786	0.0786	0.0939
Machinery	0.0558	0.0558	0.0698
Lands	0.0996	0.0996	0.1142
		EATR (%)	
Assets	**Retained earnings**	**New equity**	**Debt**
Intangible assets	37.78	37.78	39.17
Buildings	33.74	33.74	35.18
Machinery	45.73	45.73	47.12
Lands	22.79	22.79	24.18
		EMTR (%)	
Assets	**Retained earnings**	**New equity**	**Debt**
Intangible assets	13.57	13.57	-27.08
Buildings	15.73	15.73	-22.45
Machinery	13.65	13.65	-26.89
Lands	24.11	24.11	-5.52
		EATR / EMTR (%)	
Assets	**Retained earnings**	**New equity**	**Debt**
Intangible assets	1.88	1.88	11.54
Buildings	19.44	19.44	12.13
Machinery	18.87	18.87	11.44
Lands	22.03	22.03	14.72

Source: Own processing

depreciation period, have their effective average tax rate on 33.74 % in self-financing form and project can yield €7,860. From the view as the investor the loss-making project is investment in machinery. In financing form as retained earnings and new equity the project´s financial benefit with an aspect on taxation is €5,580. The average effective tax rate is from 45.73 % to 47.12 %, which is from all analysed assets the highest.

The effective marginal tax rate (EMTR) determines the actual tax burden on an additional investment after accounting for taxes. The results indicate that financing through retained earnings and new equity is equally tax-disadvantageous. The negative results for debt financing suggest that debt financing provides tax benefits for investors, likely due to the tax shield from interest deductibility. From an asset perspective, land is the most heavily taxed asset, with an EMTR of 24.11 %. This may be related to the fact that, unlike other assets, land is not subject to depreciation. The other analyzed asset categories show very similar tax burdens on additional investments after accounting for taxes. From a financing perspective, debt financing is considered the most advantageous option. The negative values for individual assets indicate that capital benefits from tax advantages, making debt financing more attractive in terms of tax efficiency.

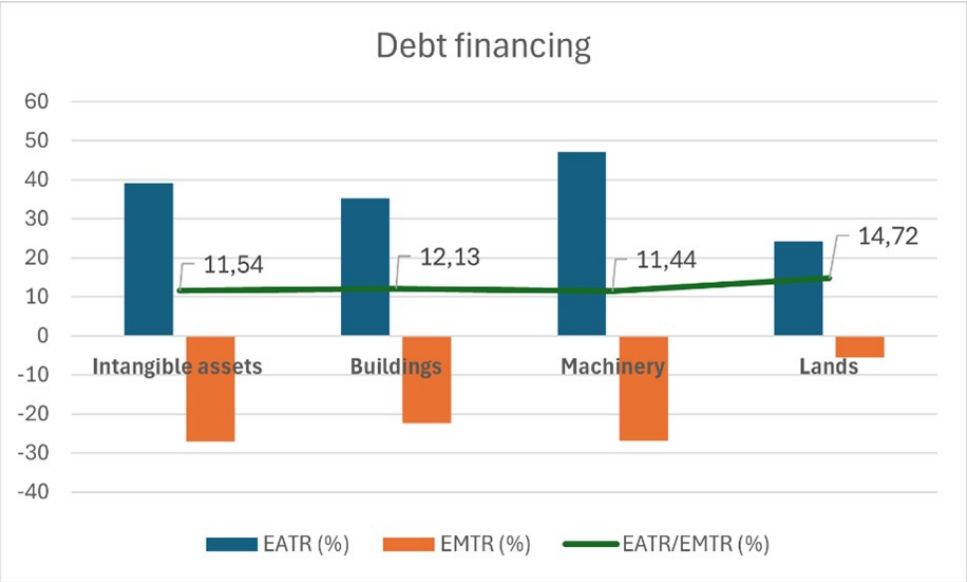

Figure 2: Results of effective tax rates in debt financing
Source: own calculation

The last indicator, EATR/EMTR, expresses the relative tax burden on the total investment compared to the additional (marginal) investment. The asset with the lowest ratio is intangible assets. The result for intangible assets indicates that additional investments are taxed in the same way as the initial (i.e., total) investment. This ratio is at the level of 1.88 %. In the case of debt financing, this relative tax burden increases to 11.54 %. For equity financing, intangible assets have the lowest tax burden. On the other hand, the highest total tax burden compared to the marginal tax burden is observed in land. For assets such as buildings, machinery, and land, the indicator is lower in debt financing compared to equity financing. This may suggest that an additional investment in an asset financed through debt is more advantageous for the investor than the total investment. This was particularly evident for intangible assets (11.54 %) and machinery (11.44 %). It follows that debt financing is more tax-efficient than equity financing when investing in assets. The most heavily taxed assets are lands, while intangible assets are taxed the least. Companies have a strong incentive to finance investments through debt, as this reduces their effective tax burden. Figure 2

3.2 Discussion

The effective rates that evaluated the location of the amount of investment used take into account the economic conditions associated with the cost of capital, the amount of accounting and tax depreciation, the rate of inflation and the nominal interest rate (the so-called discounted shareholder rate). In the presence of taxes, the return on investment varies and ensuring optimality requires the same return from different types of investment at a given margin. It is these rates that will reflect the most optimal and efficient conditions on which investors make their decisions. Cozmei, 2015 assesses that the effects of globalization have a significant impact on a wide range of national policies, including economic and tax policies. He argues that one manifestation is the competition among countries to lower corporate tax rates in order to attract more foreign capital investment, which in turn threatens the collection of corporate income taxes. The author further states that based on her findings, it has not been confirmed that downward pressure on

corporate tax rates has been reflected in a decline in corporate revenues over time. M. P. Devereux, 2007; M. P. Devereux et al., 2004; Feld and Heckemeyer, 2011 find that differences in tax rates clearly affect the location of investments. The tax rate (both effective average and marginal) and the legal tax base will be the decisive factors on the basis of which future investors decide on the amount and location of investment. In other words, investors do not control for tax revenues that vary endogenously with output fluctuations and changes in the tax base due to other factors; rates are decisive. That an increase in corporate tax rates leads to an increase in negative consequences through lower investment and thus a reduction in returns to factors of production other than capital has in turn been confirmed by Arulampalam et al., 2012; Dwenger et al., 2013; Feldstein, 1974. The authors further note that while small countries with a small share of domestic markets set their effective tax rates to near zero, large countries maintain much higher effective tax rates. In developed countries with high capital income, various tax breaks, allowances and holidays can lead not only to an increase in EMTR but also to an increase in EATR Mendoza et al., 1994. Šimkova, 2016, in her analysis that followed the construction of the EATR for Slovak conditions, states that the determination of the tax rate is a rather complex process of finding a trade-off. From the perspective of the state, the objective is to maximise tax revenue, given that it constitutes a significant component of the state budget. Conversely, from the standpoint of business and consumers, taxes are perceived as a necessary burden. The principle of corporate taxation means that profits are immediately taxed at the shareholder level (the shareholders' tax rate is used as the tax rate for investment profits). Since the taxation of capital gains is limited to each asset, the taxation of capital gains on shares cannot be considered. There are many empirical researches and studies that deal with efficient corporate taxation. Arachi and Biagi, 2005 investigated the impact and effect of differences in effective rates on investment decisions when investing capital in European countries. Alvarez and Koskela, 2005; Gries et al., 2012 studied the impact of taxation on investment under uncertainty in a theoretical framework. M. P. Devereux et al., 2002; Stickney and McGee, 1982 find that, with different forms of EATR tracking, capital can be financed by different types including the use of debt. All of these outputs have highlighted the importance of tracking effective taxation and its necessity for the decision making of foreign investors.

Conclusions

By analyzing the construction and describing the model of the Effective Average Tax Rate (EATR) and Effective Marginal Tax Rate (EMTR) on capital, the study examined how changes in the statutory tax rate (and other taxes) and additional factors contributed to the variation in the effective tax rate. An important aspect was also the method of financing, whether through internal or external sources. The analysis included a tax depreciation shield to determine the amount of tax savings from capital investments. The highest annual tax savings were achieved in 2021 for machinery, representing an annual saving of €17,740, with a payback period of four years, where the depreciation period played a significant role. The Effective Average Tax Rate (EATR) also included an economic rent indicator of the project with taxation, expressing the financial benefit of the project in relation to taxation. The analysis showed that land had the lowest value during the observed period under both financing methods. The effective average tax rate ranged from 22.79 % to 24.18 %. In terms of investment, this would represent the most efficient capital investment. On the other hand, a negative investment decision would be

made by an investor in the case of machinery, where the effective tax rate reached up to 47.12 %. Another observed indicator was the Effective Marginal Tax Rate (EMTR). This indicator demonstrated that, in terms of financing methods, equity investment (retained earnings, new equity contributions) was considered less efficient. The analysis confirmed that in 2021, debt financing provided tax advantages upon implementation. The results indicate that land had the most unfavorable conditions for additional investment, with an additional tax burden of up to 24.11 %. In contrast, for assets such as buildings, intangible assets, and machinery, the findings confirmed that additional investments provided tax benefits to investors, as evidenced by the negative values in debt financing. Finally, the tax burden was analyzed by comparing total and additional investments. The results showed that intangible assets had identical values for both total and additional investments. Under debt financing, the indicator level increased from 1.88 % to 11.54 %. For other assets, the findings confirmed that additional investment was more beneficial for investors compared to total investment. Further differences were observed across various financing methods. Debt financing demonstrated that its use for additional investment could be more tax-efficient for investors. As a result, companies have a strong incentive to finance investments through debt, given that it helps them optimize their tax burden.

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Analysis of Differences in Corporate Tax Rates in the EU Countries, Using Stochastic Dominance Analysis

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Abstract

The aim of this article is to analyze the differences in corporate tax rates among the member states of the European Union and assess whether there is evidence of tax harmonization between Eastern and Western Europe. Given the systematically lower tax rates in Eastern countries, it is essential to understand the degree of their convergence or divergence relative to Western countries to evaluate the impact of fiscal policies on investment attractiveness and market competitiveness. To achieve this objective, the study employs Stochastic Dominance Analysis (SDA), a non-parametric method that compares empirical cumulative distribution functions (ECDF) of nominal and effective tax rates in two predefined groups: Western Europe (e.g., Germany, France, the Netherlands, Spain) and Eastern Europe (e.g., Slovakia, the Czech Republic, Poland, Hungary). The analysis is based on corporate tax rate data for the period 2004–2022, sourced from official statistical databases. SDA enables the identification of whether one group systematically exhibits lower tax rates than the other, thereby revealing potential patterns of tax competition and differences in corporate tax burdens. The results indicate that Eastern Europe exhibits a higher probability of lower nominal and effective tax rates compared to Western Europe, suggesting first-order stochastic dominance. This difference is a consequence of distinct tax policies, with Eastern European countries actively using lower tax rates as a tool to attract foreign direct investment (FDI). These findings confirm the persistence of tax competition within the EU, which may have long-term implications for fiscal stability and investment allocation. The study contributes to the broader discussion on corporate taxation policy and provides empirical insights for policymakers considering how to balance tax competitiveness and fair taxation within the EU single market.

Keywords: *nominal tax rates, tax harmonization, effective tax rates*

JEL Classification: *H25, H71, F38, O521*

Introduction

Tax harmonization within the European Union is one of the most debated topics in economic policy, particularly concerning corporate income taxation. Differences in tax systems among member states significantly impact business competitiveness, investment allocation, and the fiscal stability of individual countries. While some EU states maintain high tax rates combined with incentives and exemptions, others seek to attract capital by offering lower nominal tax rates. This diversity raises the question of whether tax

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systems are gradually converging or whether tax competition persists, leading to varying conditions within the single market.

This study examines the tax burden in Eastern and Western European countries by analyzing differences in nominal and effective corporate tax rates over the period 2004–2022. It applies stochastic dominance analysis to compare the empirical cumulative distribution functions of tax rates in both regions. This approach offers insights into whether the differences between Eastern and Western Europe have been narrowing over time or if they persist, which is relevant from the perspective of EU fiscal policy and the investment environment.

1 Theoretical background

Corporate tax rates are a key instrument through which governments shape economic conditions and influence growth. They are typically divided into nominal and effective rates, each playing a distinct role in tax policy and investment decisions. While nominal tax rates represent the legally set percentage of corporate income tax, effective tax rates (ETR) provide a more accurate picture of the actual tax burden by factoring in deductions, reliefs, and incentives. Research by Devereux et al., 2008a highlights how countries adjust corporate tax rates to attract investment, fueling discussions on tax harmonization. Meanwhile, studies by Dabla-Norris and Lima, 2023 reinforce the link between tax rates, revenues, and economic growth, contrasting earlier findings by Easterly and Rebelo, 1993, who questioned this relationship.

The gap between nominal and effective tax rates significantly impacts a country's tax competitiveness and its ability to attract foreign investment. Many nations strategically maintain relatively high nominal rates while offering tax incentives that reduce the effective burden. This approach allows them to appear fiscally responsible while remaining attractive to investors. Studies by Gupta and Newberry, 1997; Lietz, 2013, and Wilde and Wilson, 2018 emphasize that effective taxation is a crucial factor in corporate decision-making. Additionally, Arnold et al., 2011 demonstrated that higher corporate tax rates, despite generating more revenue, can slow economic growth, underscoring the delicate balance between taxation, competitiveness, and fiscal policy.

2 Research methodology

In this study, we applied stochastic dominance analysis (SDA) to compare nominal and effective tax rates (ETR) between Eastern and Western European Union countries over the period 2004–2022. The analysis is based on data from Eurostat and the OECD, covering all EU member states during this period. We formulated hypotheses regarding whether Eastern European countries systematically maintain lower tax rates than their Western counterparts and whether these differences have been narrowing over time.

SDA is a statistical method that enables the comparison of distributions between two data sets without requiring assumptions about their shape, making it particularly suitable for analyzing corporate tax rates, which may not follow a normal distribution. We chose this method because it provides a robust way to assess whether one group of countries consistently has lower tax rates than the other, rather than relying on simple averages or regression-based approaches that might overlook distributional differences.

First-degree stochastic dominance (FSD) occurs when the empirical cumulative distribution function (ECDF) of one group is always below the ECDF of another group. In such a case, one distribution is said to dominate the other, indicating systematic differences in tax rates between the groups of countries. By applying this method, we can determine whether the observed differences in tax rates are persistent and significant, which has important implications for tax competition, fiscal policy, and investment attractiveness within the EU.

The empirical cumulative distribution function (ECDF) is defined as:

$$F_n(x) = \frac{1}{n} \sum_{i=1}^{\infty} \mathbf{1}(X_i \leq x) \tag{21}$$

where:
$Fn(x)$ represents the ECDF,
n is the total number of observations
X_i are the observed values in the sample
$I(X_i \leq x)$ is an indicator function that takes the value 1 if $X_i \leq x$ and 0 otherwise.

This function represents the proportion of observations in the sample that are less than or equal to a given value xxx, allowing for a non-parametric comparison of tax rate distributions across different country groups

3 Results and Discussion

The results reveal significant differences and trends in the tax policies of the analyzed countries, highlighting the factors that influence their development. In this study, we analyze both nominal and effective corporate tax rates (ETR) across EU countries, tracking their development over time from 2004 to 2022 using data from Eurostat. By examining these tax rates over nearly two decades, we identify trends, fluctuations, and differences between Eastern and Western European countries. The analysis provides insight into the dynamics of nominal and effective tax rates and their relationship with the economic environment. The discussion focuses on interpreting these findings and assessing their impact on market competition, investment decisions, and the potential future of tax harmonization in the EU. It also considers broader macroeconomic contexts and possible scenarios for future developments.

3.1 Development of tax rates in EU countries (2004-2022)

Nominal tax rates

Despite ongoing efforts to harmonize tax systems within the European Union, tax competition among member states remains significant, as reflected in the considerable variation in corporate tax rates (Figure 1). Among the V4 countries, Poland stands out as the only nation that has maintained a stable nominal tax rate throughout the entire observed period. Alongside Poland, Malta and Ireland also refrained from modifying their tax rates. Of these three, Malta has the highest rate, while Ireland has consistently kept its corporate tax at 12.5 %, and Poland at 19 %, despite long-standing government discussions about reducing it to 15 %. Other countries that have demonstrated stability in their tax policies include Austria, which has maintained a 25 % rate since 2005, and Romania, which set its tax rate at 16 % in the same year.

Country/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Austria	34	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Belgium	34	34	34	34	34	34	34	34	34	34	34	34	34	34	30	30	25	25	25
Bulgaria	20	15	15	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Cyprus	10	10	10	10	10	10	10	10	10	13	13	13	13	13	13	13	13	13	13
Czechia	28	26	24	24	21	20	19	19	19	19	19	19	19	19	19	19	19	19	19
Denmark	30	28	28	25	25	25	25	25	25	25	25	24	22	22	22	22	22	22	22
Estonia	26	24	23	22	21	21	21	21	21	21	21	20	20	20	20	20	20	20	20
Finland	29	26	26	26	26	26	26	26	25	25	20	20	20	20	20	20	20	20	20
France	35	35	34	34	34	34	34	36	36	38	38	38	34	44	34	34	32	28	26
Germany	38	38	38	38	29	29	30	30	30	30	30	30	30	30	30	30	30	30	30
Greece	35	32	29	25	35	35	24	20	20	26	26	29	29	29	29	28	24	24	22
Hungary	18	18	18	21	21	21	21	21	21	21	21	21	21	11	11	11	11	11	11
Ireland	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Italy	37	37	37	37	31	31	31	31	31	31	31	31	31	28	28	28	28	28	28
Latvia	15	15	15	15	15	15	15	15	15	15	15	15	15	15	20	20	20	20	20
Lithuania	15	15	19	18	15	20	15	15	15	15	15	15	15	15	15	15	15	15	15
Luxembourg	30	30	30	30	30	29	29	29	29	29	29	29	29	27	26	25	25	25	25
Malta	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Netherlands	35	32	30	26	26	26	26	25	25	25	25	25	25	25	25	25	25	25	26
Poland	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Portugal	28	28	28	27	27	27	29	29	32	32	32	30	30	30	32	32	32	32	32
Romania	25	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Slovakia	19	19	19	19	19	19	19	19	19	23	22	22	22	21	21	21	21	21	21
Slovenia	25	25	25	23	22	21	20	20	18	17	17	17	17	19	19	19	19	19	19
Spain	35	35	35	33	30	30	30	30	30	30	30	28	25	25	25	25	25	25	25
Sweden	28	28	28	28	28	26	26	26	26	22	22	22	22	22	22	21	21	21	21

Figure 1: Nominal corporate tax rates in %
Source: Eurostat (own processing)

Hungary currently holds the lowest nominal corporate tax rate in the EU, having reduced its rate from 19 % to 9 % in 2017 to create a more attractive business environment and encourage foreign investment. Similarly, Bulgaria has maintained a low tax rate of 10 % since 2007 without any subsequent changes. Cyprus, another country with a relatively low tax burden, kept its corporate tax rate at 10 % until 2012, when it was raised to 12.5 % in 2013. Notably, Cyprus has become a hub for many businesses engaging in tax base optimization across the EU due to its favorable tax policies.

On the other end of the spectrum, France recorded the highest nominal tax rate in the EU during the observed period, peaking at 44.4 % in 2017. Other major Western European economies, including Germany, Italy, and Spain, have traditionally maintained corporate tax rates around 30 %, though these rates have gradually decreased over time. The most significant fluctuations in corporate tax rates were observed in Greece, where the rate was 35 % in 2004, subsequently lowered to 20 %, later increased to 29 %, and stood at 24 % in 2022.

Overall, the average nominal corporate tax rate across the EU declined from 26.73 % in 2004 to 21.35 % in 2022 (Figure 2), reflecting a broader trend among national governments to enhance economic competitiveness and attract foreign investment through tax reductions.

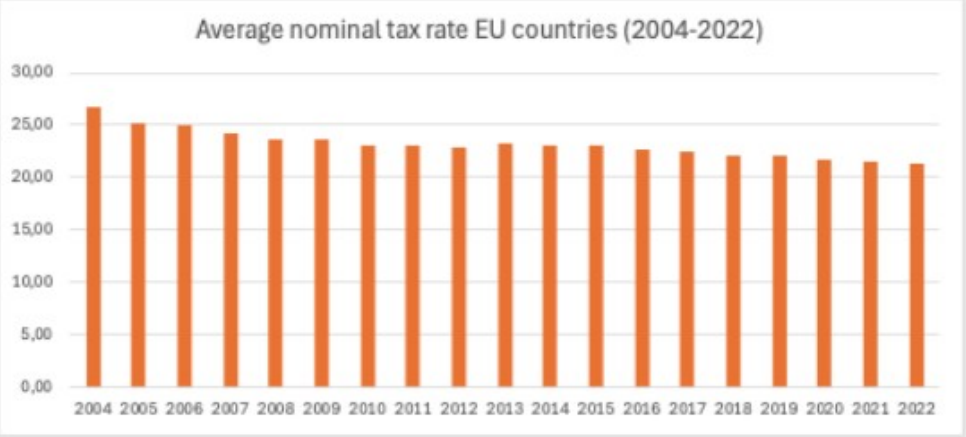

Figure 2: Development of the average nominal corporate tax rate in EU countries (2004-2022)

Source: Eurostat (own processing)

Effective tax rates

Effective corporate tax rates (ETRs) across EU countries exhibited significant variation throughout the observed period (Figure 3). The most notable fluctuation was recorded in Greece, where the difference between the highest ETR of 30.5 % in 2009 and the lowest rate of 17.5 % in 2011–2012 amounted to a substantial 13 percentage points. Another considerable change occurred in the Netherlands, where the effective tax rate dropped by 9.4 percentage points between 2004 and 2022. As of 2022, the effective tax rate in the Netherlands remains 2.5 percentage points lower than its nominal rate, demonstrating the impact of tax deductions and reliefs available to businesses. Conversely, some countries maintained relatively stable effective tax rates. Ireland is among the most consistent in this regard, with only a minor fluctuation of 0.3 percentage points throughout the entire period. Similarly, Poland experienced limited changes, with its effective tax rate ranging between 17.1 % and 17.5 %, indicating a stable tax environment for businesses. These cases suggest that certain economies prioritize predictability in their tax policies, potentially to foster long-term investor confidence. Belgium saw its lowest effective tax rate of 8.8 % in 2008 and 2009, while France recorded the highest ETR in the EU during the period, reaching 38.3 % in 2016. Such disparities reflect the diverse tax policies across the union, shaped by different economic strategies and fiscal priorities. Countries such as Bulgaria, Hungary, Cyprus, Estonia, and Latvia consistently maintained some of the lowest effective tax rates, with Bulgaria's rate remaining at 8.8 % from 2007 to 2010.

Country/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Austria	31,2	23,0	23,0	23,0	22,7	22,7	22,7	23,0	23,0	23,0	23,0	23,0	23,1	23,1	23,1	23,1	23,1	23,1	23,1
Belgium	29,5	29,5	25,7	25,4	24,9	24,7	25,3	25,9	26,3	26,5	26,7	27,8	28,3	29,3	24,9	25,0	23,2	23,2	23,1
Bulgaria	17,1	13,2	13,2	8,8	8,9	8,8	8,8	9,0	9,0	9,0	9,0	9,0	9,0	9,0	9,0	9,0	9,0	9,0	9,0
Cyprus	14,8	10,6	10,6	10,6	10,6	10,6	11,6	11,6	11,9	15,2	15,2	12,7	13,1	12,5	13,0	13,4	13,3	13,4	13,3
Czechia	24,6	22,7	21,0	21,0	18,4	17,5	16,7	16,7	16,7	16,7	16,7	16,7	16,7	16,7	16,7	16,7	16,7	17,0	17,0
Denmark	26,8	25,1	25,1	22,5	22,6	22,6	22,6	22,6	22,0	22,0	22,2	21,3	20,0	20,1	19,8	19,8	19,8	19,8	19,8
Estonia	20,4	18,8	18,1	17,3	16,5	16,5	16,5	16,5	16,5	16,5	16,5	15,7	15,7	15,7	15,7	13,9	12,1	10,2	10,2
Finland	27,2	24,5	24,5	24,5	24,5	23,6	23,9	24,7	23,3	22,6	18,6	18,9	19,1	19,5	19,6	19,6	19,6	19,6	19,6
France	35,0	34,8	34,4	34,4	34,6	34,7	32,8	32,8	34,2	34,7	38,3	38,3	38,4	33,4	33,4	33,5	31,5	28,1	26,0
Germany	35,5	35,5	35,5	35,5	28,2	28,0	28,0	28,2	28,2	28,2	28,2	28,2	28,2	28,8	28,9	28,9	28,9	28,9	28,8
Greece	30,4	27,8	25,2	21,7	21,8	30,5	21,0	17,5	17,5	24,1	24,5	27,5	27,6	27,6	27,6	22,9	22,9	21,1	21,1
Hungary	17,7	17,7	17,7	17,7	17,7	19,5	19,1	19,3	19,3	19,3	19,3	19,3	19,3	11,1	11,1	11,1	11,1	11,1	11,1
Ireland	14,3	14,3	14,4	14,4	14,4	14,4	14,4	14,4	14,4	14,4	14,4	14,1	14,1	14,1	14,1	14,1	14,1	14,1	14,1
Italy	31,8	31,8	31,8	31,8	27,3	27,5	27,5	24,9	25,1	25,1	24,2	23,8	23,6	23,7	23,8	23,8	23,9	23,9	23,9
Latvia	14,3	14,3	14,3	14,3	13,8	13,8	11,8	12,2	12,4	12,1	14,3	14,3	14,3	14,3	16,7	16,7	16,7	16,7	16,7
Lithuania	12,7	12,7	16,0	15,2	12,7	16,8	12,7	12,7	12,7	13,6	13,6	13,6	13,6	13,6	13,6	12,7	12,7	12,7	12,7
Luxembourg	26,5	26,5	25,9	25,9	25,0	25,0	25,0	24,9	24,9	25,5	25,5	25,5	25,5	23,7	22,8	21,8	21,8	21,8	21,8
Malta	32,2	32,2	32,2	32,2	32,2	32,2	32,2	32,2	32,2	32,2	32,2	32,2	32,2	24,3	24,4	25,3	25,1	25,2	23,3
Netherlands	31,9	28,4	26,7	23,1	23,1	22,2	22,2	21,8	22,6	21,6	22,6	22,5	22,5	22,5	22,5	22,5	22,5	22,5	23,2
Poland	17,1	17,1	17,1	17,4	17,4	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	16,0	16,0	16,8	15,9
Portugal	24,6	24,6	24,6	23,7	23,7	23,7	26,2	26,2	28,4	28,4	28,4	26,6	26,6	20,0	21,4	21,4	21,4	21,4	21,4
Romania	22,4	14,7	14,7	14,8	14,8	14,8	14,8	14,8	14,8	14,8	14,8	14,8	14,7	14,7	14,7	14,7	14,7	14,7	14,7
Slovakia	16,5	16,8	16,8	16,8	16,8	16,8	16,8	16,8	16,8	20,3	19,4	19,6	19,6	18,7	18,7	18,7	18,7	18,7	18,7
Slovenia	21,5	22,1	22,3	20,9	20,0	19,1	18,2	18,2	16,4	15,5	15,5	15,5	15,5	17,3	17,3	17,3	17,3	17,3	17,3
Spain	36,5	36,5	36,5	34,5	32,8	32,8	32,8	31,9	32,4	32,9	32,6	31,5	29,0	29,0	29,0	29,0	29,0	29,0	29,0
Sweden	23,1	24,6	24,6	24,6	24,6	23,2	23,2	23,2	23,2	19,4	19,4	19,4	19,4	19,4	19,4	19,4	19,4	18,7	18,7

Figure 3: Effective corporate tax rates in %
Source: Eurostat (own processing)

Similar to the trend in nominal corporate tax rates, effective tax rates also exhibited a steady decline over the years (Fig. 2). The EU-wide average effective tax rate fell from 24.45 % in 2004 to 18.98 % in 2022, signaling a broader trend among European economies to reduce not just statutory tax burdens but also the actual tax obligations of businesses in an effort to attract foreign investment.

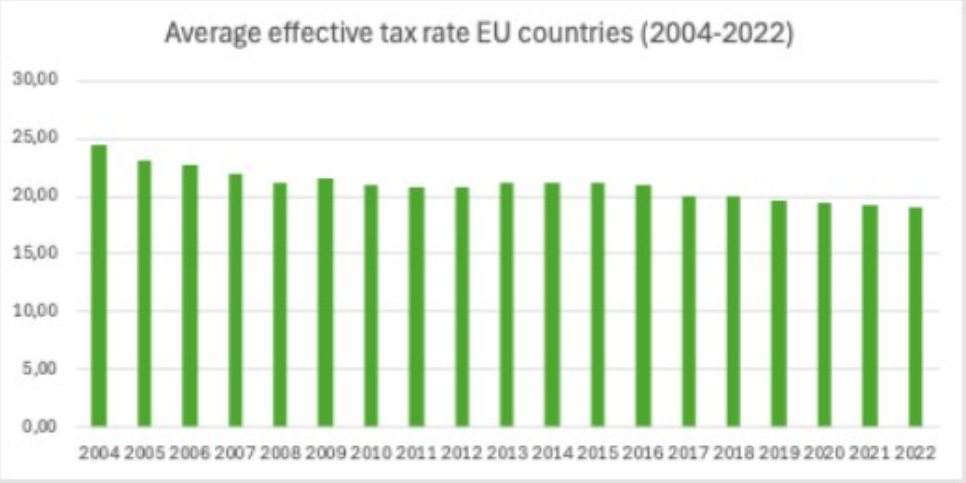

Figure 4: Development of the average effective corporate tax rate in EU countries (2004-2022)

Source: Eurostat (own processing)

3.2 Results

The stochastic dominance analysis (SDA) shows that the empirical cumulative distribution function (ECDF) of Eastern countries is positioned above the ECDF of Western countries. This indicates that Eastern countries have a higher probability of exhibiting lower tax rates compared to Western countries.

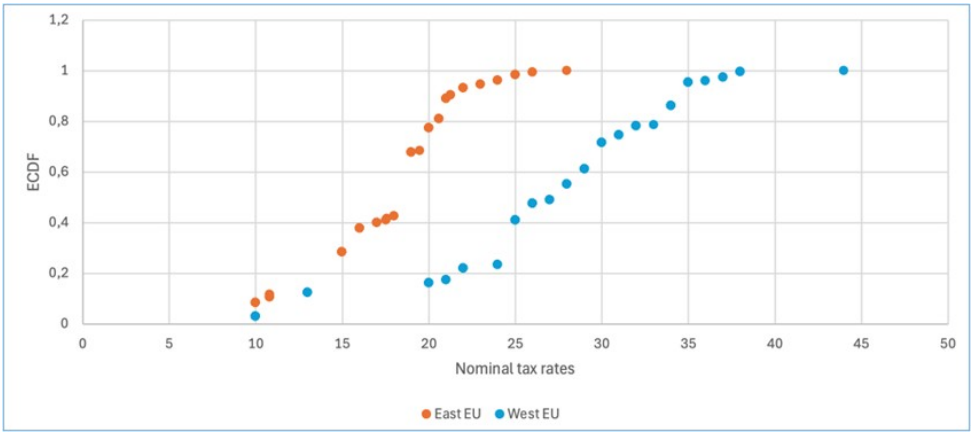

Figure 5: SDA – Nominal tax rates
Source: own based on Eurostat (2025)

The results of the SDA analysis for nominal tax rates (Figure 5) indicate that Eastern European countries systematically apply lower nominal corporate tax rates than their Western counterparts. The empirical cumulative distribution function (ECDF) curve for Eastern countries is positioned above that of Western countries, signifying a higher probability of lower nominal tax rates in Eastern Europe.

This trend is particularly evident in countries such as Bulgaria, Hungary, and Romania, where nominal corporate tax rates have remained consistently low throughout the analyzed period. These countries have implemented competitive tax policies aimed at attracting foreign investment and stimulating economic growth, contributing to their consistently lower tax burden.

In contrast, Western European countries, including France and Belgium, have maintained significantly higher nominal tax rates. These countries typically pursue fiscal policies that emphasize social welfare and public spending, resulting in a higher corporate tax burden compared to their Eastern European counterparts.

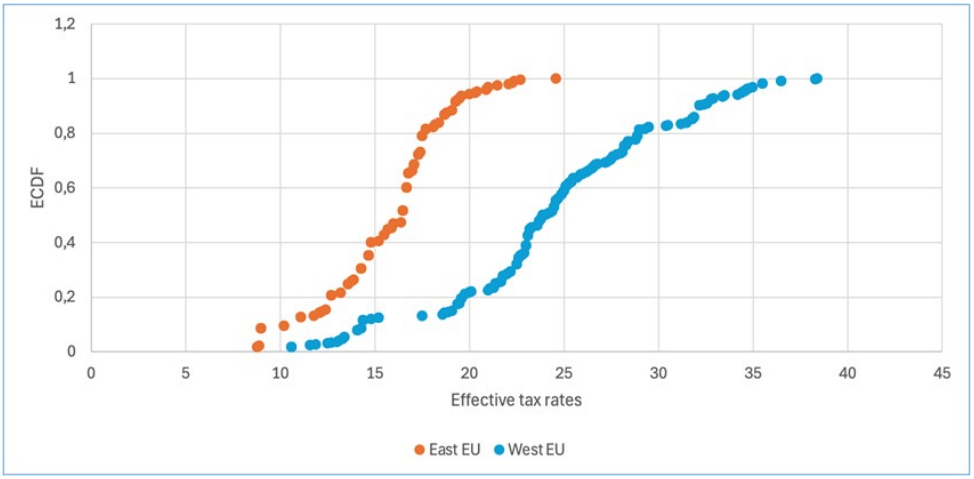

Figure 6: SDA – Effective tax rates
Source: own based on Eurostat (2025)

A similar pattern is observed when analyzing effective tax rates (ETR). The results of the SDA analysis (Figure 6) indicate that Eastern European countries have a higher probability of exhibiting lower effective tax rates, reinforcing the finding that the actual tax burden on businesses is generally lower in this region. This suggests that not only are statutory rates lower in the East, but the actual amount of tax paid relative to corporate profits remains consistently lower as well.

However, the gap between nominal and effective tax rates is more pronounced in Western European countries. While Western nations tend to impose higher statutory tax rates, many large corporations benefit from various deductions, exemptions, and preferential tax regimes that significantly reduce their actual tax liability. This results in a noticeable divergence between the officially declared rates and the taxes effectively paid by businesses.

This contrast highlights the greater use of tax incentives and optimization strategies in Western Europe. Multinational corporations operating in high-tax jurisdictions often engage in tax planning strategies that allow them to minimize their effective tax rates, sometimes even achieving tax burdens comparable to or lower than those in Eastern European countries despite higher nominal rates.

3.3 Discussion

Our findings suggest that Eastern European countries have long employed lower nominal tax rates as a tool to attract investment and foster a more business-friendly environment. This trend is characteristic of transitional economies aiming to enhance their economic competitiveness and integrate into global markets. In contrast, Western European countries tend to maintain higher nominal tax rates, which are associated with greater public expenditures, more extensive welfare systems and a relatively stable tax structure. This distinction between the two regions aligns with findings from previous studies, such as those by Feld and Heckemeyer, 2011 and Devereux et al., 2008b, which also highlight the role of tax competition in shaping corporate tax policies across Europe.

Regarding effective tax rates, our results indicate that the gap between nominal and effective rates is more pronounced in Western European countries. This is likely due to the more widespread use of tax reliefs, deductions, and preferential regimes aimed at reducing

the actual tax burden on corporations. Studies by Egger et al., 2014 and Overesch and Rincke, 2011 support this observation, emphasizing how multinational firms in high-tax Western countries strategically engage in tax planning to lower their effective tax rates. In contrast, Eastern European countries not only impose lower nominal rates but also exhibit lower effective tax rates, suggesting a deliberate policy choice to enhance competitiveness by maintaining a more favorable tax environment.

Comparing our findings to previous research, we observe a consistent trend where Eastern European countries continue to rely on lower tax burdens as an economic strategy, while Western countries balance high statutory rates with tax incentives that benefit large corporations. However, studies such as Buettner and Wamser, 2013 indicate that tax rate differentials across Europe have been narrowing in recent years, particularly as some Eastern European countries begin to align their tax policies with EU regulations. This raises the question of whether the observed patterns will persist in the long term or if further convergence in tax policies will take place across the EU.

Conclusions

The results of the stochastic dominance analysis (SDA) indicate that Eastern EU countries have a higher probability of exhibiting lower nominal and effective tax rates compared to their Western counterparts. This suggests that tax policies in Eastern Europe have been designed to maintain a competitive advantage by offering lower corporate tax rates, which serve as an incentive for foreign investment and economic growth. The persistence of this trend highlights the role of tax policy as a strategic tool for economic development in transitional economies.

In contrast, Western European countries tend to impose higher nominal tax rates, reflecting their larger public expenditures and commitment to social welfare systems. However, these countries also employ a broader range of tax reliefs, deductions, and optimization mechanisms that allow businesses—particularly multinational corporations—to significantly reduce their effective tax burdens. This results in a notable divergence between statutory and effective tax rates in Western Europe, with large corporations often benefiting from various tax planning strategies.

The findings suggest that while the differences between these two groups of countries persist, they have slightly diminished over time. This gradual convergence may be attributed to efforts toward tax harmonization within the EU, regulatory changes, and economic pressures that encourage alignment in corporate tax policies. Understanding these trends provides valuable insights for policymakers aiming to balance tax competitiveness with revenue stability and sheds light on the evolving factors that shape corporate tax burdens in individual countries.

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Visual Identification System as an Element of Brand Image Building in Social Media

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Abstract

Social media's rapid progression makes visual identity systems essential for establishing brand identity. The article examines visual identity development and its importance for communication tactics as well as its effects on brand visibility in social media spaces. Social media serves as an essential platform for sharing visual content which helps brands appear modern and fosters greater audience engagement. The research shows that organizations need to maintain visual consistency to build their digital media presence effectively while strengthening their market position.

Keywords: *visual identification system, brand image, social media*

JEL Classification:

Introduction

Rapid social media advancement requires brands to focus on visual identity which shapes their overall image. Today's social media platforms serve as fundamental components for business marketing approaches by allowing brands to engage consumers directly for image building in digital environments. In this context, a visual identity system (VIS) becomes a key element in creating a consistent and recognizable brand image. VIS includes components such as logos, color schemes, typography, and other graphic elements, which together create a unique company image. Consistency and coherence in the use of these elements on social media are critical for building trust and loyalty among audiences (Siuda and Grebosz, 2017).

Research indicates that a professionally designed visual identity not only grabs attention but also builds brand credibility. Consistent use of graphic elements across various platforms makes a company more recognizable and memorable to consumers (Peszko, 2012). VIS on social media helps brands stand out from their competitors while bolstering their market position. The study examines how visual identity systems contribute to brand image development on social media by combining evidence from both academic research and real-world cases.

1 The essence of a visual identity system

The visual identity system aims to create a unified and consistent concept for the visual presentation of a company, aligning with its mission and operational strategy (Wiktor, 2023). Visual identity (also referred to as visual identity, visualization, corporate identity, CI) consists of a collection of various elements (graphic, musical, typographic, etc.) along with directives for their use, all of which are outlined in the identity manual. This system

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ensures that marketing messages sent by the company are consistent, harmonize with each other, and thus create a synergistic effect (Wrona, 2012). Corporate Identity encompasses activities related to the organization's name, trademarks, logos, graphic symbols, colors, and graphic advertising constants. In its early stages CI concentrated only on establishing visible connections between products and their respective manufacturers. With the passing of time consistent colors, shapes, and fonts assumed greater significance in their role. Logos established a foundation of basic elements by implementing consistent rules for logos together with typography and colors. During the subsequent development phase businesses focused on standardization through repetitive patterns and uniform elements. Organizations needed to distinguish themselves from competitors and use emerging communication channels to maximize positive messaging through all available mediums. The following years brought the need for an even broader perception of visual identity (Peszko, 2012).

A visual identity system comprises a few to several hundred different components. The oft-mentioned constituent parts are logos, color schemes, typefaces, and graphic elements. These may be modernized, but they are still the most common aspects of visual identity. It does no good to ignore or try to evade this reality. No matter how fast or how slow the business world is evolving, and no matter how much effort is put into maintaining constituent parts, these four elements exist at the core of visual identity. (Bergström, 2009). Budzyński, 2002 expands these elements to include:

- company stationery (business cards, letterhead, envelopes, business documents),
- employee ID badges,
- advertising materials (information boards, brochures, leaflets),
- stamps,
- employee uniforms,
- vehicle markings,
- exterior and interior building decor,
- flags and company banners,
- individual and collective product packaging.

It turns out that today, visual identity is not just about printed materials but also about the information posted online. Nowadays, almost every customer looks for information about the brand they are interested in. Therefore, a company must remember to be visible not only physically in the real world but also virtually. Visual identity thus becomes a business card not only for the company itself but also for the quality of the products or services it sells. Thanks to it, the brand takes on character, "speaks" to the customer, and allows them to experience it. The concept of "experience economy," derived from the book by Pine and Gilmore, 1999, is becoming increasingly popular. They argued that "the shift from an economy based on products to one based on experiences is a huge revolution awaiting our markets." A prime example of a company that perfectly combines design, fashion, and experience is Apple, which currently leads the ranks of the most popular brands in the world.

Altkorn, 2004 argues that the identity a company has, meaning its beliefs and values, is often confused with its image. The way society perceives a brand does not necessarily align with the true identity and goals of the company. In order to communicate effectively with the customer, ensuring their beliefs about the brand match the company's objectives, a visual identity is needed, the features of which are described by the visual system.

2 The impact of visual identity on building a brand image on social media

A particular optical and aesthetic code known as visual identity enables an organization to communicate with its surroundings in ways that are most significant to it and that strengthen and support its favorable reputation. "Communication with the environment" or "shaping the company's image" refers to the collection of actions that the institution takes in relation to the production of these signals and their social reception (Altkorn, 2004). The following steps are involved in forming the company's image:

- the overall identification of the company (Corporate Identity, CI),
- shaping the external image of the company (Corporate Design, CD),
- the company's brand policy and its products (Branding),
- designing and implementing the visual identity system.

Collectively, these components help to create the entity's overall image; because they are interrelated, they work as a cohesive whole. The image or perception that a company or its brand acquires in the marketplace is the outcome of employing a comprehensive identity. According to Wrona, 2012, an organization can stand out in a saturated marketplace by using a well-designed visual identity, which offers a consistent framework that improves brand visibility and recognition. As social media has grown in popularity and modern technologies have advanced, brands are now focusing more on the visual component of their content on social media platforms (Zhao, 2023). Social media promotion of the brand's image helps it to attract a larger spectrum of customers. Nowadays, social media is as effective as conventional media and impacts brands. It's a great tool for tracking brand perceptions while comparing it against rivals (Reyneke et al., 2011).

Furthermore, for the brands, social media is a key way of propagating visual content about the brand. On social media platforms, brands try to develop their image and offer products to potential customers which attracts the younger generations (Zhao, 2023). The study shows that good looking and interesting content on the company's social media accounts, based on the clear visual identity, affects the perception of the brand as a new and approachable one. This strategy leads to the development of virtual communities of customers and builds their loyalty. Because they are more likely to engage with it, evoke emotions from it, and remember it, social media communication is mainly based on visual content. Moreover, communication on social media is mainly visual, which helps to engage users better than text (Podraza, 2017).

Those institutions that are now paying attention to CI and are trying to make information about it applicable not only to particular stakeholders but to all market actors are institutions of higher education. In a way, universities have become involuntary players in

the modern game called 'attention seeking'. Marketing activities aimed at communication with the environment are of great importance, and the wealth of communication forms and information delivery channels attract attention. External and internal environment of universities requires a coherent plan of communicating with them (Dejnaka, 2012).

One example of a university that has developed a complete visual identity system (VIS) in order to create a clear image and enhance the university's visibility is the Rzeszów University of Technology, which was formerly known as Ignacy Łukasiewicz University. In 2009, the authorities of the university took some measures to ensure that the visual symbols were well sorted and regulated which led to the development of a well-defined system that covered the following:

University logo and logotype – the central element of the VIS is the PRz logo, consisting of stylized letters "P" and "R" within a rectangle. A unified logotype was introduced, containing the full name of the university, as well as different versions of the logo adapted to specific uses, such as monochrome or negative versions.

- Departmental marking system – each department of the Rzeszów University of Technology has an individual symbol, designed according to unified graphic rules. These elements create a consistent and functional visual system, facilitating the identification of organizational units within the university.

- Color code – to increase legibility and emphasize the unique character of individual departments, specific colors were assigned to them. The primary color of the university is dark blue, used in both the logo and all official communication and promotional materials.

- Typography – within the VIS, a consistent typographic system was introduced based on the sans-serif font FF Unit in various styles. In official documents and promotional materials, system fonts such as Calibri and Cambria are also allowed, enabling flexible adaptation of visual communication to different formats.

- Promotional materials and stationery – the visual identity system of PRz also includes guidelines for designing business cards, letterheads, envelopes, diploma covers, and a wide range of promotional materials such as brochures, leaflets, posters, and billboards. The common style of these elements strengthens the consistency of the university's image and facilitates communication with the environment.

- Rules for using symbols – detailed guidelines were established for scaling, positioning, and combining the university and department logos. In official documents, the PRz logo is prominently displayed, while in promotional materials, greater flexibility in graphic layout is allowed. Strict adherence to these rules ensures high aesthetics and clarity in visual materials.

The visual identity system at the Rzeszów University of Technology is consistent and applied by all organizational units of the university, including the Department of Management, which actively uses social media platforms such as Facebook, Instagram, and LinkedIn to communicate with the academic community and promote events and achievements. An analysis of the content published on these platforms shows that the Department applies elements of the visual identity system developed in the Rzeszów University of Technology's brand book.

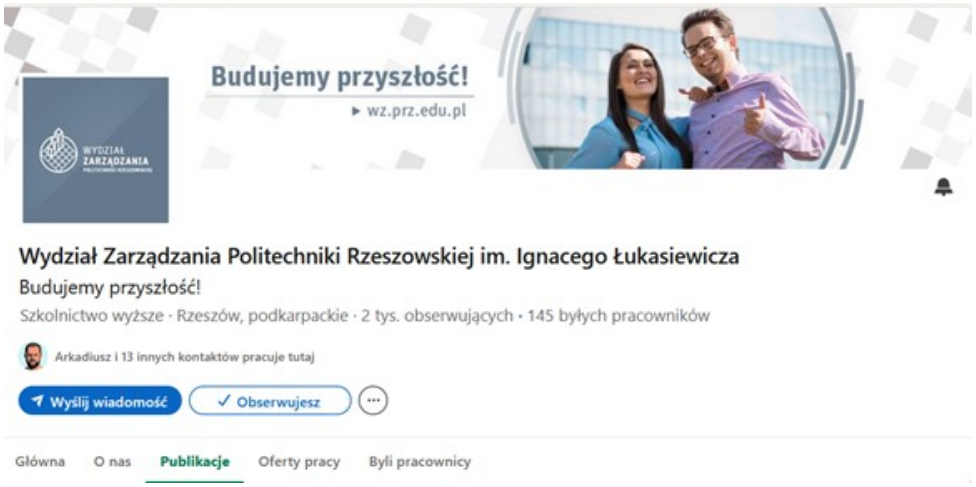

Figure 1: The use of visual identity on LinkedIn
Source: The Department of Management profile on LinkedIn "Wydział Zarzadzania Politechniki Rzeszowskiej – LinkedIn", 2025

Figure 2: The use of visual identity on Facebook
Source: The Department of Management profile on Facebook "Wydział Zarzadzania Politechniki Rzeszowskiej – Facebook", 2025

Visual materials, such as graphics, photos, banners, and videos, maintain the consistent color scheme and typography that are characteristic of the Rzeszów University of Technology. Department of Management uses logo, the university's typical colors, and fonts consistent with the university's official style ensures that communication on social media platforms is professional and recognizable.

Figure 3: The use of visual identity on Instagram
Source: The Department of Management profile on Instagram "Wydział Zarzadzania Politechniki Rzeszowskiej – Instagram", 2025

Figure 4: A LinkedIn post in line with visual identity
Source: The Department of Management profile on LinkedIn "Wydział Zarzadzania Politechniki Rzeszowskiej – LinkedIn", 2025

Figure 5: A Facebook post in line with visual identity
Source: The Department of Management profile on Facebook "Wydział Zarzadzania Politechniki Rzeszowskiej – Facebook", 2025

Figure 6: A Instagram post in line with visual identity
Source: The Department of Management profile on Instagram "Wydział Zarzadzania Politechniki Rzeszowskiej – Instagram", 2025

Student organizations and students organizing events at the Faculty of Management also use elements of the Rzeszów University of Technology's visual identity, though to

varying degrees. In materials promoting conferences, workshops, or industry meetings, the official colors and logos are often visible.

Figure 7: The application of visual identity in graphics prepared by students
Source: The Department of Management profile on Facebook "Wydział Zarzadzania Politechniki Rzeszowskiej – Facebook", 2025

The Department of Management regularly publishes content on Facebook, Instagram, and LinkedIn, enabling effective communication with different audience groups. On LinkedIn, a more formal communication style dominates, while on Facebook and Instagram, content with a more relaxed tone appears, primarily aimed at students.

Conclusions

The visual identity system is also used in helping to develop the brand's image on social media platforms. These platforms have grown and thus have impacted the way of visual identity development as companies have had to shift their approaches to the constantly changing digital environment. Visual identity has turned into not only the means of distinguishing the brand and making it easier for customers to remember but also the essential component of the brand's identity on the digital platform. Maintaining a consistent and cohesive visual presence on social media platforms enhances the brand position and affects consumer loyalty and engagement.

Higher education institutions, including the Rzeszów University of Technology, also understand the importance of visual identity. The use of a comprehensive visual identity system is very helpful in improving communication with the internal and external environment. For example, the Faculty of Management uses elements of the visual identity system on social media platforms in accordance with the university's rules. The unit's visibility and professionalism are enhanced by the regularly posted content on Facebook, Instagram, and LinkedIn. The use of visual identity on social media not only ensures the consistency of the brand image but also the perception and positioning in the market. It is therefore important that modern organizations, including universities, ensure the unity of their visual communication to be able to attract and engage their audiences.

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Innovation Expenditures of Industrial Enterprises of Selected EU Countries

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Abstract

The study examines innovation expenditures of industrial companies in selected EU countries, analyzing data from 2009 to 2018 for a total of 254 industrial companies from Belgium, France, Germany, and Sweden. The data was sourced from the Orbis database. The primary aim of the research is to identify the factors influencing R&D expenditures using panel regression techniques. To achieve this, the study uses two models: a static fixed effects model and a dynamic Generalized Method of Moments (GMM) model. The results indicate that in both models, certain factors show a significant relationship with R&D expenditures. Specifically, Intangible Fixed Assets (IFA), Net Income (NI), and Employees (EMP) exhibit a positive and significant effect on innovation spending. Conversely, Return on Assets (ROA) shows a negative relationship with R&D expenditures in both models, indicating that firms with higher profitability are less inclined to allocate funds for research and development. While these findings hold across both the static and dynamic models, the results for other indicators diverge between the two models, suggesting that different variables may have varying impacts depending on the modeling approach used. Overall, the study provides insights into the key drivers of R&D expenditures in industrial companies and highlights the importance of financial and organizational factors in shaping innovation investment.

Keywords: innovation, R&D expenditures, industrial companies, EU countries

JEL Classification:

Introduction

Innovation is essential for economic reality, especially given the increasing domestic and international competition. In a dynamic economic environment where technological changes and new business models are constantly evolving, innovation becomes a key factor in maintaining competitiveness and achieving success for both companies and countries. Innovation can enhance products and processes, leading to higher productivity, better customer service, and greater efficiency. Thus, innovation is closely linked to productivity, which in turn connects it to competitiveness. (Afzal et al., 2019)

Innovation expenditures of industrial enterprises represent the financial resources invested in the development of new products, technologies, processes, and services to enhance competitiveness and production efficiency. These expenditures include costs related to R&D, modernization of production facilities, implementation of automation and digitalization, as well as collaboration with research institutions and startups. Investments in

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innovation enable companies to respond to dynamic market conditions, reduce production costs, improve product quality, and contribute to sustainable development. In the current global environment, innovation expenditures are a key factor in achieving a long-term growth strategy and maintaining a competitive edge. Innovation performance reflects a company's or country's ability to create products or processes efficiently, adding value and enhancing market competitiveness. The innovation activities of firms play a crucial role in a country's economic growth, with each country having its own specific approaches to supporting innovation and research and development activities, which include various political, economic, and technological strategies. These activities encompass not only R&D investments but also support for startups, modernization of production processes, and the adoption of new technologies. Innovation is essential for adapting to rapidly changing markets and increasing competitiveness in the global economy.

1 Theoretical background

Questions regarding the definition and measurement of innovation in empirical literature are most often associated with indicators of R&D activity and patent data, which are sometimes considered inputs, while others are regarded as outputs. (Gault, 2018) A group of researchers, Xu et al., 2021, highlights that investment policies focused on R&D play a crucial role in supporting innovation, which subsequently translates into concrete outcomes. These policies enable the transformation of achieved returns into economic processes through investments. Similarly, Garbuz and Topala, 2017 and Humbatova and Hajiyev, 2019 argue that the development of a sustainable innovation-based economy and its competitiveness is closely linked to consistent investments in research and practical education of professionals in this sector. Higher R&D expenditures are a necessary prerequisite for faster economic growth, measured by GDP per capita. Technological progress influences GDP, and dynamic growth is not possible without innovation. A collective of authors, Sokolov-Mladenović et al., 2016, unequivocally confirmed that R&D investments positively impact the real rate of economic growth under all circumstances, even during financial crises, aligning with the findings of Ding et al., 2024. According to Sinimole and Saini, 2020, R&D expenditures are an important indicator for assessing national competitiveness. Recognizing the relationship between innovation and competitiveness is key, especially for developing and catching-up economies. This perspective aligns with other researchers, such as Blanco et al., 2016 and Kaur and Singh, 2016, who state that governments consider R&D investments as a driving force behind economic growth and increased national competitiveness.

The relationships between R&D expenditures, innovation, productivity, and the export of high-tech products, as well as the channels through which these causal links may arise, were explored by Hammar and Belarbi, 2021. Their findings suggest that a country's level of development is a key factor in determining the nature of these relationships compared to the degree of financial openness. The impact is diverse, with positive, negative, and neutral effects occurring depending on the innovation indicator used and the threshold variable level. A study by Ramadani, 2009 focusing on developed countries demonstrates a positive relationship between R&D, innovation, and productivity. In developed countries, R&D investments are higher than in developing nations, yet the impact on economic growth may be similar. (Akcali and Sismanoglu, 2015) The importance of financial support for research activities emphasized by Leite and Cardoso, 2023, particularly because research implementation contributes to building innovative capacities, leading to

improvements in the overall economic structure. R&D funding is considered a priority for sustainable development in most countries. A study by Ivanová and Žárská, 2023 shows a positive correlation between R&D expenditures and the innovation index of the Visegrád Four countries, with the Czech Republic emerging as the leader, while for Slovakia and Hungary, the relationship between variables was not statistically significant. The main question posed by Dobrzanski et al., 2021 was whether continuously increasing R&D expenditures lead to proportionality between expenditures and achieved results and whether they genuinely improve efficiency. Inefficient allocation of R&D funds may contribute to widening the innovation gap; therefore, it is essential to examine whether increased R&D spending truly results in proportional outputs and improved efficiency. Authors Dritsaki and Dritsaki, 2023 revealed a long-term positive and significant relationship between R&D expenditures and the Global Innovation Index, whereas in the short term, this relationship exhibited a negative trend. R&D expenditures create conditions for the application of advanced and higher-quality technologies, thereby fostering innovation development. The growth in the number of patents plays a key role in a country's innovation progress, as it enables the introduction of new products and manufacturing processes. This process simultaneously supports the shift in a country's exports from low-tech products to those with higher technological sophistication. Mohamed et al., 2022 analyzed the impact of technological innovations on economic development in developing countries. They found that the growth of technological innovation indicators (education expenditures, patents, R&D expenditures, number of researchers, high-tech product exports, and R&D employment) leads to increased economic growth in both the short and long term. Furthermore, a long-term bidirectional causal relationship between technological innovation and GDP was demonstrated, while in the short term, causality runs from innovation to GDP.

Kacprzyk and Doryń, 2017 examined the relationship between innovation and economic growth in the EU, finding that R&D expenditures did not significantly impact growth, whereas patents proved to be an important GDP indicator in new member states. Huňady and Pisár, 2021 assumed that the impact of R&D expenditures on patents could be positive since internal research capabilities, especially those focused on basic research, are crucial for companies in generating creative outputs. Foreign direct investment also significantly contributes to the connection between R&D, innovation, and economic growth. (Ding et al., 2024; Prah, 2022) Several authors (Greco et al., 2022; Haddad et al., 2022; Sinoi, 2021) recommend that governments support firms' innovation activities through effective public and industrial policies that stimulate creativity and vitality.

2 Research methodology

The aim of our research is to answer the research question:

Which factors determine the innovation expenditures of industrial enterprises in selected countries?

To address this question, the following hypotheses were tested:

H1: Ceteris paribus, Intangible Fixed Aseets, Net Income, Employees, Return on Equity and Return on Assets have a statistically significant positive impact on R&D expenditures.

H2: Ceteris paribus, Solvency and Capital Equity have a statistically significant negative impact on R&D expenditures.

In the empirical part of the study, answers will be provided through methods of analysis and comparison, with an emphasis on econometric modeling of panel data. We work with microdata from 254 industrial enterprises in Belgium, France, Germany, and Sweden over the period 2009 to 2018. (Table 1)

Table 1: The input variables of the analysis of the impact of selected determinants on R&D expenditures

Variable	**Abbreviation**	**Unit**
R&D expenditures	R&D	million €
Intangible Fixed Assets	IFA	million €
Net Income	NI	million €
Employees	EMP	number of persons
Return on Equity	ROE	net income to equity in percentage
Return on Assets	ROA	net income to total assets in percentage
Solvency	SOLV	equity to total assets ratio in percentage
Capital Equity	EC	million €

Source: own processing

The analytical process in this research is based on thorough data preparation and the use of statistical tools that minimize the risk of errors and improve the quality of results. The significance level of all tests is set at 5 %. The econometric software R will be used for data processing. The first step involves performing a correlation test and a Variance Inflation Factor (VIF) test, which help identify and minimize multicollinearity among independent variables. This step is crucial, as multicollinearity can distort regression estimates, reducing the accuracy of the analysis. The next step includes conducting descriptive statistics and creating a correlation matrix, which provides an overview of fundamental trends and relationships between variables.

The key analytical tool used is panel regression, which allows for the combination of cross-sectional data from different countries with time series, ensuring a more precise analysis of the impact of independent variables on dependent variables. It is also effective in addressing heterogeneity across countries, ensuring robust and reliable results.

The baseline equation for panel regression (i.e., the Pooled Regression Model) is formulated as follows:

$$y_{it} = \alpha + \mathbf{x}'_{it}\boldsymbol{\beta} + \varepsilon_{it} \tag{22}$$

Where,
y_{it} value of dependent variable,
α constant capturing the effect not explained by the independent variables,
x_{it} vector of independent variables for individual observations i at time t,
β vector of estimated coefficients,
ϵ_{it} standard error for individual observations i = 1, ..., N at time t = 1, ..., T.

For panel models, cross-sectional unit heteroskedasticity is typical, and therefore, a model for panel data with heteroskedasticity can be written as follows:

$$y_{it} = \mathbf{x}'_{it}\boldsymbol{\beta} + \mathbf{z}'_{it}\boldsymbol{\alpha} + \varepsilon_{it} \tag{23}$$

Where,

x'_{it} is the vector of independent variables containing K regressors, excluding the constant.

Heterogeneity is captured in $z_i\alpha$, where:

z_i is the constant term and a set of specific effects (individual or group-specific).

The equation of the fixed effects model is as follows:

$$y_{it} = \mathbf{x}'_{it}\boldsymbol{\beta} + c_i + \varepsilon_{it} \tag{24}$$

Where,

c_i is equal to $z'_{it}\alpha$ represents the unit-specific effect for each unit i and specifies the estimated conditional means,

ϵ_{it} is the idiosyncratic error term, which includes unobservable factors that evolve over time t and affect the dependent variable. (Wooldridge, 2013)

The relationship in the random effects model is expressed as follows:

$$y_{it} = x'_{it}\beta + E\left[z'_i\alpha\right] + \left(z'_i\alpha - E\left[z'_i\alpha\right]\right) + \varepsilon_{it} = x'_{it}\beta + \alpha + (u_i + \varepsilon_{it}) \tag{25}$$

Where, u_i are the random effects between units.

The choice of the appropriate model, however, primarily depends on the result of the Hausman test.

3 Results and discussion

Our goal was to identify the factors determining R&D expenditures, utilizing panel regression to analyze the relationships between economic indicators and firms' innovation expenditures. In the first phase, we developed a comprehensive model covering all firms and subsequently created partial models for individual countries. After conducting diagnostic tests, we selected the most appropriate model specification and estimated the regression coefficients. The results enabled us to evaluate the significance of individual variables and identify the key determinants of R&D expenditures in industrial enterprises of selected countries.

3.1 Results

The first step (1) of the analysis was Pooling regression model, a combined regression model with selected variables. Based on favorable results and a high coefficient of determination, we continued with the overall model. In the second step (2), we estimated a model with fixed individual effects, which controlled for unobserved heterogeneity among firms. In the third step (3), we estimated a model with fixed time effects but concluded that they were unnecessary. In the fourth step (4), we applied a random effects model, which allowed the inclusion of time-invariant variables. The F-test and Honda test (5) and (6) showed that fixed effects are statistically significant. In the seventh step (7), we applied the Hausman test, which indicated that the fixed effects model is consistent, so we used it. The final step (8) involved testing different types of effects, with results showing that individual effects are significant, while time effects are not. Based on the twoways model result, we selected a panel model with both individual and time effects,

which provides a more robust analysis. The results of the mentioned tests, as well as the diagnostic tests, are presented in Table 2.

Table 2: The results of the tests

Assumption	**Test**	**Statistic (p-value)**	**Interpretation**
Individual effect	F-test	$F = 32.787$ (0.000)	There are statistically significant individual effects in the model.
	LM test	$\chi^2 = 6289$ (0.000)	
Time effect	F-test	$F = 0.25282$ (0.986)	There are no statistically significant time effects in the model.
	Honda test	$\chi^2 = 3.002$ (0.000)	
Two-way effect	F-test	$F = 31.739$ (0.000)	There are statistically significant two-way effects in the model.
	Honda test	$\chi^2 = 6292$ (0.000)	
Model fit	Hausman test	$\chi^2 = 39.697$ (0.000)	The fixed effects model is appropriate for use.
Stationarity	Maddala Wu Unit Root Test	$X^2 = 1265$ (0.000)	The data is stationary.
Serial correlation	Breusch-Godfrey/Wooldridge test	$\chi^2 = 604.21$ (0.000)	There is serial correlation in the model.
Cross-sectional dependence	Pesaran CD test	$z = 221.87$ (0.000)	There is cross-sectional dependence in the model.
Heteroskedasticity	Studentized Breusch-Pagan test	$BP = 812.44$ (0.000)	There is heteroskedasticity in the model.

Source: own processing

Based on the identified issues, it is necessary to modify the model by applying robust methods, specifically the variance-covariance matrix, which accounts for the presence of serial correlation, cross-sectional dependence, and heteroskedasticity, thereby ensuring the validity and reliability of the estimates.

The results of the econometric panel regression modeling are presented in the following Table 3. Model 1 presents a static fixed-effects panel regression model with individual and time effects, in which the clustering of random errors method was implemented, meaning that standard errors were adjusted to account for possible correlations of errors within firms. Model 2 represents a dynamic GMM model, which includes the lagged (delayed) variable of R&D expenditure.

The results of the fixed-effects model with individual and time effects show that most of the regressors have a statistically significant impact on the dependent variable, with a very strong positive effect from NI and EMP (p-value ¡ 0.0001). Other independent variables with a significant positive effect are IFA and ROE, with higher values of these variables leading to an increase in R&D expenditure. SOLV and ROA showed a significant negative effect, meaning that as the values of these variables increase, R&D expenditure decreases. The regressor EC did not have a statistically significant effect on the dependent variable in this case (p-value = 0.9302). Based on the model's R^2 value (0.6183), we claim that approximately 61.83 % of the variability of the dependent variable is explained by

the independent variables. The adjusted R^2, accounting for the number of variables, is 0.5731, indicating that the model still provides relevant results, showing robustness with several statistically significant variables capable of explaining a substantial portion of the variability in the dependent variables.

Table 3: The results of the econometric panel regression

Variable	**Model 1**	**Model 2**
lag(VaV_1)	7.4081e-01***	7.4081e-01***
	(1.5247e-02)	(1.5247e-02)
IFA	2.31e-02**	1.3910e-02***
	(7.24e-03)	(3.2869e-04)
NI	1.63e-01***	3.5086e-02***
	(1.34e-02)	(6.4919e-04)
EMP	1.31e+01***	5.0769e+00***
	(3.38e+00)	(6.4596e-01)
ROE	1.91e+01	1.7882e+00
	(7.49e+00)	(2.5769e+00)
ROA	−3.40e+02*	−7.3996e+01*
	(1.20e+02)	(3.0871e+01)
SOLV	−2.58e+02**	−3.6622e+01**
	(8.54e+01)	(2.3344e+01)
EC	−1.25e-02	−1.0455e-01***
	(1.42e-01)	(7.6908e-03)
Number of observations	2540	2540
R^2	0.6183	
Adjusted R^2	0.5731	

Note: ***, **, * indicate significance levels of 0.1%, 1%, and 5%. The standard deviation is given in parentheses.

Source: own processing

The results of the dynamic panel regression using the GMM method showed that R&D expenditure is influenced by previous R&D expenditure with a high statistical significance of the lagged value (p-value ¡ 2.2e-16). Additionally, the variables IFA, NI, and EMP have a positive and significant effect on R&D expenditure (p-values ¡ 0.0000), meaning that larger and financially stronger companies invest more in R&D. Other significant variables include ROA and EC, which showed a negative impact. It was found that ROE and SOLV have an insignificant effect on R&D expenditure (p-values ¿ 0.05). The Sargan test (Test of Overidentifying Restrictions) confirmed the validity of the instruments used (p-value = 0.1436). The autocorrelation tests of the first and second order showed that there is no second-order autocorrelation (p-value = 0.5169). The Wald test confirmed that at least one independent variable has a statistically significant effect (p ¡ 2.22e-16) on the dependent variable and the model as a whole is statistically significant. These statistical significance tests indicate that the model is correctly specified, and the instruments used in the regression are valid.

3.2 Discussion

The results of testing the fixed-effects model with individual and time effects (Model 1) and the dynamic GMM model (Model 2) show differences in significance, but also in the

strength of the effects. Statistically significant and positive effects are observed for the variables IFA, NI, and EMP in both models, with the effect of EMP being stronger in the GMM model. The regressor ROA indicates a statistically significant negative effect in both models, but is less pronounced in the GMM model. The variables ROE and SOLV showed statistical significance in the fixed-effects model but lost significance in the GMM model. In contrast, the EC variable is negative in the fixed-effects model but not significant, while in the GMM model, it is strongly significant, which may be due to the dynamic structure of the data or endogeneity. Our analysis revealed that in both comprehensive models, a significant positive impact of intangible fixed assets on R&D expenditures was confirmed. We assume that companies investing in intangible assets, such as patents, trademarks, and licenses, are more inclined to allocate resources to R&D. This claim is supported by the research of Kumari and Mishra, 2021, who confirmed that companies focused on innovation and the protection of their technologies and products tend to increase their R&D expenditures, thereby improving their competitiveness and gaining access to better resources. Based on the significant positive impact of net profit on R&D expenditures, this determinant can be considered important. The number of employees has a positive and statistically significant effect on R&D expenditures, which corresponds to the findings of Muhammad et al., 2024, who state that larger firms invest in R&D more easily compared to smaller enterprises. Larger firms are also more likely to seek diverse opportunities and visibility to gain access to better resources. The positive effect of return on equity on R&D expenditures was statistically significant only in the static model. Based on the results, we argue that return on equity may not always be a decisive factor influencing R&D expenditures. The impact of return on assets on R&D expenditures was statistically significant, leading us to conclude that return on assets is relevant in this case for decision-making regarding R&D allocation. The impact of solvency on R&D expenditures was statistically significant only in the fixed effects model. In contrast, the negative effect of capital on R&D expenditures was confirmed only in the GMM model, while previous research has reached different conclusions. On one hand, Yang, 2022 examined the impact of corporate capital on R&D intensity and found that this relationship is significantly negative. On the other hand, the empirical results of Wang et al., 2016 indicate that the level of endogenous financing is positively related to R&D investments, while the ratio of assets to liabilities has a significantly negative effect on these investments. Overall, it can be stated that R&D investments are influenced by multiple factors, with corporate decision-making depending on a combination of financial conditions, firm size, and strategic orientation.

Conclusions

Based on the analysis of data from 2009 to 2018, sourced from the Orbis database, the study identified key factors such as Intangible Fixed Assets (IFA), Net Income (NI), and Employees (EMP), which have a positive and significant impact on R&D expenditures. On the other hand, Return on Assets (ROA) shows a negative relationship with R&D expenditures. The results varied for other indicators depending on the model used, indicating that different variables may have different effects on innovation spending depending on the methodological approach. This study's findings offer understanding of the drivers behind R&D investment within the European industrial landscape. The observed positive correlation between IFA, NI, and EMP underscores the importance of a company's intellectual capital, financial health, and human resources in fostering innovation. Specifically,

the significance of intangible assets highlights the growing reliance on knowledge-based economies and the strategic value of investments in areas like software, patents, and brand recognition. The negative relationship between ROA and R&D expenditures suggests a potential short-term focus on profitability over long-term innovative ventures, which could have implications for sustained competitiveness. Furthermore, the model-dependent variations in results emphasize the complexity of R&D investment decisions and the need for researchers to carefully consider the chosen methodology when analyzing these phenomena. These insights can inform policymakers and company executives in developing strategies to promote innovation and enhance the competitiveness of EU industries.

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Session IV.: Challenges in Economics

Ethics in International Business and the Introduction of the Digital Euro

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Abstract

The introduction of the digital euro by the European Central Bank (ECB) represents a milestone in financial digitalization and brings both opportunities and ethical challenges,particularly for savings banks. This paper examines the ethical dimensions of international business and digital finance, focusing on transparency, fairness, and responsibility. Methodologically, the study integrates a literature review of regulatory frameworks and ethical considerations, alongside an analysis of empirical survey data on consumer attitudes. The findings highlight key concerns such as data protection, financial inclusion, and regulatory oversight. The research underscores the necessity of balancing technological innovation with ethical considerations to foster customer trust and ensure sustainable digital financial services.

Keywords: *financial ethics, consumer trust, regulatory oversight, digital literacy, privacy concerns, central bank digital currency (CBDC)*

JEL Classification: *E42, G21, G28, K20, M14*

Introduction

The European Central Bank's (ECB) introduction of the digital euro marks a fundamental transformation in the financial landscape, aimed at modernizing payment transactions while offering a secure digital alternative to cash. As a central bank digital currency (CBDC), the digital euro is designed to enhance financial stability, increase payment efficiency, and strengthen Europe's autonomy over its financial infrastructure. However, this development raises significant ethical concerns, particularly in terms of data privacy, financial inclusion, and regulatory oversight.

While digital financial solutions can provide significant benefits, the ethical implications of such advancements must be carefully assessed. This paper investigates how savings banks can address these ethical challenges and ensure that digital financial services remain accessible, transparent, and fair for all customers.

1 Theoretical background

1.1 Ethics in International Business

Ethics in international business encompasses principles such as transparency, fairness, and responsibility. Transparency ensures open communication and prevents information asymmetry between financial institutions and their customers. Fairness guarantees equal treatment of all clients, regardless of socioeconomic status or digital literacy. Responsibility mandates ethical decision-making that prevents harm to consumers and society. In

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a globalized financial market, institutions must align their business practices with ethical frameworks that consider the social and economic impact of digital financial tools (Auer et al., 2021).

The increasing role of financial technology (FinTech) companies and digital banking solutions highlights the importance of maintaining an ethical approach. The introduction of new financial instruments, such as the digital euro, necessitates the implementation of strong regulatory frameworks that ensure consumer protection and prevent financial exclusion. Ethical considerations must be at the forefront of financial digitalization efforts to maintain trust and reliability within the industry.

1.2 Introduction of the Digital Euro and Ethical Issues

The digital euro introduces a range of ethical concerns, such as privacy, surveillance, and the risk of financial exclusion. On the one hand, it presents an opportunity to create a more inclusive and efficient financial ecosystem. On the other hand, the potential for excessive transaction monitoring raises concerns about user privacy and state surveillance Froymovich, 2021.

A primary ethical dilemma associated with the digital euro revolves around the balance between transaction traceability and user privacy. While digital transactions need to be monitored to prevent fraud, money laundering, and terrorist financing, excessive data collection poses risks of misuse and potential violations of personal privacy rights ((ECB), 2020). The ethical challenge lies in implementing adequate security measures while ensuring that users' financial autonomy and privacy remain protected.

Another concern is the potential exclusion of certain population groups. While digital banking offers numerous advantages, individuals without access to digital devices, including elderly populations and those in remote areas, may find it challenging to integrate into a digital financial system. Ensuring accessibility for all socio-economic demographics is crucial to avoiding financial marginalization.

1.3 Relevance of Ethics for Savings Banks

Savings banks play a crucial role in financial inclusion and ethical banking. As regional financial institutions, they serve communities that may not have easy access to digital banking solutions. Ethical banking practices involve ensuring that financial products and services are accessible to all customers while upholding data privacy and security Engert and Fung, 2017.

Savings banks must address ethical concerns surrounding the digital euro by:

- Ensuring financial inclusion through alternative service models, such as hybrid cash-digital systems.
- Enhancing customer education on digital financial literacy.
- Implementing stringent data protection measures to maintain consumer trust.

By integrating ethical principles into digital finance adoption, savings banks can navigate the transition responsibly and ensure that ethical concerns are addressed effectively.

2 Research methodology

This study employs a multi-faceted qualitative research approach to examine the ethical challenges associated with the introduction of the digital euro. The methodology is designed to provide a comprehensive analysis by utilizing various sources of information and research methods. The study integrates a literature review of existing regulatory frameworks, financial ethics theories, and case studies from European financial institutions. It also includes an evaluation of reports from financial regulatory authorities such as the European Central Bank (ECB), the Bank for International Settlements (BIS), and the International Monetary Fund (IMF).

Additionally, the research includes a data-driven assessment of consumer attitudes towards digital financial solutions Baltagi, 2021. Public opinion surveys and financial market reports were analyzed to understand the level of trust consumers have in digital currencies and their willingness to transition from cash-based transactions to digital alternatives. A survey conducted by the Deutsche Bundesbank revealed that approximately 50 % of respondents could envision using a digital euro as an additional payment option. However, only 41 % of respondents had prior knowledge of the digital euro, indicating a substantial information gap. Privacy emerged as a paramount concern, with over 75 % of participants rating it as very important or important in the context of the digital euro. Furthermore, 59 % emphasized the significance of an offline version of the digital euro to ensure privacy levels comparable to cash.

Eurostat data from 2023 indicates that 6.0 % of the EU population aged 16–74 had never used the internet. This statistic highlights a segment of the population that may face challenges in accessing digital financial services. Additionally, disparities exist across regions; for instance, the Greek region of Kentriki Elláda reported that 17.3 % of its population had never used the internet, underscoring regional variations in digital engagement. These findings underscore the importance of addressing privacy concerns and enhancing digital literacy to ensure inclusive adoption of digital financial solutions across diverse demographics.

3 Results and discussion

3.1 Results

The analysis of the ethical implications surrounding the digital euro highlights key concerns regarding data protection, financial inclusion, and power distribution within the financial system. The introduction of the digital euro presents both advantages and challenges for savings banks, particularly in balancing regulatory compliance with ethical principles.

Data Protection and Privacy

One of the most significant findings concerns the tension between transaction traceability and individual privacy. While the digital euro aims to provide a secure and transparent payment system, there are concerns regarding excessive data collection and potential misuse ((ECB), 2020). The ECB proposes an “anonymous mode” for smaller transactions, ensuring some level of privacy, whereas larger transactions would remain fully traceable for regulatory purposes. However, the implementation of such mechanisms remains uncertain,

and financial institutions must ensure that privacy concerns do not deter users from adopting the digital euro. Savings banks must implement strict data security measures, ensuring compliance with GDPR while fostering customer trust (Boar and Wehrli, 2021). This involves not only technical safeguards such as end-toend encryption but also robust internal policies that limit unnecessary data access and processing.

Additionally, the study suggests that user concerns over financial data control may influence adoption rates. Customers may be hesitant to switch to the digital euro if they perceive a higher risk of government surveillance or data breaches compared to traditional banking methods (Auer et al., 2021). The implementation of decentralization techniques, such as distributed ledger technology (DLT), may mitigate some of these risks by ensuring data security and integrity.

Trust and Customer Education

The study also reveals that customer trust in digital financial solutions remains a key challenge. Survey data indicate that a significant portion of the population lacks awareness of the digital euro, with only 41 % of respondents having prior knowledge of its existence (Bundesbank, 2023). Furthermore, privacy concerns are paramount, with over 75 % of participants emphasizing its importance. This data underscores the need for a structured and transparent communication strategy by savings banks to address these concerns.

Savings banks must take proactive measures, including targeted customer education campaigns and transparency in data usage policies, to enhance trust and acceptance (Engert and Fung, 2017). Interactive platforms, webinars, and physical workshops could serve as effective tools to educate different demographic groups on how to securely use the digital euro. Ensuring that customers understand the benefits, security measures, and privacy safeguards associated with the digital euro will be vital in fostering widespread adoption.

Furthermore, the role of traditional banking institutions in educating their customers on cybersecurity and digital financial literacy should not be underestimated. Savings banks could introduce digital financial literacy programs specifically tailored to elderly populations and individuals with limited experience in digital banking. Implementing personalized consultations in local branches and providing accessible learning materials could further facilitate trust-building efforts.

Financial Inclusion

The findings highlight potential financial exclusion risks, particularly for vulnerable groups such as elderly populations and individuals in rural areas. Eurostat data shows that 6 % of the EU population aged 16–74 has never used the internet, with significant regional disparities (Eurostat, 2023). This underscores the necessity of providing alternative access points, such as hybrid cash-digital systems and financial literacy programs, to ensure equitable access to digital financial services.

To address financial inclusion concerns, savings banks must develop solutions that integrate both digital and traditional banking methods. Strategies such as maintaining cash accessibility alongside digital transactions, offering non-smartphone-based digital payment options, and ensuring that offline transactions remain feasible are essential to guaranteeing widespread usability of the digital euro (Boar and Wehrli, 2021).

Additionally, partnerships with governmental and non-governmental organizations can facilitate financial inclusion efforts. Collaborating with community centers, social service

providers, and educational institutions can help reach underserved populations and equip them with the necessary digital skills to confidently engage with digital financial solutions.

3.2 Discussion

Ethical Challenges in the Implementation of the Digital Euro

The introduction of the digital euro poses complex ethical challenges for savings banks. Data privacy concerns must be addressed through advanced encryption techniques and transparent communication about data usage (Auer et al., 2021). Ensuring that customer transaction data is not misused for surveillance purposes is critical to maintaining trust in the financial system. The balance between compliance with anti-money laundering regulations and preserving user privacy remains a significant ethical dilemma. Savings banks must work closely with policymakers to ensure that privacy protections remain a top priority in digital euro infrastructure design.

The study also raises concerns about the long-term effects of digital payment dominance on individual financial autonomy. A complete transition from cash to digital currency could lead to an overreliance on digital payment systems, making individuals vulnerable to cybersecurity threats and technical failures (Riksbank, 2020). Therefore, the digital euro must be designed in a way that maintains consumer choice and resilience in financial transactions.

The Role of Savings Banks in Promoting Financial Inclusion

Given their regional focus and strong community ties, savings banks have a crucial role in preventing financial exclusion. They must actively develop solutions for customers with limited digital access, including maintaining physical banking services, offering digital literacy workshops, and supporting offline functionalities for the digital euro. By integrating ethical considerations into their digital transformation strategies, savings banks can help bridge the digital divide (Arner et al., 2020).

Moreover, savings banks should advocate for inclusive regulatory measures that prevent any form of digital discrimination. Ensuring that individuals without access to smartphones or stable internet connections can still participate in the financial system is critical ((ECB), 2020). Governments and financial institutions should work together to provide accessible and userfriendly alternatives, such as card-based digital euro wallets or offline payment solutions.

Implications for Policy and Regulation

Regulatory bodies must establish clear frameworks that protect consumer rights while enabling innovation in digital finance. Collaboration between the ECB, national authorities, and financial institutions is essential to designing policies that ensure transparency, fairness, and accountability (Boar and Wehrli, 2021). Savings banks must advocate for regulatory approaches that prioritize consumer protection and ethical financial practices.

The ethical concerns surrounding financial surveillance, data ownership, and algorithmic decisionmaking in digital finance require continuous oversight. Policymakers should enforce periodic evaluations of the digital euro's impact on society, ensuring that technological advancements align with ethical standards. Transparency in data handling and

robust accountability mechanisms should be mandated by regulators to prevent the misuse of financial data (Rogoff, 2016)

Conclusions

The findings emphasize the need for a balanced approach that integrates technological innovation with ethical considerations. Savings banks must address privacy concerns, enhance customer education, and promote financial inclusion to foster public trust in the digital euro. Ethical banking practices, combined with strong regulatory oversight, will be essential in ensuring the successful and responsible adoption of this new financial instrument.

To ensure long-term success, savings banks must implement comprehensive digital strategies that prioritize user needs and uphold fundamental ethical principles. Proactive engagement with customers, adaptive financial solutions, and collaboration with regulators and social organizations will be key factors in shaping a fair and inclusive digital euro ecosystem. By adopting a responsible approach, savings banks can position themselves as leaders in ethical digital finance, ultimately fostering trust and sustainability in the evolving financial landscape.

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Tax Competition in the Context of Corporate Taxation: A Bibliometric Analysis

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Abstract

This study provides a bibliometric analysis of tax competition in the context of corporate taxation, based on research articles indexed in the Web of Science (WoS) database from 1993 to 2025. Using the bibliometrix and biblioshiny packages in R, we examined the evolution of research in this field, focusing on publication trends, geographical distribution, and keyword analysis. The dataset initially contained 457 articles, which were later refined to 383 articles after applying relevance filters. To ensure methodological rigor, only peer-reviewed journal articles were included, while books, book chapters, conference proceedings, and editorials were excluded. Our findings reveal two distinct research cycles. The first period (1993–2014) primarily investigates the theoretical aspects of tax competition, including capital mobility, profit shifting, and the role of tax incentives in attracting foreign direct investment. This phase largely focuses on the economic impact of tax policies and the risks of a "race to the bottom". The second period (2015–2025) shifts toward practical tax policy considerations, such as effective tax rates, tax optimization strategies, and international tax coordination efforts, particularly in the context of the OECD BEPS initiatives. This phase reflects the growing regulatory scrutiny and global efforts to address corporate tax avoidance. The results indicate an increasing academic and policy interest in international tax regulation, driven by economic globalization and changes in global tax governance. This study provides insights into the development of tax competition research, identifying key themes, influential contributions, and emerging trends, offering a foundation for future investigations into corporate tax policies and international fiscal coordination.

Keywords: *bibliometric analysis, tax policy, base erosion and profit shifting, capital mobility, effective tax rate*

JEL Classification: *F21, H20, H25*

Introduction

Tax competition, as a fundamental aspect of international taxation, has long been the subject of intense research in economics and economic policy. Globalization and digitalization have further heightened concerns regarding tax strategies employed by multinational enterprises, which take advantage of regulatory differences between countries. In response to these challenges, the OECD and the European Union (EU) have introduced measures to limit tax competition and harmful tax practices. These policy changes have shaped academic discourse and contributed to the increasing volume of research on tax competition, its mechanisms, and its consequences. Although tax competition is a widely studied

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topic, only a few studies systematically analyze its research landscape using bibliometric methods. Bibliometric analysis enables a quantitative assessment of scientific output, identifying key research trends, influential authors, and thematic shifts over time (Aria and Cuccurullo, 2017). Therefore, this study aims to map the intellectual structure of tax competition research by examining scientific production, citation patterns, and thematic evolution using bibliometric tools. The objectives of this study are:

The objectives of this study are to analyze the development of tax competition research over time by assessing publication trends and citation patterns, to examine the geographical distribution of scientific output and identify the main contributing countries in this research area, and to explore thematic developments and emerging research areas through keyword analysis. To achieve these objectives, we conducted a bibliometric analysis of 383 research articles indexed in the Web of Science (WoS) database from 1993 to 2025. The methodological approach includes performance analysis, keyword mapping, and country-based comparisons. The study's findings contribute to a better understanding of the evolution of tax competition research and provide a foundation for future studies in the taxation of multinational corporations and international tax regulation.

1 Theoretical background

Tax competition is a crucial aspect of the modern economic environment, particularly in relation to corporate taxation. This review focuses on various dimensions of tax competition, its impact on the economy and policy, as well as the approaches and recommendations provided by researchers in this field. Tax competition is defined as a process in which countries lower their tax rates to attract investments and stimulate economic growth. Mukherjee et al., 2017 highlights that tax competition can have both positive and negative effects on economic performance, requiring a balance between competitiveness and the sustainability of public finances (Guziejewska et al., 2014). Rota-Graziosi, 2019 examines the supermodularity of tax competition and its impact on various dimensions of tax systems, emphasizing the complexity and multidimensional nature of tax policy (Rota-Graziosi, 2019). They investigate how globalization and capital mobility influence national tax policies. He argues that countries aiming to attract foreign investment are compelled to lower their tax rates, leading to a "race to the bottom" (Helcmanovská and Andrejovská, 2021).

Glaeser et al., 2023 add that tax competition can negatively affect employment, an essential aspect that governments should consider when formulating their tax policies. Evers et al., 2015 and Swank, 2016 focus on the effects of tax competition on public finances. Evers et al., 2015 argues that lowering tax rates can result in a decline in tax revenues, potentially harming public services funding (Overesch and Rincke, 2011). Swank, 2016 adds that governments must carefully evaluate how their tax policies impact social equity and economic stability (Tudor and Appel, 2016).

Buettner et al., 2018 and Zhang et al., 2022 analyze different approaches to tax policy in the context of tax competition. Buettner et al., 2018 suggests that countries should consider the long-term economic effects of their tax policies rather than focusing solely on short-term gains from attracting investments (Overesch and Rincke, 2009). Zhang et al., 2022 explores the impact of the digital economy on tax policies, emphasizing the need for tax systems to adapt to new challenges. Shin, 2020 examine how market competition can influence corporate tax avoidance strategies, indicating that strong competition may lead to more aggressive tax avoidance practices. Discussions on the need for international co-

operation in tax competition are becoming more prominent. Garcia-Bernardo et al., 2021 and Agrawal and Wildasin, 2020 explore how countries could collaborate to regulate tax competition and ensure fair tax burdens (Bhattarai et al., 2017; Zirgulis and Šarapovas, 2017). Działo, 2015) highlights the strong phenomenon of tax competition within the EU and suggests that tax harmonization may be necessary to protect member states from the adverse effects of tax competition.

Various empirical studies, such as those by Devereux et al., 2008 and Mihóková et al., 2018, provide evidence on how tax competition affects investment decisions and economic growth (Helcmanovská and Andrejovská, 2021; Mihóková et al., 2018). These studies show that countries with lower tax rates tend to attract more foreign investment but at the cost of reduced tax revenues.

2 Research methodology

For the bibliometric analysis of tax competition in the context of corporate taxation, we utilized the Web of Science (WoS) database, one of the most recognized academic databases, providing extensive coverage of high-quality scholarly publications (Donthu et al., 2021). The careful construction of the dataset is crucial for the success of bibliometric research; therefore, we devoted significant attention to formulating an effective search strategy. The search was based on a combination of keywords and Boolean operators (AND, OR, NOT) to ensure a balance between specificity and comprehensiveness in the retrieved results (Aria and Cuccurullo, 2017). Keywords were applied in titles and author keywords to maximize relevance while maintaining focus on the research field. The search strategy covered the period from 1993 to 2025, initially identifying 457 records in the WoS database. After applying additional filtering criteria, which included the selection of relevant scientific fields and the exclusion of non-relevant research areas, the dataset was reduced to 383 articles. Documents that did not meet the research criteria were excluded. We focused exclusively on peer-reviewed journal articles, while books, book chapters, conference papers, and editorials were excluded to ensure the consistency of the analyzed dataset. For data processing and analysis, we utilized R software, specifically the bibliometrix and biblioshiny packages, which are widely used in bibliometric studies for scientific mapping and quantitative literature analysis. In our bibliometric analysis, we focused on three main research areas:

- Performance analysis – tracking publication trends, citation analysis, and identifying the most influential authors and sources.
- Geographical distribution of research output – comparing scientific production across countries to identify key contributors in the field of tax competition.
- Keyword analysis – identifying the most frequently used terms and thematic areas
- the studied period.
- obtain the most accurate results, we first exported the data from WoS in BibTeX format. Subsequently, using bibliometrix, we conducted data preprocessing, which included removing duplicates, data cleaning and identifying and removing incomplete records.

- ter refining the dataset, we conducted an analysis of scientific production by year, country, and key topics. The results were presented through graphical visualizations, with a focus
- the evolution of research in two distinct periods (1993 – 2014 and 2015 – 2025) to identify changes in research trends. For a more precise interpretation of trends, we divided the analyzed period into two phases:
- 1993 – 2014 – A period primarily characterized by the research of theoretical aspects
- tax competition, focusing on capital mobility, profit shifting, tax incentives, and their impact on foreign direct investment and economic growth.
- 2015 – 2025 – A period marked by the growing research interest in effective tax rates, tax optimization, and global tax policy in the context of OECD BEPS initiatives (OECD, 2016).

This methodological approach ensures a comprehensive overview of the evolution of research in tax competition and corporate taxation, allowing for an in-depth analysis of key trends, influential academic contributions, and future research directions.

3 Results and discussion

In this chapter, we present and discuss the results of various bibliometric analyses. It is important to note that multiple approaches were explored in both performance analysis and science mapping. However, to maintain clarity, coherence, and within the constraints of this paper's length, we have selected only the most essential and insightful findings. The following sections provide a detailed examination of the key trends and patterns identified in the study, starting with an overview of the publication trends in tax competition research.

The table 3 provides key statistics and compares the development of research in two periods (1993–2014 and 2015–2025). The results indicate an increase in publication activity, with the number of documents rising in the second period. International collaboration and the number of co-authors per document have increased, suggesting the growing globalization of research. In contrast, the average number of citations per document has declined, likely due to the expansion of publications and a shorter citation cycle. Overall, the analysis suggests that research in this field is expanding and diversifying, reflecting changes in global tax policy and regulations.

3.1 Publication Trends in Tax Competition Research (1993–2025)

The analysis of the annual production of scientific articles in the field of tax competition and corporate taxation (see Figure 1) has revealed significant trends in the development of academic interest in this topic.

Table 1: Summary Statistics of Research (1993-2025)

Description	1993-2025	1993-2014	2015-2025
Main information about data			
Timespan	1993-2025	1993-2014	2015-2025
Sources	216	101	146
Documents	383	168	215
Annual Growth Rate %	3.49	15.33	14.28
Document Average Age	9.81	16	5.01
Average citations per doc	16.76	27.67	8.23
References	11,622	4,250	8,077
Document contents			
Keywords Plus (ID)	560	248	449
Author's Keywords (DE)	872	313	661
Authors			
Authors	679	249	451
Authors of single-authored docs	105	53	53
Single-authored docs	118	59	59
Co-Authors per Doc	2.17	1.91	2.37
International co-authorships %	26.37	24.4	27.91

Source: Own elaboration

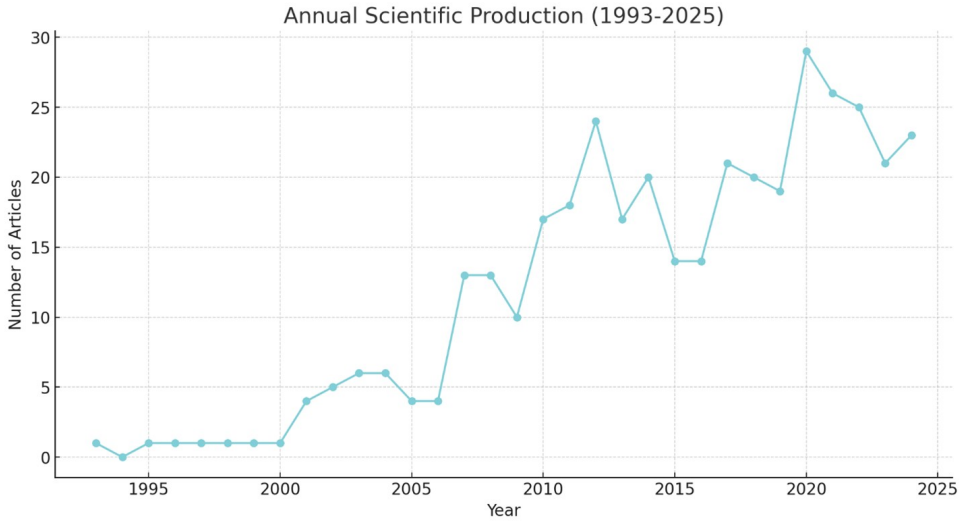

Figure 1: Annual Scientific Production (1993-2025)
Source: Own elaboration

The highest number of publications was recorded in 2020, while the average annual growth rate of research was not stable, showing periods of rapid growth as well as stagnation. The periods of significant growth were particularly evident in the years 2012, 2017, and 2020, which may be linked to major economic and political events. For instance, the 2008 global financial crisis may have prompted academics to examine more closely the effects of tax competition on the stability of public finances and economic growth. In 2015 - 2017, the OECD BEPS (Base Erosion and Profit Shifting) initiative likely stimulated discussions on international tax policies and the need for coordination among countries. The COVID-19 pandemic in 2020 led to unprecedented economic measures, which may have

contributed to emphasizing the role of corporate taxation in stabilizing public finances. Conversely, periods of stagnation or decline were identified in the years 1994, 2005, and 2009, during which there was a temporary slowdown in academic production in this field. This decline may be attributed to factors such as periods of economic growth without major tax reforms, during which tax competition research was not a priority, or a shift in academic focus towards other areas related to tax policy. Overall, the trend suggests that the topic of tax competition and corporate taxation is becoming increasingly important in academic discussions, with its significance rising particularly in periods of economic uncertainty and regulatory changes.

3.2 Geographical Distribution of Research Output

Scientific research on tax competition and corporate taxation is primarily concentrated in economically developed countries, while some regions are underrepresented in academic discussions (see Figure 2).

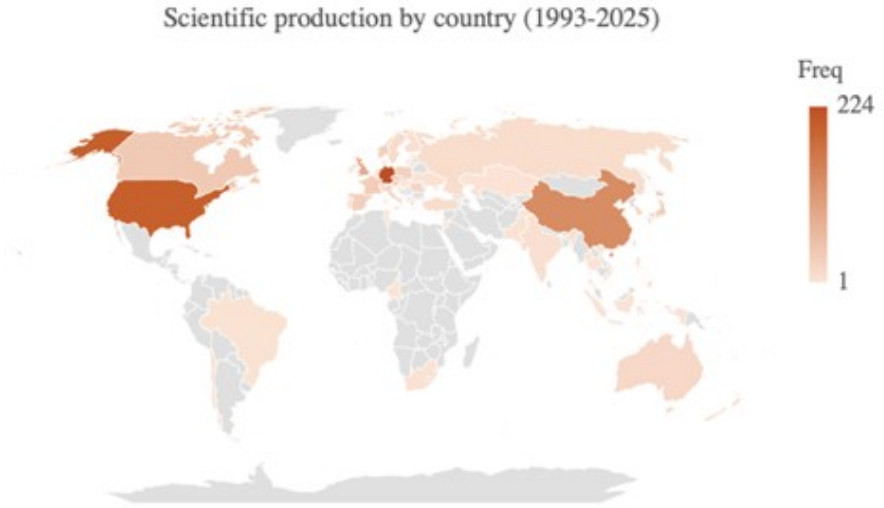

Figure 2: Scientific production by country (1993-2025)
Source: Own elaboration

The highest number of publications comes from Germany (224), the USA (198), and China (131), indicating that the discourse is mainly shaped by countries with significant global economic influence. Germany's dominance may be attributed to its active role in European tax policies and tax harmonization within the EU. The USA's engagement may be linked to major tax reforms, such as the Tax Cuts and Jobs Act (TCJA) of 2017, and its impact on international tax planning. China's growing presence in tax research may be driven by the development of its tax policies and increasing regulation of corporate taxation. Other significant contributors include the United Kingdom (85), Canada (39), Japan (37), and the Czech Republic (34).

The UK's involvement may be influenced by discussions on tax sovereignty after Brexit. Canada and Japan may focus their research on the impact of OECD tax initiatives and cooperation in tax rule harmonization. The Czech Republic's engagement may stem from its experience with low corporate tax rates and efforts to attract foreign investment. Central and Eastern Europe (Czech Republic, Slovakia, Poland) may show increasing research output due to their focus on tax incentives and their impact on economic growth.

Switzerland (27) may have a higher research presence due to its role as a global financial center with a favorable tax regime.

Conversely, several countries, such as Russia, Turkey, and Croatia (10–9 publications), have lower research output, possibly due to limited involvement in global tax initiatives. Developing economies such as Pakistan, Vietnam, and Cameroon produce minimal research in this field, potentially due to a lack of academic resources, a lower prioritization of tax policy in national strategies, or limited participation in international tax reforms. Overall, it appears that scientific research on tax competition is dominated by OECD and EU countries, while the effects of tax competition on developing countries remain less explored. A possible solution to this imbalance could be the inclusion of a broader range of countries in academic research, allowing for a more comprehensive understanding of tax competition in a global context.

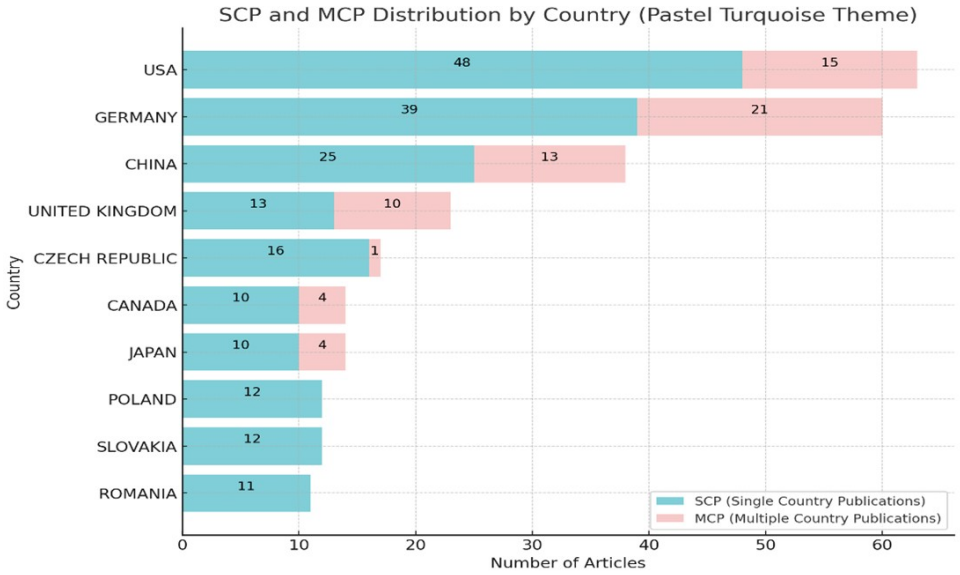

Figure 3: Distribtion of scientific publication by country
Source: Own elaboration

Figure 3 presents the distribution of scientific publications by country, distinguishing between SCP (Single Country Publications) and MCP (Multiple Country Publications). This graph enables an analysis of which countries are the most active in research on tax competition and corporate taxation while also illustrating the extent of their international collaboration.

SCP (Single Country Publications) refers to publications authored exclusively by researchers from a single country. A high share of SCP indicates that research institutions in a given country are capable of producing a significant volume of scientific literature in this field without the need for international collaboration.

MCP (Multiple Country Publications) represents publications co-authored by researchers from multiple countries. A higher share of MCP may indicate strong international linkages and collaboration between research teams, which is crucial when studying tax competition in a global context, where national tax policies influence international capital flows and investment decisions.

The graph reveals that most publications originate from economically developed countries, which are also major centers of global economic activity. These countries have strong academic foundations and a significant number of experts specializing in international

taxation. A high share of MCP in countries such as Germany, the USA and the United Kingdom suggests that research in this field is becoming increasingly interconnected at a global level, reflecting the importance of tax policy coordination among nations amid growing economic integration. These countries actively participate in international tax reforms and discussions on tax harmonization, particularly concerning OECD and EU initiatives related to global minimum taxation and combating tax avoidance.

3.3 Influential Authors and Citation Analysis

Figure 4 presents the 10 most cited authors in academic research published between 1993 and 2014. The number of citations is an important indicator of the influence of specific studies and authors in shaping the discussion on tax competition in the context of corporate taxation.

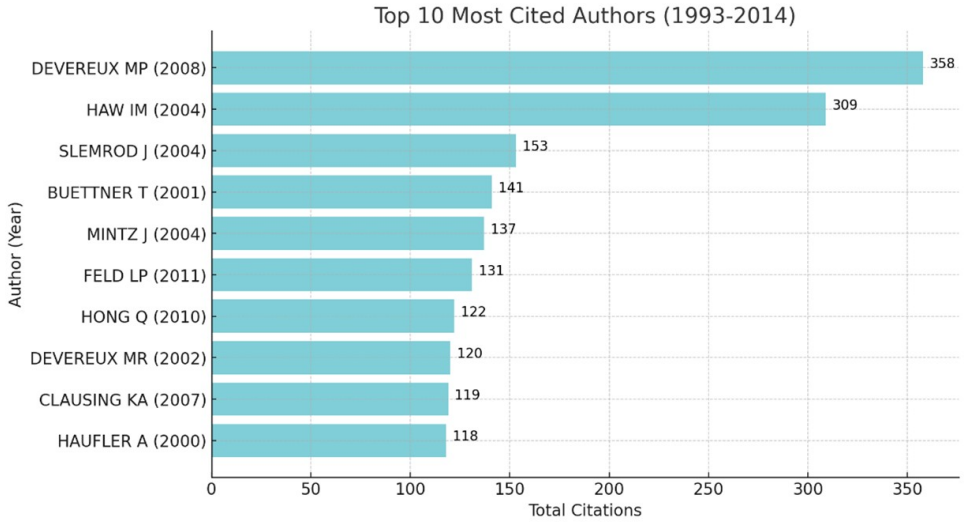

Figure 4: Top 10 most cited authors (1993-2014)
Source: Own elaboration

The most cited author is M.P. Devereux (2008) with 358 citations, indicating that his work is among the most influential in this field. His research focuses on the impact of tax competition on corporate taxation and investor decision-making, significantly shaping academic discourse and policy development in international taxation. Haw I.M. (2004) ranks second with 309 citations, with his research contributing to a better understanding of the relationship between tax policies and corporate behavior in a global context. Other notable authors include Slemrod J. (2004, 153 citations), Buettner T. (2001, 141 citations), and Mintz J. (2004, 137 citations). Their studies explore the theory of tax competition, tax efficiency, and fiscal policy issues in an international context. A common trend among the most cited authors is their frequent publication in prestigious journals such as Journal of Public Economics, Journal of Accounting Research, and International Tax and Public Finance, reflecting the high academic impact of their work.

A particularly notable aspect is the repeated presence of M.P. Devereux (2008, 2002, 2013) among the most cited authors, highlighting his key role in shaping research on tax competition and corporate taxation. This confirms that discussions on tax competition are heavily influenced by a few leading scholars whose research serves as a foundation for subsequent studies. Overall, the citation analysis shows that the most influential studies

on tax competition were published between 2000 and 2014, indicating a significant rise in academic interest in this topic during that period.

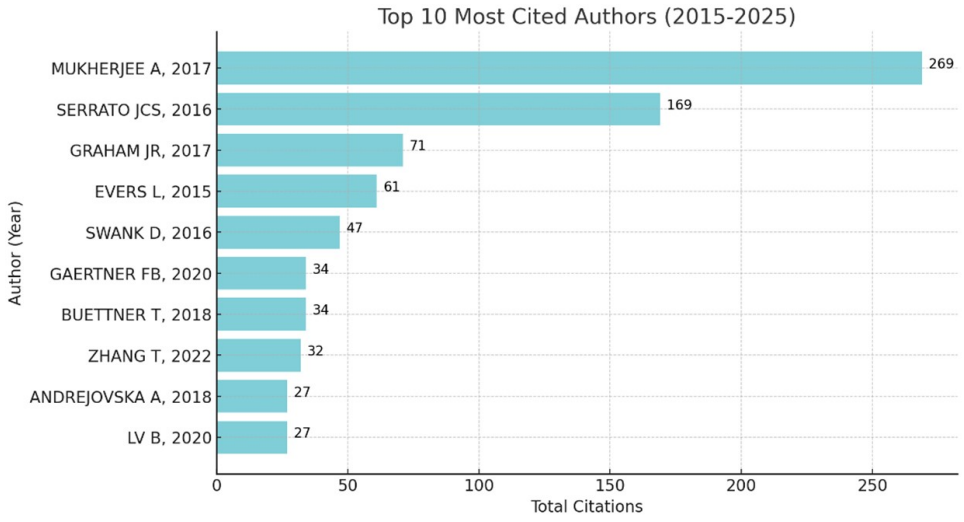

Figure 5: Top 10 most cited authors (2015-2025)
Source: Own elaboration

Figure 5 presents the 10 most cited authors in academic research published between 2015 and 2025, with the number of citations reflecting the significance of their work in shaping the discussion on tax competition and corporate taxation. A high number of citations indicates that their research has had a substantial impact on academic debates and policy-making in the field of international taxation. The most cited author is Mukherjee et al. (2017) with 269 citations, highlighting his key contribution to research on the impact of tax policy on corporate decision-making, particularly in investment and innovation. Serrato (2016), with 169 citations, analyzes how changes in corporate taxation affect economic entities, including firms, workers, and investors, providing valuable insights into the redistributive effects of tax competition. Graham JR (2017), with 71 citations, examines the effects of tax competition on corporate innovation behavior and long-term strategic decisions in a global economic environment.

Other significant studies focus on issues of international taxation and profit shifting. Evers et al. (2015) (61 citations) and Buettner T (2018) (34 citations) explore the effectiveness of various tax incentives and how different tax regimes influence cross-border investment decisions by multinational corporations. Swank D (2016) (47 citations) investigates political factors affecting competition between states in setting tax rates and their impact on fiscal policy. With the increasing digitalization of the economy, research on the taxation of digital firms has also emerged. Zhang T (2022) (32 citations) analyzes the challenges of taxing e-commerce and digital services, which is becoming an increasingly important issue in the context of international tax competition. Gaertner FB (2020) (34 citations) examines tax uncertainty and its impact on corporate financial decision-making, focusing on how regulations and legislative changes influence corporate tax strategies. The most cited authors from 2015 to 2025 have played a crucial role in academic discussions on tax competition and corporate taxation. The high number of citations of their work indicates that their research has provided essential insights into the effects of tax competition on corporate behavior, profit shifting, and international tax policy.

3.4 Key Research Themes and Their Evolution

The analysis of keywords in publications on tax competition and corporate taxation across two distinct periods (1993–2014 and 2015–2025) reveals significant changes in academic discourse (see Figure 6 and Figure 7).

Figure 6: Wordcloud of Most Frequent Keywords (1993-2014)
Source: Own elaboration

While some topics have remained stable as the core of research, others have either experienced a sharp rise or a decline in interest. These shifts may result from new regulatory initiatives, changes in the global economic environment, or increasing pressure for transparency and efficiency in tax systems. In both analyzed periods, tax competition maintained its position as the dominant research topic, being the most frequently used term in publications (43 times in 1993–2014, 47 times in 2015–2025).

This confirms the long-term academic interest in the mechanisms of tax competition among states and its impact on the business environment. Similarly, corporate taxation and foreign direct investment remained stable themes, suggesting that researchers continuously focus on how tax policies influence multinational corporations' economic decisions and international investment flows.

Significant changes in research priorities are reflected in the emergence of topics that were not as prominent in the first period. In 2015–2025, the concept of the effective tax rate gained prominence, whereas it was not among the most frequently used keywords in the earlier period. This shift likely reflects growing academic and political interest in the actual tax burden on firms, which differs from nominal tax rates due to various exemptions, deductions, and tax incentives. Closely related to this is the substantial rise in the use of the term tax avoidance, which was absent from the top 10 in the first period but gained high frequency in 2015–2025. This trend can be attributed to increasing political and regulatory pressure to curb aggressive tax planning by multinational corporations, which has become a major issue. Several factors may explain these changes in research priorities.

Figure 7: Wordcloud of Most Frequent Keywords (2015-2025)
Source: Own elaboration

One of the main reasons is OECD regulatory initiatives, which have implemented measures against aggressive tax planning since 2015, particularly through the Base Erosion and Profit Shifting (BEPS) project. These initiatives likely increased academic interest in practical tools for measuring firms' real tax burdens and the effectiveness of different tax systems Conversely, some topics that were significant in the first period have seen a decline in interest. Transfer pricing, which was a key theme in the first period, has lost relevance in the later period. This decline may be due to a shift in research focus from specific tax strategies used by firms to broader concerns, such as effective tax rates and global initiatives to combat tax avoidance.

Conclusions

This study provides a comprehensive bibliometric analysis of research on tax competition and corporate taxation, identifying key publication trends, research themes, and the geographical distribution of output over the past three decades. The analysis of 383 research articles indexed in the Web of Science (WoS) database from 1993 to 2025 revealed two major research cycles. The first period (1993–2014) focuses on the theoretical aspects of tax competition, such as capital mobility, profit shifting, and tax incentives. In contrast, the second period (2015–2025) reflects a growing emphasis on effective tax rates, tax optimization, and global tax frameworks such as OECD BEPS. The results indicate that academic interest in tax competition has significantly increased due to global political changes and economic events. The introduction of OECD BEPS reforms, discussions on a global minimum tax, and rising concerns about tax optimization by multinational corporations have shaped the current direction of research. Furthermore, the geographical analysis revealed that most research originates from OECD countries, particularly Germany, the USA, and China, reflecting these economies' strong involvement in international tax policy discussions. From a methodological perspective, this study demonstrates the value of bibliometric analysis in mapping research trends and identifying influential contributions in this field. Future research could extend this study by incorporating alternative databases (e.g., Scopus), examining co-authorship networks, or analyzing the impact of specific tax reforms on academic discourse.

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Housing Affordability and Income Inequality

Simona Tóthová[1]

Abstract

Housing is a fundamental human need and a key determinant of social and economic well-being. This study explores the relationship between housing policies, affordability, and income inequality, with a particular focus on regions in the Slovak Republic. Using a comparative approach, the research examines variations in housing availability, ownership patterns, and the role of state interventions in ensuring access to adequate housing. The main focus of the study is on the defining of the Total household disposable income using regression analysis, the study identifies significant determinants of household income, including gross salary, regular property taxes, imputed rent, total housing costs, and the minimum monthly income required for subsistence. The findings highlight that wealthier individuals tend to bear higher housing costs, while lower-income groups struggle with affordability, exacerbating social inequality. The study underscores the need for targeted housing policies, including social housing investment, rental market regulation, and income support measures to improve housing accessibility and reduce income disparities. Addressing these challenges is essential for fostering social cohesion and economic stability. Future research should explore long-term housing affordability trends and policy effectiveness across different economic and social contexts.

Keywords: *affordable housing, housing inequality, income inequality, right to housing, disposable household income*

JEL Classification:

Introduction

Housing is universally recognized as a fundamental human need, essential for a dignified life. It goes beyond being merely a place to live; housing is tied to the fulfilment of basic human needs and is a reflection of the social and economic conditions in which a person lives. In many international frameworks, housing is defined as a fundamental human right that ensures an adequate standard of living, promotes social progress, and enhances living conditions. (Dulaková Jakúbeková, 2022)

In Europe, housing is considered one of the core social rights, essential not only for individual well- being but also for the stability and dignity of society as a whole. (Dulaková Jakúbeková, 2022) Housing is not just about access to a physical space but includes a broader set of rights such as safety, privacy, and the right to a healthy environment, which together contribute to a dignified life. (Dulaková Jakúbeková, 2022)

The right to housing is a right that should be available to all, regardless of their personal background. It should ensure that people have access to adequate shelter, irrespective of their economic situation. (Zákon č. 311/2001 Z. z., 2001) Within the

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European Union, housing is often categorized based on ownership, whether it's owned or rented and the availability of different housing types varies significantly across countries.

Housing markets and availability vary across the EU, with some countries experiencing a greater share of rental housing, while others have a higher proportion of homeowners. In some cases, there is a significant lack of affordable rental options, particularly social housing, which makes it difficult for lower-income individuals and families to secure adequate shelter. (Lux and Kostelecký, 2011)

In recent years, rising energy prices and the increasing cost of living have put additional pressure on households, especially those with lower incomes, making housing more difficult to afford. (Tomšová, 2003) As a result, state intervention becomes crucial in ensuring that everyone has access to affordable housing and that housing-related expenses do not become an insurmountable burden. (Lérová, 1981)

Housing policies differ across the EU, influenced by national circumstances, market conditions, and economic cycles. These differences impact the availability and affordability of housing, contributing to inequality and social polarization. (Whitehead, 2007) Income inequality can also negatively affect economic growth and social cohesion, making it harder for disadvantaged groups to access opportunities and resources. (Tomšová, 2003)

This study examines the significance of housing policies, the right to housing, and their relationship to social and economic well-being. (Tomšová, 2003) It explores how these factors affect the availability and affordability of housing, with a focus on the Slovak Republic and the European Union, and provides insight into the challenges and opportunities for improving access to housing for all citizens. (Whitehead and Scalon, 2007)

1 Theoretical background

Housing is a basic human need and is seen as an element of a dignified life. (Dulaková Jakúbeková, 2022) Housing and its essence are not territorially bound to a specific country, but to the way in which a person's essential needs are met. (Labaj, 1993)

The Universal Declaration of Human Rights (1948) defines housing as a fundamental human right for all citizens, in terms of the right to housing and the right to an adequate standard of living, to social progress and the improvement of living conditions. (Dulaková Jakúbeková, 2022)

The European Charter on Housing (2006) expresses the right to housing as one of the fundamental social rights valid throughout Europe. (Dulaková Jakúbeková, 2022) It defines housing as an essential and important part of a person's life, representing a social right according to the European social model, which is an element of human dignity. (Lux and Kostelecký, 2011)

Housing and the right to housing are not just the right to a dwelling, but mean much more. (Dulaková Jakúbeková, 2022) The European Social Charter also links the right to housing to the promotion of access to affordable housing, which should achieve an adequate standard of living in an effort to prevent and eliminate the problem of homelessness and ensure the financial availability of housing for persons without sufficient resources to secure housing. (Lux and Kostelecký, 2011)

In the Slovak Republic, the right to housing is expressed as a social right, the meaning of which is not only the right to housing, but also other rights related to this right, the right to safety, certainty in the area of the legal form of housing, the right to privacy, the

right to a healthy environment and the provision of drinking water, or many other rights necessary and indispensable for a dignified

human life. (Stanek, 1990) The right to housing belongs to all citizens regardless of nationality, age, gender or ethnicity. (Dulaková Jakúbeková, 2022)

Within the EU, we distinguish between housing based on one of the following criteria:

- in one's own home – called housing in one's own home, (Lérová, 1981)
- rental housing – called housing in another's home, while rental housing can be divided into market or commercial housing, in which the rent price is agreed on the basis of the demand for rental property and the supply of property, and social or public housing, in which the characteristic feature is the fact that the rent price is lower than the market price and is intended primarily for groups of the population with lower disposable income. (Balchin, 2013; Borel, 2019; MASCHAYKH, 2016)

Housing cannot be a public good, because living in a certain apartment means having the right to exclude other people from its use, consumption. (Tvrdoň, 2013) Housing is not only not close to being a public good, but is its opposite. (Whitehead and Scalon, 2007) By living, I not only exclude others from my housing, but I also greatly influence the quality of housing of my neighbors. (Balchin, 2013; Ball, 2015; Dedinsky, 2022; Whitehead and Scalon, 2007)

Differences in the availability and nature of housing can be observed between individual countries in the EU. If we focus on the area of housing by type – house or flat, in which individual households live, we can consider it as an approximately balanced area. (Whitehead, 2007) Within individual countries, we can only observe insignificant differences. In the Slovak Republic, the ratio of people living in flats and the ratio of people living in houses is approximately balanced and very close to the average distribution within EU countries. In recent years, especially during and after the pandemic crisis, it was possible to record a significant shift of the population from flats to houses and at the same time from big cities to the countryside. (Dedinsky, 2022) This trend continues and represents the opposite situation to the urbanization that we recorded in the last years of the last century. (Balchin, 2013; Ball, 2015; Whitehead and Scalon, 2007)

Differences are recorded mainly in the area of the nature of housing – ownership of real estate (living in one's own home) or renting real estate (living in someone else's home). The majority of the population in the Slovak Republic lives in private property, this share represents ninety percent, and on the contrary, only ten percent of the population lives in subletting. (Lux and Kostelecký, 2011) Only half of these rentals represent housing in social rental apartments, which allows us to conclude that the situation with social housing and the availability of rental apartments is not favorable. (Tvrdoň, 2013) Within the EU, the Slovak Republic is in penultimate place in terms of the share of rental real estate, a worse situation in this area can be observed in Romania and a comparable level to our country is reached in Croatia, Lithuania and the Czech Republic. Within the EU, we record the highest share of rentals in Germany and Austria. (Dulaková Jakúbeková, 2022; MASCHAYKH, 2016; Tomšová, 2003)

The area of public rental housing and the provision of social housing is an important issue related to the issue of homelessness and ensuring affordable housing for all citizens. Support from the state is essential to achieve this goal. This aspect is especially important in the counties, in which the housing is not available for the whole society. (Beňová, 2017) The availability of social rental housing is very limited in the Slovak Republic. (Dulaková

Jakúbeková, 2022) This has a negative impact on the overall economic development and progress of the country, as well as attracting the workforce to cities. In the case of providing social housing and addressing housing policy issues, countries such as the Netherlands, Ireland, Denmark, Sweden and Slovenia can be considered as additionally supportive of the given area.

Currently, we can observe a significant increase in energy prices, and for this reason we can also expect an increase in the number of households that cannot afford housing and related expenses. In this case, it is necessary for the state to intervene in this issue and propose appropriate measures that would help households reduce housing and housing-related expenses, as this is a problem that affects all citizens not only in the Slovak Republic, but also in other EU countries. (Labudová, 2020) The issue of high energy prices and the associated increase in housing expenses will affect mainly the population group with lower and middle incomes. Measures by the state must be targeted, but at the same time fair, with the aim of motivating the population and directing them towards reducing consumption, while at the same time providing and ensuring the right to housing and satisfying the basic needs necessary for a dignified human life. (Beňová, 2017; Labudová, 2020; Whitehead and Scalon, 2007)

Support for housing in the form of a social rental system can be implemented directly or indirectly. The direct method is aimed at specific parts of the population for whom housing can be considered unaffordable or very difficult to access. (Borel, 2019) This part of the population would not be able to afford housing, the price of which would be determined on the basis of the action of market forces, without support or subsidies from the state. Indirectly, the state can help and increase the availability of housing in a given country in general, while these measures affect the entire population regardless of the disposable income of households or the social group to which a particular household belongs. (Fund, 2010) The indirect method of measures also benefits the population from a higher income group, for whom this type of assistance would not be necessary. We can also encounter such cases today in the case of various energy price caps, state subsidies for mortgage loans or various forms of motivating the population to save energy, which will reduce overall household spending. Individual EU countries use a combination of these two forms, but to varying degrees preferring either direct or indirect methods of supporting housing. (Borel, 2019; Čavojský and Petřivý, 1983; Fund, 2010)

In the EU, we distinguish four basic approaches to housing policy. The first feature is institutional diversity. Each country has unique approaches to social and housing policy, and different rules on mortgage markets. The second feature is the lack of housing options. This is mostly addressed in an attempt to squeeze a large number of housing options into a small area in a convenient location. The third feature is different regulations in individual EU countries. (Stanek, 1999) Despite a common policy applicable in all EU countries, each country can create its own laws, rules and regulations, the effect of which on the availability of housing can be facilitating or more burdensome. The fourth feature is cyclical fluctuations. The real estate market is characterized by changes in individual economic cycles. From a long-term historical perspective, we can state that in some economic cycles there was a significant increase in demand for real estate, also called a real estate boom, while in some phases it was possible to record stagnation or a decline in demand, especially in periods of significant recession. (Dulaková Jakúbeková, 2022)

Income inequality and social polarization can have a negative impact on economic growth and the quality of life in a society. High inequality can cause certain groups of the population to have limited access to resources and opportunities, which can lead to lower

economic growth. Since these groups are often disadvantaged, they may be less motivated to work and invest in their education. They may also be more vulnerable to crime and other negative social factors. (De Maio, 2007)

Social polarization, which stems from income inequality, can also affect the quality of life. In a polarized society, tensions and conflicts between groups can occur, which can lead to negative consequences for everyday life. (Pickett and Wilkinson, 2015) Polarization can cause groups to not cooperate and can reduce social trust. (De Maio, 2007) Overall, inequality and social polarization can be a major problem for economic growth and the quality of life in a society, so measures should be taken to reduce inequality and polarization and improve social stability and trust. (De Maio, 2007)

When economic growth is accompanied by significant inequalities, such as income inequality, there may be a lack of investment in human capital. (Pickett and Wilkinson, 2015) People from lower-income backgrounds may not have the same access to education and training opportunities as those from higher-income backgrounds, which can limit the growth potential of the economy as a whole. When a significant portion of the population lives in poverty, they may not have the purchasing power to stimulate economic growth, which can further exacerbate inequality. (De Maio, 2007)

2 Research methodology

We analyse the total disposable household income as a dependent variable and as independent variables we consider dwelling type, ownership status, and the voice of the neighbors, vandalism and other housing problems, education. In the research is considered the person on the head of the specific household. Based on the analysis we find only these four variables as significant for this model. This model is statistically significant, and also all of the independent variables in the model are statistically significant, where α equals 5 %.

$$\begin{gathered}\text{Total household income} = f(x_1, x_2, x_3, x_4, x_5) \\ TDHI = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \beta_4 x_{4t} + \beta_5 x_{5t} + u_t\end{gathered} \tag{26}$$

Where:
x_1 = Gross salary from job
x_2 = Regular property taxes
x_3 = Imputed rent
x_4 = Total housing costs
x_5 = Minimum monthly income sufficient for subsistence

We interpret the results of the regression. The estimated baseline income when all independent variables are equal to zero is €3,090. A €1 increase in gross salary is associated with an increase in income by €0.4554. A €1 increase in property taxes is associated with a €23.27 increase in income. This suggests that individuals who pay higher property taxes likely own more valuable properties, which is correlated with higher income levels. A €1 increase in imputed rent corresponds to a €0.6654 increase in income. A €1 increase in total housing costs is associated with an €18.68 increase in income, indicating that individuals with higher incomes tend to spend more on housing. A €1 increase in the estimated minimum monthly income needed to cover basic living expenses is associated with an increase in actual income by €5.166. This could reflect regional or household-level differences in cost of living.

Table 1: Statistical significance of variables and model

Description	**parameter estimation** β	**t value**	**Pr**$(>\|\mathbf{t}\|)$	**statistical significance**
intercept	3090.00	13.008	$< 2e-16$	***
x_1 = Gross salary from main job	0.4554	41.940	$< 2e-16$	***
x_2 = Regular property taxes	23.2700	9.825	$< 2e-16$	***
x_3 = Imputed rent	0.6654	13.212	$< 2e-16$	***
x_4 = Total housing costs	18.68	18.791	$< 2e-16$	***
x_5 = Minimum monthly income sufficient for subsistence	5.166	44.235	$< 2e-16$	***
Adjusted R-squared			0.8566	
p-value				$< 2.2e-16$

Source: own processing based on EU SILC 2020

The model suggests that gross salary, housing costs, and property-related expenses significantly influence income levels. The strong positive coefficients for property taxes, imputed rent, and total housing costs indicate that wealthier individuals tend to have higher expenses in these categories. Additionally, the adjusted R^2 value of 0.8566 suggests that 85.66 % of the variation in income is explained by the independent variables, making this a strong model.

2.1 Summarisation of the test

After testing all assumptions of the correctness of the model (normality, homoscedasticity, autocorrelation, multicollinearity and model specification), we can conclude that all assumptions are met. In the following graph (Figure 1), we visualise the histogram of the variable Total disposable household income.

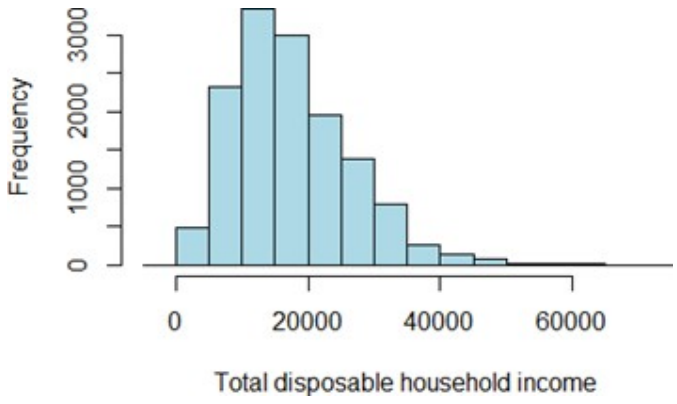

Figure 1: Total disposable household income
Source: own processing based on EU SILC 2020

In the following figure, we can see the boxplots of the selected variables total disposable household income, gross salary from main job, regular property taxes, imputed rent, total

housing costs, minimum monthly income sufficient for subsistence. Based on the figure, we can visualise the values as minimum, maximum, outliers, median and others.

Table 2: Descriptive statistics of variables in the model

Description	Min.	1st Quartal	Median	Mean	3rd Quartal	Max.
1) Total disposable household income	0	10973.9	16104.1	17647.9	23006.8	72741.8
2) Gross salary from main job	0	0	0	4914	10072	51800
3) Regular property taxes	0	18	29	34.37	38.53	380
4) Imputed rent	0	1255	1669	1902	2294	20106
5) Total housing costs	0	160.3	200	204.9	240.5	800
6) Minimum monthly income sufficient for subsistence	140	800	1000	1229	1500	5000

Source: own processing based on EU SILC 2020

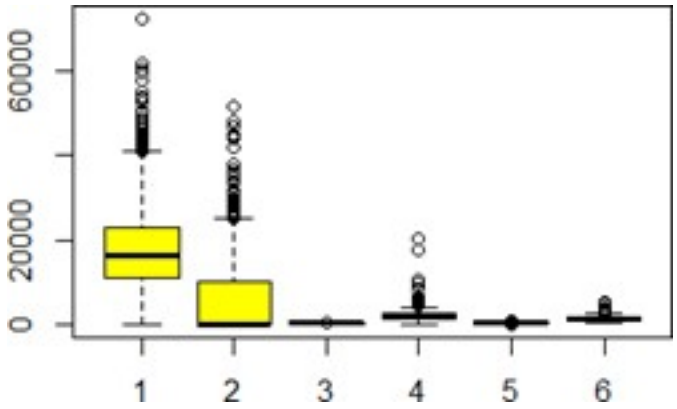

Figure 2: Boxplots of the selected variables

Note: 1 - Total disposable household income, 2 - Gross salary from main job, 3 - Regular property taxes, 4 - Imputed rent, 5 - Total housing costs, 6 - Minimum monthly income sufficient for subsistence

Source: own processing based on EU SILC 2020

The table presents statistical data on various financial aspects related to household income, salary, taxes, housing costs, and subsistence levels. The values are categorized into six statistical measures: Minimum (Min.), First Quartile (1st Quartile), Median, Mean, Third Quartile (3rd Quartile), and Maximum (Max.), providing insight into income distribution and financial obligations.

The minimum recorded income is 0, indicating the presence of households with no disposable income. The 1st quartile value is €10,973.9, meaning that 25 % of households earn below this amount annually. The median disposable income is €16,104.1, showing that half of the households earn below this value, while the other half earn more. The mean (average) income is slightly higher at €17,647.9, suggesting that a small number of high-income households pull the average up. The 3rd quartile value of €23,006.8 indicates that 75 % of households have an income below this amount. The maximum recorded disposable income reaches €72,741.8, showing significant disparity.

According to the variable gross salary from main job, dealing with the values minimum, first quartile, and median values are all 0, suggesting that a substantial portion of households have no income from a primary job, possibly due to unemployment or reliance on other income sources. The mean salary is €4,914, significantly lower than the 3rd quartile value of €10,072, which indicates that only the top 25 % of households earn above this

amount. The maximum recorded salary reaches €51,800, reflecting a significant income gap.

Regular property taxes range from €0 (indicating exemptions or ownership of non-taxable properties) to a maximum of €380. The median annual tax is €29, while the mean is slightly higher at €34.37, indicating that most households pay relatively low property taxes.

The minimum value is €0, likely representing households that do not own a property or have no assigned imputed rent (Estimated rental value of owned homes). The median imputed rent is €1,669, with a mean of €1,902, suggesting that many homeowners benefit from significant housing value contributions. The maximum recorded imputed rent reaches €20,106, reflecting high-value properties.

The total housing costs range from €0 (possibly for homeowners with no mortgage or housing expenses) to a maximum of €800. The median monthly housing cost is €200, while the mean is €204.9, indicating a relatively balanced cost distribution.

The minimum required income for subsistence is €140, though this is exceptionally low compared to the other quartile values. The median necessary income is €1,000, meaning that half of the population requires at least this amount for basic living expenses. The mean subsistence income is €1,229, and the 3rd quartile shows that 75 % of people require at least €1,500. The maximum reported subsistence requirement is €5,000, possibly reflecting high living standards or large households.

3 Results

In the visualization (Figure 3), the bar charts clearly highlight the disparities in reported issue and the pie chart effectively illustrates the proportional distribution of each problem, emphasizing the weight of each issue in the total dataset. In this chapter we focus on the comparison of the problems with housing based on the regions.

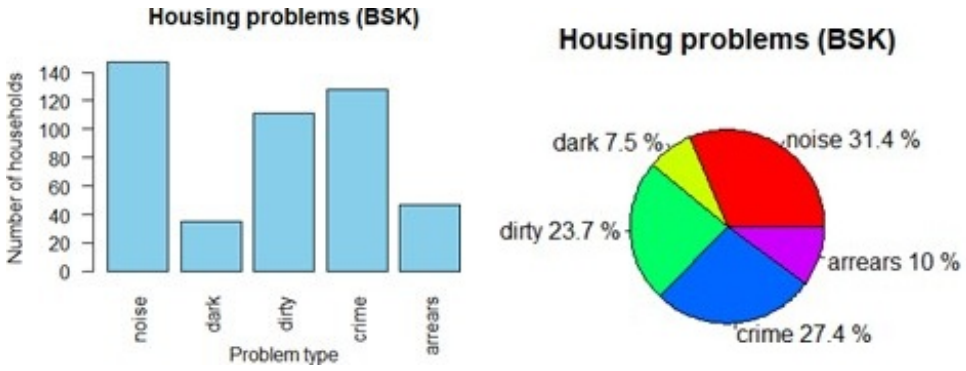

Figure 3: Housing problems in Bratislava Region 2020
Note: BSK - Bratislava Self-Governing Region
Source: own processing based on EU SILC 2020

The data represents the frequency of various housing-related issues in the Bratislava region, visualized through a bar chart and a pie chart. The most common problem in Bratislava region was the problem with the noise, this problem was reported by 147 households, which represent 30.6 % of the household problems in the specific region, therefore we can expect that those households experience problems with loud neighbours, traffic or constructions noise. The second most common issue was crime present in 128

households, represented by 26.7 % of the whole housing problems. This can include crime-related concerns, indicating potential safety and probable security issues possible in this area. The third most common issue is dirty, mentioned in 111 households represented by 23.2 % of the whole household problems, cleanliness appears to be major concern, which can be related to waste management, pollution, or general upkeep of the neighbourhood. Less frequent issues were arrears, such as struggling with financial difficulties, possibly rent or utility payment delay, and also darkness, for example poor lighting conditions, were mentioned at the least reported issues, though it may be contributed to safety concerns.

The results suggest that urban noise, safety concerns, and cleanliness are the most pressing housing problems in Bratislava Region. Addressing these issues, such as better urban planning, security measures, and waste management, could significantly improve living conditions.

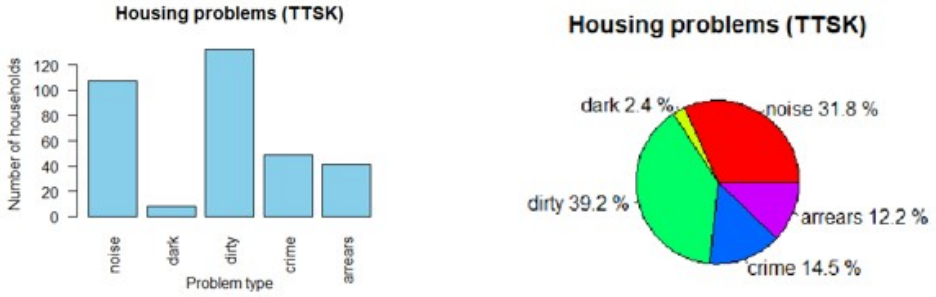

Figure 4: Housing problems in Trnava Region 2020
Note: TTSK - Trnava Self-Governing Region
Source: own processing based on EU SILC 2020

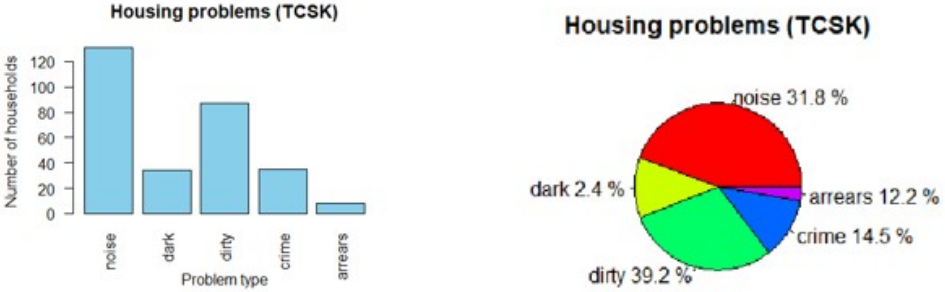

Figure 5: Housing problems in Trenčín Region 2020
Note: TCSK - Trenčín Self-Governing Region
Source: own processing based on EU SILC 2020

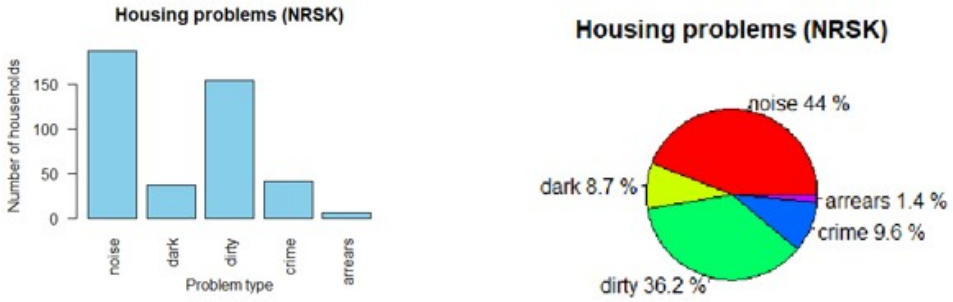

Figure 6: Housing problems in Nitra Region 2020
Note: NRSK - Nitra Self-Governing Region
Source: own processing based on EU SILC 2020

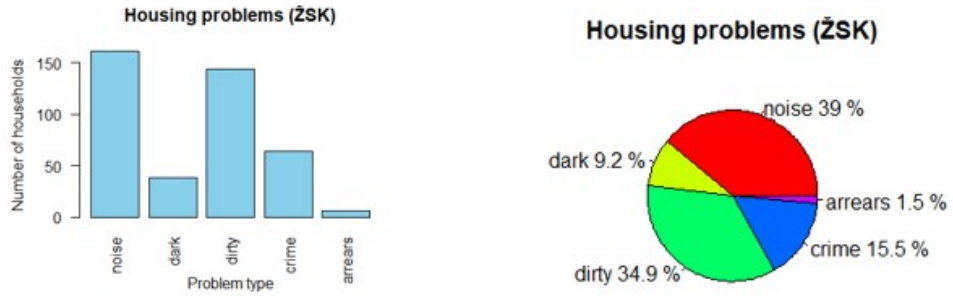

Figure 7: Housing problems in Žilina Region 2020
Note: ŽSK - Žilina Self-Governing Region
Source: own processing based on EU SILC 2020

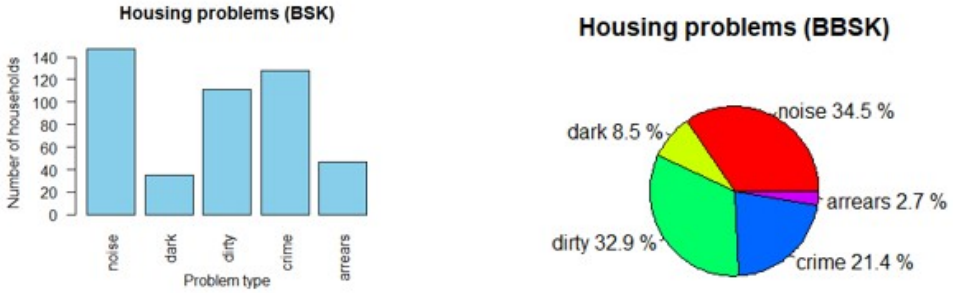

Figure 8: Housing problems in Banská Bystrica Region 2020
Note: BBSK - Banská Bystrica Self-Governing Region
Source: own processing based on EU SILC 2020

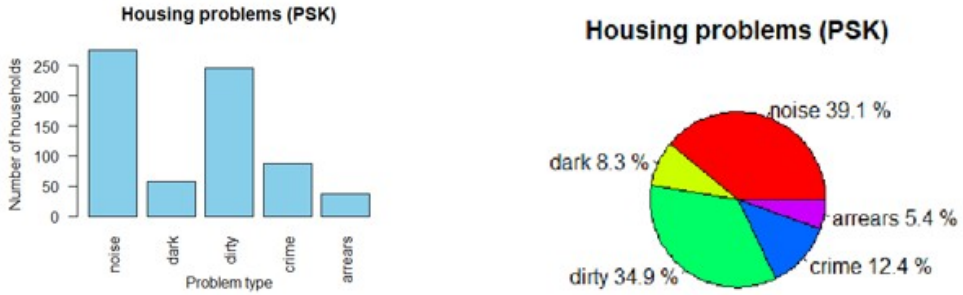

Figure 9: Housing problems in Prešov Region 2020
Note: PSK - Prešov Self-Governing Region
Source: own processing based on EU SILC 2020

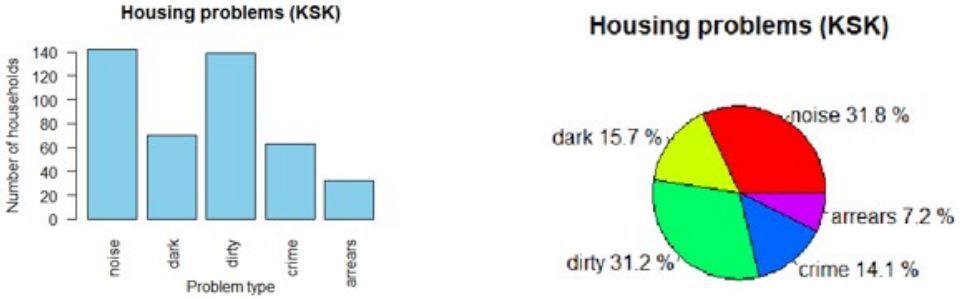

Figure 10: Housing problems in Košice Region 2020
Note: KSK - Košice Self-Governing Region
Source: own processing based on EU SILC 2020

4 Discussion

The issue of housing accessibility needs to be addressed through various state measures, housing allowances, relief for young people who often cannot afford to pay a mortgage or own a property, and the provision of state-owned rental apartments. (Zákon č. 311/2001 Z. z., 2001)

Contribution to state-supported rental housing – currently, an employer can provide an employee with a contribution to state-supported rental housing. From 1 January 2023, this contribution can be provided to an employee who is a tenant of a state-supported rental housing apartment on the basis of a contract under a special regulation. This contribution can be a maximum of €4 per square meter of floor area of the apartment, up to a maximum of €360 per calendar month. The employee must also be in an employment relationship with the employer on the last day of the calendar month for which the contribution is provided. It would be necessary to amend this law and this contribution from the employer should not be voluntary, but should be mandatory for the employer to provide the given contribution to the employee who meets the specified conditions and is interested in the given contribution. (Labudová, 2018)

State rental apartments - as presented by the Speaker of Parliament, state rental apartments should significantly improve the situation with the availability of housing. So far, this proposal has not been used in practice, registration for these rental apartments is starting, but nowadays it is necessary for these apartments to be provided as soon

as possible and at the same time to a larger extent, as we can observe a high interest in these rental apartments. In the case of state rental apartments, the rent paid is lower than the market price, and therefore the total housing costs are significantly lower for these households that could live in these apartments. Abroad, especially in Western Europe, there are many such apartments that have helped millions of applicants. Reliefs for young people and more advantageous mortgages – these reliefs are not sufficient today. These reliefs represent, for example, a tax bonus on interest paid, representing an amount of 50 % of the interest paid in the relevant tax period, with a maximum of €400 per year. This relief can only be claimed by the debtor, not the co-debtor. Currently, this tax bonus can be claimed by a taxpayer who is at least 18 and at most 35 years old on the date of submitting the application for a housing loan and whose monthly income did not exceed 1.3 times the average monthly wage in the economy. (Zákon č. 311/2001 Z. z., 2001)

Conclusions

In conclusion, housing is not just a fundamental necessity but a cornerstone of human dignity, social inclusion, and economic stability. It serves as a key determinant of well-being, influencing access to education, employment, and healthcare, while also shaping the broader social and economic landscape. Across Europe, disparities in housing affordability and availability underscore the pressing need for well-structured policies that ensure access to adequate housing for all, regardless of income or social background.

The ongoing challenges of rising living costs, energy prices, and income inequality place additional strain on lower-income households, making state intervention and social housing initiatives more important than ever. Governments must adopt comprehensive housing policies that balance market- driven approaches with social responsibility, ensuring that housing remains a right rather than a privilege. Without targeted action, growing housing inequalities could exacerbate social polarization, hinder economic growth, and further disadvantage vulnerable populations.

This study highlights the crucial role of housing policies in fostering social cohesion and economic development, with a particular focus on the Slovak Republic and the European Union. By strengthening public housing initiatives, supporting affordable rental markets, and addressing systemic inequalities, policymakers can create sustainable solutions that promote long-term housing security. Ultimately, ensuring access to affordable, safe, and adequate housing is essential not only for individuals but for the stability and prosperity of society as a whole.

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Artificial Intelligence in Consulting

Ina Wunderlich[1], Marcel Lincényi[2]

Abstract

The aim of this research paper is to identify and describe best-practice use cases of artificial intelligence in the consulting industry. With the help of a qualitative research method, which includes expert interviews, central fields of application of AI in consulting are worked out. The results show that AI currently primarily performs supporting tasks, for example in data analysis and automated reporting, which increases the efficiency of consulting processes. However, human expertise remains crucial for comprehensive project management and strategic decisions. The research paper contributes to the discussion on innovation processes in management and is therefore closely linked to the main topics of the conference. It offers both practitioners and academics new perspectives on how AI can be profitably integrated into consulting processes.

Keywords: *artificial intelligence, consulting, use cases, project management*

JEL Classification: *M9*

Introduction

Artificial Intelligence (AI) is an innovative concept that has fundamentally transformed how many industries operate and the quality of services they provide. AI is now present in a variety of areas, from autonomous vehicles and personal assistants to customized and personalized products. Particularly in the business world, AI has created the potential to better understand collected data, allowing companies to optimize processes, minimize risks, foster growth, and improve efficiency. However, it is important to note that AI is an extremely complex technology, and only a few companies are able to fully harness its potential. Most current AI applications rely on machine learning and deep learning.

While AI has radically changed many industries, the consulting sector has been slower in adopting and utilizing these tools. The Living Dictionary Lexico defines AI as "the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages."

The primary goal of this research is to provide readers with a clear understanding of how business consulting is currently conducted and to what extent AI is integrated into the solutions or services offered to clients. An important part of the study was also to determine when AI is seen as an appropriate solution to meet clients' needs. This research aims to introduce readers to the consulting industry and demonstrate how AI is currently applied and utilized in the field.

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Another objective of this study is to examine whether the views of the interviewed expert align with the theoretical framework and literature and how the industry functions in practice. However, this research is not intended to be a scientific paper with precise research data. It relies on secondary data, such as literature and articles, as well as primary data from an interview conducted with an experienced consultant.

1 Theoretical background

1.1 Automation and efficiency

The application of Artificial Intelligence (AI) in management consulting is revolutionizing how firms deliver value, driven by advancements in data processing, predictive analytics, and machine learning capabilities. As industries across the board adopt digital transformation strategies, consulting firms are increasingly leveraging AI to enhance efficiency, enable data-driven insights, and address complex client needs. AI's capacity for rapid data analysis, pattern recognition, and predictive modeling allows consultants to optimize processes and offer clients more customized solutions (Davenport and Ronanki, 2018).

A core benefit of AI in consulting is its ability to automate routine, labor-intensive tasks, such as data cleaning, sorting, and initial analyses, freeing consultants to focus on strategic, high-impact work. For example, AI algorithms can automatically process and interpret data from various sources, allowing consultants to build detailed, data-driven reports in a fraction of the time previously required (Brock and von Wangenheim, 2019). Additionally, predictive analytics enables consultants to offer forward-looking insights, helping clients make proactive rather than reactive decisions (Gentsch, 2018).

1.2 Data-driven decision-making

AI has demonstrated significant potential in data-driven decision-making processes, as well as in enhancing client interaction and relationship management. Natural Language Processing (NLP), for instance, can analyse client feedback or large amounts of textual data to identify sentiment, needs, and emerging concerns. This allows consultants to create tailored strategies that align with client expectations and market sentiment (Chui et al., 2018). NLP's capacity to interpret unstructured data makes it an invaluable tool in areas like customer relationship management and market analysis, as consultants can more accurately map consumer behaviours and preferences (Gamage et al., 2020).

1.3 Strategic Planning and Decision Support

In strategic planning, AI-driven tools such as simulation modelling and scenario analysis are becoming integral to consulting. These models allow firms to test multiple strategies against potential market changes, economic shifts, or regulatory impacts. Consultants can thus offer clients strategic recommendations backed by robust, AI-generated forecasts, which is particularly advantageous in dynamic industries like finance, healthcare, and technology.

A further area of AI application is decision support systems. By integrating machine learning algorithms, consulting firms can enhance decision-support platforms, allowing clients to assess scenarios with greater depth and precision. AI-based decision support

tools streamline complex analyses, which can otherwise be time-consuming and resource-intensive, adding value across industries and enabling clients to make quicker, more informed decisions (Kaplan and Haenlein, 2019).

Despite the clear benefits, the application of AI in consulting is not without challenges. A primary limitation of AI is its dependency on quality data inputs, as inaccurate or biased data can lead to erroneous conclusions. Moreover, AI models require human oversight for interpretation, as they often lack the contextual understanding necessary for complex strategic decisions (Jones and Castle, 2020). Consultants must therefore play an active role in ensuring the data's relevance, accuracy, and ethical use, which requires additional resources and expertise (Wilson and Daugherty, 2018).

Another challenge lies in aligning AI outputs with the broader context of client needs. AI excels at processing data within set parameters, but it may struggle to adapt to unique or changing client contexts, limiting its utility in situations where a high degree of personalization or adaptive strategy is required (Ekbia and Nardi, 2017). Consulting firms thus must balance AI's capabilities with the human insight required for contextual understanding and decision-making.

As AI technologies continue to evolve, their applications in consulting will likely expand, supporting areas such as cognitive computing and digital transformation. The integration of AI-driven virtual assistants and interactive client dashboards, for example, can improve client engagement by allowing real-time access to data insights and fostering more dynamic consultant-client interactions (Company, 2020). Furthermore, as AI becomes increasingly sophisticated, its role in strategy development and decision-making will deepen, making it a core component of future consulting methodologies (Brynjolfsson and McAfee, 2017).

A promising area for future research is the development of AI systems that can better mimic human intuition and adaptive reasoning. Hybrid AI-human models are emerging, enabling AI systems to assist rather than replace human consultants, which fosters "collaborative intelligence." This approach emphasizes the synergy between human insight and AI precision, ensuring that clients receive comprehensive, contextualized guidance that addresses both quantitative and qualitative factors (Raisch and Krakowski, 2021).

The study form (Frey and Osborne, 2013) categorizes work tasks into three broad areas: transactional, relational, and expertise tasks. Each category has a different level of susceptibility to AI automation and unique implementation considerations.

Transactional tasks are routine, day-to-day activities with standardized operational procedures and cadences. These tasks are highly susceptible to AI disruption. Before the implementation of AI, these tasks are predominantly performed by humans. However, after AI implementation, a significant portion of these tasks will be automated, leading to substantial productivity gains. The study indicates that 50 % of transactional tasks will be automated, while the remaining 50 % will be assisted by AI (Frey and Osborne, 2013).

Relational tasks involve managing, consulting, and guiding others, requiring significant human interaction. These tasks have minimal susceptibility to AI disruption. Before AI implementation, relational tasks are entirely human-centric. Post-AI implementation, these tasks will largely remain human-centric, with 80 % of these tasks continuing to be performed by humans and 20 % being assisted by AI (Frey and Osborne, 2013).

Expertise tasks are knowledge-based tasks that require the application of specialized skills. These tasks have low to moderate susceptibility to AI disruption. Before AI implementation, expertise tasks are primarily human driven. After AI implementation,

there will be a balanced integration of AI, with 50 % of these tasks being assisted by AI and the other 50 % remaining human-driven (Frey and Osborne, 2013).

2 Research methodology

2.1 Interview as a research method

The interview is a key data collection method for qualitative research, where information is gathered through structured, semi-structured, or unstructured questions (Adhabi and Blash-Anozie, 2017). As Adhabi and Blash-Anozie, 2017 explain, an interview is an interactive process involving targeted questions to gain specific insights. In qualitative research, interviews aim to understand subjects' perspectives, uncover the meanings behind their experiences, and explore their lived realities (Kvale, 1996).

Despite its value, interview research faces criticism for potential bias, especially if alternative viewpoints are lacking, and for its perceived lack of scientific validity, as responses can be subjective or influenced by emotions (Adhabi and Blash-Anozie, 2017). In this study, interviews were chosen as the primary method due to limited literature on AI's application in business consulting, specifically on its implementation and recommendations to clients. Interviewing an experienced professional provided valuable insights into the practical use of AI in consulting and the thought process guiding consultants' decisions.

2.2 Selection of the Person Interviewed

In this study, three individuals from the consulting industry were interviewed to gather diverse perspectives on the impact of AI in consulting. The first interview was conducted with a senior manager from Campana Schott, who works as a client advisor for project and transformation management. The second interviewee was the Head of AI at Klynfeld-Peat-Marwick-Goerdeler (KPMG) Switzerland, and the third was a consultant from the Tax and Legal department at KPMG Switzerland. This selection allows for drawing conclusions from a range of hierarchical levels and client proximities, as the interviewees come from both a Big Four firm and a smaller boutique consultancy. This diversity provides a comprehensive view of the consulting industry.

All interviewees were asked the same set of open-ended and semi-structured questions. This approach allows for flexibility, enabling the interviewees to freely discuss relevant topics while also ensuring that key aspects are addressed. Each interview lasted between 50 and 70 minutes and was conducted in German. The interviews were conducted online, transcribed, and the statements were linguistically standardized, consolidated, and evaluated.

To gain a comparative perspective from another industry, the financial sector was selected, as it has undergone the most significant changes due to AI in recent years. An additional interview was conducted with a department head of sales management for private customers. The same set of questions was posed to this interviewee. This interview, also conducted in German, lasted 50 minutes. This approach allows for a comparison between the consulting and financial sectors, providing insights into the broader impact of AI across different industries.

2.3 Interview Questions

Not all questions were asked during the interview, but all topics mentioned in the questions were addressed. Below are the questions that were prepared in advance:

- Could you please introduce yourself, including your background and job responsibilities?
- What is your perspective on AI?
- Can you provide an overview of how business consulting is typically conducted?
- What are the current hot topics in various industries?
- Do you offer AI solutions, and if so, what types?
- How do you assess the best AI solution for your clients?
- What is your perspective on AI within the consulting industry?
- What are your thoughts on the future of AI in consulting?
- Which tasks do you think remain largely or exclusively in human hands?

3 Results and discussion

3.1 Analysis of AI Integration in Consulting Practices

The interviews provide an in-depth look into the interviewees' backgrounds, their views on AI, and the ways they integrate AI into consulting practices. The experts began by introducing their professional journeys, outlining their responsibilities and experience in consulting. This context underlines their authority in discussing AI's role within the industry and offers valuable insights into how consulting is adapting to technological advancements.

On the topic of AI, the experts conveyed a balanced perspective, recognizing AI as a powerful tool for enhancing productivity and streamlining processes but also highlighting its limitations, particularly in areas where complex, nuanced problem-solving is required. According to the interviewees, AI serves as a valuable resource but should not be seen as a universal solution. This approach reflects a realistic view of AI's current capabilities, appreciating its contributions while maintaining a critical view on its boundaries within the consulting sector.

When asked to provide an overview of traditional business consulting practices, the interviewees explained that consulting is rooted in understanding client needs, analyzing their challenges, and delivering tailored solutions. While AI has become a significant focus, they stressed that the consulting process remains primarily about meeting the client's specific objectives, rather than focusing solely on the latest technological trends. This highlights a core value in consulting, which is to prioritize client needs over any given technology, no matter how advanced.

Regarding current industry trends, the interviewees noted that digital transformation, process automation, and data-driven decision-making are top priorities across various sectors. AI was identified as a key area of interest, particularly in industries seeking to

optimize supply chains, improve customer experience, and harness predictive analytics for strategic planning. These trends align with broader industry insights, showing how businesses are increasingly leveraging AI to gain competitive advantages.

When discussing their company's AI solutions, the interviewees mentioned a range of offerings, including automation tools, data analysis capabilities, and machine learning models. These solutions are aimed at boosting operational efficiency and providing scalable, practical improvements. Notably, the experts emphasized that while AI solutions are available to clients, they are not positioned as one-size-fits-all answers. This suggests a thoughtful approach to AI, where solutions are tailored to the specific needs and objectives of each client.

In determining the best AI solution for clients, the interviewees described a methodical process that begins with an assessment of the client's unique requirements and challenges. They explained that potential AI solutions are only proposed after a careful evaluation of how well they align with the client's business goals. This approach underscores the importance of using AI thoughtfully, ensuring that it serves a real business purpose rather than being implemented for novelty's sake.

From an industry perspective, the interviewees view AI as both a promising opportunity and a potential disruptor within consulting. They acknowledged AI's ability to enhance productivity and expand consulting capabilities, while also recognizing that it could challenge traditional consulting roles. This dual perspective suggests that while AI might simplify or even automate some aspects of consulting, it is likely to shift the demand toward services that rely on complex human judgment and creativity.

Looking ahead, the interviewees expressed cautious optimism about AI's future in consulting. They predicted that AI will become a staple in the industry as more companies become aware of its advantages, particularly for data analysis and process optimization. However, the experts were careful to note that AI is unlikely to replace human consultants entirely; rather, it will serve as a complementary tool that allows consultants to deliver more impactful solutions. Their outlook suggests that AI will shape consulting practices and redefine how value is delivered to clients, while human expertise will remain essential in areas that require strategic insight and innovative thinking.

3.2 Differences Between AI in Consulting and AI in the Finance Sector

The interviews revealed notable differences in how AI is applied in the consulting and finance sectors. In consulting, AI is primarily used to enhance productivity, streamline processes, and provide data-driven insights that help consultants deliver tailored solutions to clients. The focus is on using AI to support human consultants by automating routine tasks, enabling more efficient data analysis, and offering predictive analytics to inform strategic decision-making.

In contrast, the finance sector has seen a more profound transformation due to AI. Financial institutions leverage AI for a wide range of applications, including risk assessment, fraud detection, personalized financial services, and algorithmic trading. AI in finance is often integrated into core business processes, where it plays a critical role in enhancing operational efficiency, improving customer experience, and driving innovation. The finance sector's reliance on AI for real-time data analysis and decision-making highlights its potential to significantly disrupt traditional financial services.

The interview with the department head of sales management for private customers

at a major financial institution provided valuable insights into these differences. The interviewee emphasized that the finance sector's early adoption of AI has led to substantial changes in how financial services are delivered, with AI becoming an integral part of daily operations. This contrasts with the consulting sector, where AI is still primarily seen as a tool to augment human capabilities rather than replace them entirely.

By comparing the use of AI in these two sectors, it becomes clear that while both industries benefit from AI's capabilities, the extent and nature of its impact differ significantly. The finance sector's more advanced integration of AI serves as a model for other industries, including consulting, to understand the potential benefits and challenges of adopting AI technologies.

Conclusions

The purpose of this research is to provide readers with insights and information about consulting in general and to examine how AI is applied in the industry, based on four interviews conducted with experts in the field. The findings indicate that the extensive theoretical research aligns with the interviewees' views, suggesting that both the theoretical and practical perspectives mutually validate the conclusions drawn.

This research will be valuable for anyone interested in understanding business consulting in general, its operational mechanisms, how AI is currently implemented in consulting, and what role AI may play in the industry's future. It also benefits individuals who wish to learn more about the diverse areas one can work in as a consultant.

The information obtained from the interviews was not surprising and further supported our initial assumptions. However, there were intriguing points regarding how AI is not always the primary solution and that it is simply one tool among many others that consultants use to address clients' issues.

The aim of this research was to assess the extent to which AI solutions and tools are offered as consulting solutions, identify specific solutions provided, and gain a clearer picture of the current capabilities of consulting companies regarding AI implementation.

Unfortunately, the study did not provide an in-depth understanding of how AI is implemented within the consulting industry, as there were no case studies from which to draw such information. From the theoretical analysis and the interviews, it was also evident that AI does not yet play a central role in selecting the appropriate solution for clients. Consultants evaluate clients' needs and choose the most suitable approach, irrespective of the technology involved.

Clients' needs vary greatly, so the required solutions differ as well. Many companies are uncertain about how to implement AI or how it could benefit them. At this point, consultants play a crucial role, suggesting simpler applications like automation, RPA, or chatbot functionalities to introduce AI to the company. As the company becomes more familiar with the benefits and operations of AI, they can then implement more complex and advanced solutions.

Currently, there are numerous smaller consulting firms that specialize solely in AI solutions. They help companies embark on AI by providing straightforward analyses on areas of focus or developing simple algorithms for specific tasks. The AI consulting sector is still relatively new, with no dominant players controlling it.

The findings support several assumptions, as seen in the Harvard Business Review article *AI May Soon Replace Even the Most Elite Consultants*, which discusses the substantial changes the consulting industry will likely face in the coming years. Although the

interviews suggested that AI would enhance efficiency and productivity in the industry in the long term, AI represents an inevitable threat.

However, these findings cannot be considered definitively valid, as they are based on only four interviews, leaving the data insufficient to be scientifically robust. There is also the possibility of bias, as the subject was explored from only a limited number of perspectives. Nonetheless, the alignment between the theoretical work and interview findings suggests that there is truth in the conclusions presented in this paper. The credibility of this paper would be improved by conducting interviews with more experts to confirm the findings and reduce the impact of bias.

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Trade Fairs as a Tool for Promoting Regional Products on the Example of the Subcarpathian Flavors Cluster

Ewelina Nycz[1]

Abstract

This article aims to analyze the participation of producers of local, regional, traditional and organic products affiliated with the Subcarpathian Flavors Cluster in trade fairs. Trade fairs are an important tool for promoting regional products, increasing their visibility, enabling direct contact with customers and supporting regional brand building. The study used desk research methodology, including analysis of cluster documentation, producer websites and social media profiles, and a data classification key developed in Excel. In cases where data was incomplete, producers were contacted directly by phone or email to verify participation. The results show that 67 % of cluster members have participated in trade fairs ranging from local and regional (e.g. EKOGALA, Festival of Subcarpathian Flavours) to national (e.g. NATURA FOOD in Lodz) to international (e.g. Summer Fancy Food Show in New York, BIOFACH in Nuremberg). Fairs are not only a sales opportunity, but also allow producers to improve their image and engage in informal benchmarking. The analysis confirmed that regional fairs were often associated with better booth presentation and local branding, while international events emphasized simplicity due to logistics. These findings underscore the importance of strategic planning for trade show participation and the role of cluster support in collective promotion. Trade fairs are a valuable tool for showcasing culinary heritage and strengthening the market position of regional food producers.

Keywords: *fairs, regional product, cluster, promotion, food marketing*

JEL Classification: *M31, L66, Q13, Q57, R11*

Introduction

The aim of this article is to analyze the participation of producers of regional products (understood as local, regional, traditional, and organic) associated within the Subcarpathian Flavours Cluster in trade fairs. The article discusses the role of trade fairs as a promotional tool, using the example of members of the Subcarpathian Flavours Cluster. The theoretical section outlines the foundations of regional and product marketing, as well as the specifics of ecological and regional products on the market. The research methodology was based on desk research, including an analysis of cluster documentation, the cluster's website, as well as the websites and social media profiles of its members. The data were aggregated using a specially prepared classification key in an Excel spreadsheet. In cases where information was incomplete, producers were contacted directly - by phone or email—in order to fill in the gaps. The results and discussion section presents the scale and characteristics of the producers' participation in trade fairs.

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1 Theoretical background

Trade fairs have always played a crucial role in marketing, serving as platforms for sales and industry networking for exhibitors. These events allow companies to showcase their latest offerings, assess consumer reactions, and refine their products based on real-time feedback from potential buyers and industry experts. Trade fairs fulfill several important functions, including the introduction of new products, facilitating meetings with potential clients, and contributing to increased sales revenues. Research indicates that micro, small, and medium-sized enterprises have reported sales growth ranging from 20 % to 80 % as a result of trade fair participation. Undoubtedly, they remain an effective marketing tool for product promotion.

Trade fairs are a key mechanism for promoting regional products, strengthening local economies, and fostering business relationships. They focus on specific geographic areas, enabling local companies to present their offerings and contribute to regional economic development (Soroka and Wojciechowska-Solis, 2019). Trade fairs play a crucial role in promoting the identity of regional products. They provide local producers with a platform to showcase their unique offerings, thereby preserving and highlighting regional heritage and traditions. These events offer buyers insight into the existence and benefits of local and traditional markets, fostering a deeper connection between consumers and the cultural significance of these products. This not only increases market visibility but also encourages sustainable tourism by presenting local culture and cuisine (Jaďuďová et al., 2020).

Moreover, trade fairs facilitate the utilization of resources and cooperation among local businesses. They provide opportunities for sharing experiences and best practices, which can lead to innovative approaches in the promotion and marketing of regional products. This collaborative environment not only strengthens local entrepreneurship but also contributes to a more integrated economic ecosystem within the region. Therefore, initiatives aimed at supporting the development and promotion of regional products are of great importance. One such solution is the formation of clusters. A cluster is a group of interconnected firms, specialized suppliers, service providers, and institutions related to a particular sector that both compete and cooperate with one another (Porter, 2001).

The Subcarpathian Flavours Cluster initiative was established in January 2013 by 21 entities from the Podkarpackie region. These include producers of regional, traditional, and organic products, owners of gastronomic establishments offering local and traditional dishes, as well as business environment organizations—most notably the Association for the Development and Promotion of Podkarpacie "Pro Carpathia", which serves as the cluster's coordinator. The cluster's objectives include integrating producers, enhancing cooperation with the scientific community, promoting local products, and obtaining external sources of funding (Pieniażek and Nycz, 2015). The Subcarpathian Flavours Cluster stands out in particular for its focus on quality and tradition in food production in the Podkarpackie region. This strategic initiative aims to enhance the visibility and market appeal of regional food products through the cooperation of local producers, educational institutions, and other stakeholders (Smaki", 2022). Clusters such as this one play a crucial role in the globalized economy, as they support the development of participating enterprises and promote regional entrepreneurship (AUMA (Ausstellungs– und Messe–Ausschuss der Deutschen Wirtschaft e.V.), 2014).

Regional products currently play a significant role at many regional, national, and international trade fairs. They promote not only the products themselves, but also culi-

nary heritage and their producers (Ministry of Agriculture and Rural Development, 2025; Rolniczego, 2025). For example, in the Podkarpackie Voivodeship, flagship trade fairs for regional product producers include EKOGALA – the International Fair of High Quality Food and Products – as well as the Festival of Subcarpathian Flavours. Both events aim to showcase the potential of the products and, consequently, their producers (EKOGALA, 2025; Górno, 2025). These events focus on specific geographic areas, providing local producers with a platform to reach a broader audience and to foster connections with potential buyers and partners (Grześ-Bukłaho, 2016).

2 Research methodology

The research methodology applied in this article is based on desk research (Maison, 2022). The collected material included documentation of the Subcarpathian Flavours Cluster's activities, such as publications, the cluster's official website, websites of individual members, and their social media profiles. The analyzed data were aggregated using a classification key prepared in an Excel spreadsheet. The aim of the analysis was to identify whether a given cluster member participated in trade fairs or related events. Clear data selection criteria were adopted: trade fairs/events (code: 0 – if not applicable, 1 – if applicable). In cases where information was insufficient, the producers were contacted directly—by phone or email—to supplement the data.

3 Results and Discussion

The analysis results indicate that 67 % of the members of the Subcarpathian Flavours Cluster participated in trade fairs. Cluster members took part in trade fairs as exhibitors at:

- local and regional fairs: the Festival of Subcarpathian Flavours in Górno, the Alpine-Carpathian Cooperation Forum in Rzeszów, and EKOGALA – the International Fair of High Quality Food and Products;
- national fairs: the "Regionalia" Regional Products Fair in Warsaw and the NATURA FOOD International Fair of Organic and Traditional Food in Łódź;
- international fairs: the Summer Fancy Food Show in New York (USA) and the BIOFACH Fair in Nuremberg (Germany).

Table 1: Participation of cluster members in trade fairs (as of 30 May 2022)

Category	**Value**
Number of cluster members	68
Percentage of members participating in the trade fair	67%

Source: own research based on collected data.

The analysis of websites and social media profiles revealed the significance of trade fairs in establishing direct relationships with customers through participation in local, regional, and national events. Websites and social media posts often featured photographs of trade fair booths, showcasing interactions with customers, sales processes, and product tastings.

Attention to brand image was also observed, particularly in the form of well-branded booths, promotional materials, and the attire of representatives presenting at the stands. In the case of international fairs, simpler booth arrangements were noted, along with more formal dress codes among cluster representatives and a smaller number of products on display. This may have resulted from the specific nature of the fairs themselves (e.g., sales-oriented vs. promotional events), as well as from logistical considerations. Booths presented at regional and national fairs in Poland were generally larger, which is likely due to the higher costs associated with participation and exhibition space at international events.

The analysis also identified cases of participation in trade fairs as visitors, for example during events such as the Cheese Festival in Bra (Italy) or the Jarmark Świetojański in Poznań (Poland), as reported in public communications. Such participation serves as an opportunity to observe good practices and to initiate potential cooperation.

Conclusions

Consumer interactions at trade fairs play a crucial role in shaping purchasing behavior and overall product experience. Understanding the mechanisms behind consumer decision-making is essential from both marketing and managerial perspectives, as it allows for the identification of factors influencing purchasing and consumption patterns (Guerrero et al., 2020). Trade fairs serve as an effective promotional platform for local producers, enabling direct interaction with consumers and representatives of companies interested in regional and sustainable offerings. By showcasing local and traditional products, these events enhance the attractiveness of rural areas and contribute to the preservation of cultural heritage and traditional agricultural practices (Jaďuďová et al., 2020). Participation in trade fairs allows producers to build brand recognition, strengthen customer loyalty, and strategically position themselves in markets, including international ones (Silva et al., 2018). The analysis of the participation of Subcarpathian Flavours Cluster members indicates a high level of awareness regarding the potential benefits of trade fair involvement. This is confirmed by the cluster's intensive activity at both national and international levels. Both the individual participation of producers and joint cluster initiatives—such as the organization of collective exhibition stands - contribute to the development of the regional product sector in the Podkarpackie Voivodeship and strengthen the market position of these products both nationally and internationally. Through their presence at international events, regional products from Podkarpacie gain opportunities for promotion beyond Poland's borders, building the recognition and brand value of Subcarpathian Flavours.

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Understanding Financial Exclusion: A Global Analysis

Tamara Petrikova[1]

Abstract

The financial sector worldwide has undergone a significant digital transformation in recent years, helping to increase financial inclusion. However, there are still some countries where the level of financial inclusion is low, indicating the reasons for financial exclusion. The main aim of the study is to identify the reasons for financial exclusion and identify factors with a significant impact on these phenomena. For this analysis, we use respondent-level data from the Findex global database on a sample of 123 countries in 2021, a dataset containing over 127000 observations. An analysis of eight factors that contribute to individuals not having a bank account shows that low education and low income belongs among the key factors leading to financial exclusion. On the other hand, access to the Internet reduces the likelihood of exclusion, especially for involuntary reasons for financial exclusion.

Keywords: *digitalisation, financial exclusion, findex, probit model.*

JEL Classification: *G21*

Introduction

The financial sector has experienced a radical digital transformation in recent years. This shift was further accelerated by the adoption of digital financial solutions during the COVID-19 pandemic, reshaping how people interact with financial services. According to last Findex database findings, 76 % of adults globally now hold an account at a financial institution, significant increase from 50 % a decade ago. However, despite this progress, financial inclusion is still unequally distributed across regions. Ozili, 2023 highlighted, that large segments of the population in certain areas still face financial exclusion due to limited banking infrastructure and underdeveloped digital payment systems. As a result, many individuals depend on cash transactions or informal financial networks, such as borrowing from family and friends. The prevalence of informal financial practices further deepens economic disparities and slows financial sector development. Zins and Weill, 2016 emphasize the importance of distinguishing between voluntary and involuntary financial exclusion when designing policies to enhance financial inclusion. Addressing these barriers is essential for fostering economic growth and ensuring broader access to financial services worldwide.

1 Theoretical background

Financial inclusion is commonly defined as access to and use of formal financial services, serving as a key indicator of financial development. The concept has been explored from

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various perspectives in the literature. Allen et al., 2016 and Demirgüç-Kunt et al., 2022 emphasize that opening a financial account is the foundational step toward inclusion. Account holders can send and receive money and benefit from additional financial services, which help them manage financial risks more effectively than those without access. According to the Database, 2023, financial inclusion involves providing accessible and affordable financial products adaped to the various needs of individuals and businesses. These services include payments, savings, loans, and insurance, ensuring responsible and appropriate financial participation.

In contrast, financial exclusion refers to barriers that prevent individuals from accessing essential financial services. Leyshon and Thrift, 1995 describe it as a process that marginalizes disadvantaged individuals from financial opportunities. Sinclair, 2001 defines financial exclusion as the inability to obtain necessary financial services, while Claessens, 2006 links it to broader social exclusion, where access depends on education, employment, and income. Cabeza-García et al., 2019 highlight income inequality as a major factor influencing financial inclusion, as individuals with lower incomes face greater difficulties accessing financial services. Limited financial access not only reinforces poverty but also slows economic growth. Furthermore, Wang and Guan, 2017 argue that financial exclusion exacerbates income inequality, threatens social stability, and impedes social development goals.

Zins and Weill, 2016 emphasize the importance of distinguishing between voluntary and involuntary exclusion. People who choose not to open an account due to personal preferences or financial constraints fall into the voluntary exclusion category. In contrast, involuntary exclusion arises from external barriers such as geographic inaccessibility, high costs, or documentation requirements. The Database, 2023 identifies multiple reasons for financial exclusion, including a lack of disposable income, high service costs, difficulties in meeting identification requirements, and distrust in financial institutions. Cano et al., 2013 further highlight low financial literacy, lack of awareness about financial products, and unstable employment as additional factors limiting financial access.

Demirgüç-Kunt et al., 2022 dentify socio-demographic factors such as gender, age, employment, income, and education as a key determinants of determining financial inclusion and identifying the reasons for financial exclusion. The authors also argue that financial exclusion across countries leads to inefficiencies that hinder economic growth. Understanding these factors is crucial for governments, central banks, and regulators to implement effective policies that promote financial inclusion.

Our study builds on previous research. Our contribution lies in integration of digitalisation into the group of independent variables. Additionally, we introduce a nonlinear approach to financial exclusion analysis. A key contribution of our work is applying the Robin Hood algorithm, as presented by Simonsohn, 2018, to examine potential nonlinear relationships between age and financial exclusion. This method allows us to explore whether age consistently affects financial exclusion in a single direction or whether the relationship changes at a certain threshold. By incorporating these elements, our research provides deeper insights into the determinants of financial exclusion in an increasingly digitalized financial landscape.

2 Research methodology

Today, having a financial account is essential for accessing financial services. Fungáčová and Weill, 2014 highlight the importance of distinguishing between voluntary and in-

voluntary financial exclusion, as this differentiation has important policy implications. Addressing involuntary exclusion highlights barriers to financial inclusion that can be mitigated through appropriate policy interventions. Involuntary financial exclusion applies to individuals who do not own an account because financial institutions are too far away, the costs are too high, they lack the necessary documentation, or they do not trust financial institutions. On the other hand, voluntary financial exclusion occurs when adults choose not to have a financial account due to a lack of financial resources, religious reasons, an account owned by another family member, or a personal belief that financial services are unnecessary.

To examine financial exclusion, we utilize data from the Findex database and apply a regression model with a binary dependent variable, following the approach of Coss, 2015. This model allows us to assess the relationship between explanatory variables and the likelihood of financial exclusion. We assume that this probability depends linearly on the characteristics of the individuals in the dataset, represented by the explanatory variables in our model.

Our analysis relies on survey responses from 2021, using micro-level data to identify the key determinants of financial exclusion. We investigate how personal characteristics (independent variables) influence different reasons for being excluded from the financial system (dependent variable). The fundamental structure of the probit model applied at the micro level can be expressed as follows:

$$\begin{aligned} \text{Financial exclusion}_i = \beta_0 &+ \beta_1 \text{Gender}_i + \beta_2 \text{Age}_i + \beta_{21} \text{Age}_i^2 \\ &+ \beta_3 \text{Education}_i + \beta_4 \text{Income}_i + \beta_5 \text{Employment}_i \\ &+ \beta_6 \text{Internet}_i + \beta_7 \text{Country}_i + \epsilon_i \end{aligned} \tag{27}$$

To determine the main reasons why individuals do not have an account at a financial institution, we analyse responses from the Database, 2023. Respondents were asked to indicate whether specific factors contributed to their lack of a financial account. Each response option (e.g., too far away, too expensive, lack of necessary documentation, distrust in financial institutions, religious reasons, insufficient funds to use financial services, another family member already owns an account, no need for financial services) is treated as a separate dummy variable. If a respondent selected a particular reason, the variable is assigned a value of 1; otherwise, it is set to 0. If the results from the Robin Hood algorithm indicate a nonlinear relationship, the model will incorporate a quadratic term for the Age variable to better capture potential variations in the impact of age on financial exclusion.

Table 1 presents variable definitions. The analysis includes only respondents who provided a clear "yes" or "no" answer regarding their reasons for financial exclusion.

3 Results and Discussion

The statistical analysis of barriers to financial account ownership reveals that, across all countries, the most frequently cited reason for not having an account is a lack of financial resources. Approximately 70 % of unbanked individuals identified this as the primary obstacle. Our findings indicate that this issue was particularly prevalent in Sub-Saharan Africa (48 %) and the Middle East North Africa (45 %) in 2021. The second most commonly reported barrier is the high cost of financial services, mentioned by 35 % of respondents, with individuals in Latin America the Caribbean (22 %) and Sub-Saharan

Table 1: Definition of variables

Name	**Definition**
Gender	Dummy = 1, if female; 0 otherwise
Age	Age in years
Education: primary	Dummy = 1, if respondent has primary tertiary education; 0 otherwise
Education: tertiary	Dummy = 1, if respondent has primary tertiary education; 0 otherwise
Income: quintile 1	Dummy = 1, if respondent is within the first income quintile; 0 otherwise
Income: quintile 2	Dummy = 1, if respondent is within the second income quintile; 0 otherwise
Income: quintile 3	Dummy = 1, if respondent is within the third income quintile; 0 otherwise
Income: quintile 4	Dummy = 1, if respondent is within the fourth income quintile; 0 otherwise
Employment	Dummy = 1, if respondent is employed; 0 otherwise
Internet	Dummy = 1, if "internet access" in Findex is 1; 0 otherwise
Country	Country dummy
Distance	Dummy = 1, if FIN11A in Findex is 1; 0 otherwise
Expensive	Dummy = 1, if FIN11B in Findex is 1; 0 otherwise
Lack of documentation	Dummy = 1, if FIN11C in Findex is 1; 0 otherwise
Lack of trust	Dummy = 1, if FIN11D in Findex is 1; 0 otherwise
Religious	Dummy = 1, if FIN11E in Findex is 1; 0 otherwise
Insufficient funds	Dummy = 1, if FIN11F in Findex is 1; 0 otherwise
Family	Dummy = 1, if FIN11G in Findex is 1; 0 otherwise
No need	Dummy = 1, if FIN11H in Findex is 1; 0 otherwise

Source: own

Africa (21 %) being the most affected. Other significant reasons for financial exclusion include a perceived lack of need for formal financial services (32 %), absence of necessary documentation (28 %), long distances to financial institutions (27 %), distrust in financial institutions (23 %), and reliance on a family member's account (20 %). Religious beliefs appear to play a minor role, with only 8 % of respondents citing them as a factor. These findings are consistent with previous research by Fungáčová Weill (2015) and Allen et al. (2016), which examined global patterns of financial exclusion. Their studies suggest that individuals with limited financial resources often view bank accounts as unnecessary, as the costs associated with maintaining an account may outweigh the perceived benefits.

Demographic analysis indicates that 47,12 % of respondents are women, with an average age of 41,71 years. Approximately 25 % of respondents have only primary education or lower, while 24,23 % have completed higher education. Income distribution shows that 16.16 % of respondents belong to the lowest income quintile, whereas 25,82 % are in the highest income bracket. Additionally, over 64 % of respondents are employed, and 73,17 % reported having internet access.

To better understand financial exclusion, our analysis follows the framework proposed by Amari and Anis, 2021, distinguishing between different exclusion types. Involuntary financial exclusion occurs when individuals face external barriers preventing account ownership, such as geographic distance, high service costs, lack of required documentation, and low trust in financial institutions. Voluntary exclusion, on the other hand, results from personal choices, including religious beliefs, financial constraints (lack of funds), reliance on an existing family member's account, or a lack of perceived need for financial services. Table 2 and Table 3 present these categories in detail, illustrating the factors contributing to financial exclusion worldwide.

Income significantly influences the likelihood of financial exclusion, particularly among

individuals in the lowest income quintile, who face the highest barriers. These include long distances to financial institutions, high service costs, and a lack of required documentation. Additionally, they are more prone to distrusting financial institutions. Distance is especially problematic, as traveling to bank branches can be both expensive and inconvenient. Research by Mossie, 2023 suggests that expanding digital banking services, including online and mobile banking, could help bridge this gap and improve financial access.

Education level is another critical factor in involuntary financial exclusion. Individuals with only primary education are more affected by barriers such as distance, high service costs, and documentation requirements - the latter increasing exclusion probability by 6,11 %. Limited financial literacy, often linked to lower education levels, makes it harder for individuals to navigate banking systems. Enhancing financial education at an early stage could help mitigate these challenges. On the other hand, individuals with higher education are less impacted by geographical and documentation-related barriers but are more likely to distrust financial institutions. Their increased awareness and access to financial information may lead to greater scrutiny of banking practices, particularly during economic instability.

Table 2: Involuntary reasons

Category	**Geographical distance**	**High costs of financial services**	**Lack of necessary documentation**	**Low trust in banks**
Gender	0.0150 (0.0144) ***	0.0081 (0.0138) **	0.0055 (0.0140) ***	0.0331 (0.0146) ***
Age	-0.0095 (0.0044) ***	-0.0044 (0.0044) **	0.0002 (0.0044) ***	-0.0021 (0.0044) ***
Age^2	–	–	–	–
Education: primary	0.0930 (0.0105) ***	0.0138 (0.0133) **	0.0199 (0.0199) **	0.0198 (0.0199) ***
Education: tertiary	-0.4577 (0.0690) ***	-0.0167 (0.0206) **	0.0232 (0.0287) ***	0.0199 (0.0199) **
Income: quintil 1	0.0223 (0.0225) ***	0.0291 (0.0229) ***	0.0102 (0.0247) **	0.0227 (0.0227) **
Income: quintil 2	0.0549 (0.0226) ***	0.0697 (0.0241) ***	0.0224 (0.0242) ***	0.0435 (0.0212) ***
Income: quintil 3	0.0239 (0.0228) **	0.0567 (0.0257) ***	0.0247 (0.0214) ***	0.0357 (0.0245) ***
Income: quintil 4	–	–	–	–
Employment	0.0368 (0.0134) ***	0.0417 (0.0144) **	0.0520 (0.0163) ***	0.0047 (0.0167) ***
Internet	0.0101 (0.0105) ***	0.0150 (0.0132) **	0.0150 (0.0153) ***	0.0150 (0.0153) ***
Country fixed effects	No	Yes	Yes	Yes
No. observation	39220	39220	39220	39220
AIC	44911	44911	44911	44911
Pseudo R2	0.0235	0.0098	0.0437	0.0069
Likelihood	-22443 (df=12)	-25118 (df=13)	-22491 (df=13)	-21258 (df=13)

Note: The dependent variable represents one of the involuntary factors contributing to financial exclusion. The first row presents the estimated marginal effects, while the second row displays the standard errors. Asterisks indicate statistical significance at the *** 99%, ** 95%, and * 90% confidence levels.

Source: own

Integrating Internet access into the analysis allows us to explore whether it helps overcome barriers to financial inclusion. We hypothesize that better Internet availability reduces involuntary exclusion, particularly by addressing issues such as the distance to financial institutions and high transaction costs of in-person banking. Our findings confirm that individuals with Internet access face fewer challenges related to geographical constraints and service costs. However, access to information alone does not necessarily improve trust in financial institutions.

When it comes to voluntary financial exclusion, individuals from low-income households are more likely to forgo financial accounts if another family member already has

one or if they see no need for it. This pattern is most evident among those in the lowest income quintiles, suggesting that financial constraints lead households to consolidate banking resources rather than maintain multiple accounts.

Employment status influences both voluntary and involuntary financial exclusion. Employed individuals are more affected by factors such as distance, service costs, lack of documentation, and distrust in banks. However, they are less likely to avoid financial services for reasons related to family or personal preference. Gender disparities also play a role in financial exclusion. Women are more likely than men to lack financial accounts due to barriers such as geographical distance, cost, distrust, religious beliefs, and economic constraints. This is consistent with previous research indicating that women in underserved regions face greater socio-economic and structural challenges in accessing financial services.

Table 3: Voluntary reasons

Category	**Religious beliefs**	**Financial constraints**	**Existing family account**	**Lack of need for financial services**
Gender	0.0064 (0.0191) **	-0.0152 (0.0142) ***	-0.0318 (0.0155) ***	0.0266 (0.0139) ***
Age	-0.0001 (0.0006) *	0.0019 (0.0015) **	0.0055 (0.0017) ***	-0.0001 (0.0004) ***
Age^2	–	–	–	–
Education: primary	0.0260 (0.0200) **	0.0037 (0.0037) ***	0.0131 (0.0066) ***	-0.0192 (0.0192) ***
Education: tertiary	-0.0022 (0.0036) **	-0.0007 (0.0049) **	0.0136 (0.0066) ***	-0.0192 (0.0192) ***
Income: quintil 1	0.0154 (0.0053) ***	0.0652 (0.0074) **	-0.0484 (0.0096) ***	-0.2141 (0.0221) ***
Income: quintil 2	0.0085 (0.0082) ***	0.0653 (0.0067) **	-0.0025 (0.0025) ***	-0.0166 (0.0055) ***
Income: quintil 3	0.0008 (0.0087) **	0.0655 (0.0058) **	0.0014 (0.0030) ***	-0.0059 (0.0033) ***
Income: quintil 4	–	–	–	–
Employment	0.0011 (0.0013) **	0.0655 (0.0014) ***	0.0157 (0.0009) ***	0.0139 (0.0005) ***
Internet	0.0015 (0.0200) ***	0.1473 (0.0165) ***	0.0160 (0.0160) **	0.0144 (0.0144) ***
Country fixed effects	Yes ***	Yes ***	Yes ***	Yes ***
No. observation	39220	39220	39220	39220
AIC	46563	37829	48713	37293
Pseudo R2	0.0082	0.0224	0.0355	0.0108
Likelihood	-11324 (df=12)	-23268 (df=13)	-18901 (df=13)	-24344 (df=12)

Note: The dependent variable represents one of the voluntary factors contributing to financial exclusion. The first row presents the estimated marginal effects, while the second row displays the standard errors. Asterisks indicate statistical significance at the *** 99%, ** 95%, and * 90% confidence levels.

Source: prepared by the author

Age is generally not a significant determinant of financial exclusion, except in documentation - related challenges. Younger and older individuals are more likely to be excluded due to difficulties understanding or obtaining required documents. The youngest respondents (15+) are also more likely to rely on family accounts or perceive no need for financial services, as they often depend on cash allowances from their parents. These findings align with previous research (Fungáčová Weill, 2015; Zins Weill, 2016; Amari Anis, 2021) across different regions, reinforcing the need for targeted policies to address involuntary and voluntary financial exclusion.

Conclusions

The use of financial services is an integral part of modern life. The issue of financial inclusion has gained prominence with the increasing implementation of digital technologies

in the banking sector. Access to financial accounts enhances the availability of financial services, encouraging the use of additional banking products. Conversely, limited access to these services places certain groups at risk of financial exclusion due to distance from banks, lack of awareness about financial products, low financial literacy, insufficient internet access, and psychological barriers like distrust in financial institutions or high living costs.

Given the ongoing digitalisation, it is crucial to analyse the level of financial inclusion and the reasons behind financial exclusion. Using probit regression analysis, we examine key factors influencing financial exclusion. The Robin Hood algorithm and a two-line test also help assess potential nonlinear relationships between exclusion factors and respondents' age. Our findings indicate that socio-demographic characteristics, including gender, income, education, employment status, and age, significantly influence financial exclusion. The results suggest that digitalisation is vital in enhancing financial inclusion, leading to increased access to accounts, savings, credit, and digital payments. A higher degree of digitalisation effectively reduces barriers to financial access.

By identifying the causes of financial exclusion, regulatory authorities can address factors that contribute to low financial inclusion rates. This could lead to efforts to remove these barriers, ultimately promoting the use of financial services and fostering economic development. Expanding access to formal financial services enables individuals to manage their finances better, invest, and start businesses, contributing to overall economic growth. Financial service providers should also work on improving the accessibility of their services. Investments in digital banking and financial literacy initiatives can help individuals with the knowledge to make informed financial decisions, benefiting customers and banks by reducing operational costs. In addition to expanding online services, strengthening IT security and resilience is crucial.

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