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Preface

It is with great pleasure that we present the second issue of *Research Papers in Economics and Finance* (REF) for 2024. This volume features nine articles that address pressing topics in contemporary economics and finance, offering novel perspectives and practical insights to advance academic discourse and policymaking.

Yanina Dymitrowska, from Poznań University of Economics and Business, provides a comprehensive analysis of the relationship between natural resource funds, institutional quality and governance, exploring their role in mitigating the "resource curse". Her systematic literature review highlights the importance of robust institutions in enhancing the effectiveness of resource funds and identifies areas for future research in this critical domain.

Zofia Polkowska, affiliated with the Warsaw School of Economics, examines the development of innovation in the Polish banking sector, with a focus on the interplay between regulatory frameworks and technological advancements. Her study emphasises the need to balance the adoption of innovative financial solutions with customer protection and sector stability, underlining the importance of collaboration between banks, regulators and FinTech entities.

Kamil Gemra, from the Warsaw School of Economics, and Piotr Kwestarz, an independent researcher, investigate the relationship between investor demand during initial public offerings (IPOs) and long-term stock price performance on the Warsaw Stock Exchange. Their findings provide valuable insights for investors, highlighting how IPO dynamics influence post-debut stock behaviour over different time horizons.

Izabela Witczak, from the University of Łódź, explores the significance of tax risk for Polish companies, drawing on empirical research conducted in the Wielkopolska region. Her article underscores the growing awareness among managers of tax-related challenges and the necessity for tailored tax risk management strategies to mitigate potential financial and reputational consequences.

Lenka Přečková, from Silesian University in Opava, and Eva Vávrová, from Masaryk University, analyse the impact of the COVID-19 pandemic on the finan-

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cial health of commercial insurance companies in the Czech Republic. Their study highlights the resilience of the sector and the critical role of digitalisation in navigating crises, with particular emphasis on the contrasting effects on life and non-life insurance.

Piotr Manikowski, from Poznań University of Economics and Business, Weronika Szymczak-Łączna, an independent researcher, and Bojan Srbinoski, from the University St. Kliment Ohridski, delve into the insurability of cryptocurrency wallet risks, offering a pioneering perspective on incorporating cryptocurrency-related risks into the insurance sector. Their research contributes to the growing discourse on digital asset management and risk mitigation in modern financial systems.

Jacek Jankiewicz and Przemysław Garsztka, both from Poznań University of Economics and Business, and Jyoti Thakur, from the National Council of Applied Economic Research in India, present a comparative analysis of the economic activities of women in Polish and Indian families. Their study sheds light on the influence of cultural norms and education on women's participation in market and non-market activities, revealing both similarities and differences in these two distinct contexts.

Damian Luty, from Poznań University of Economics and Business, and Rafał Iwański, from the University of Szczecin, address the Duhem-Quine problem in economic methodology, proposing a multi-criteria framework for evaluating economic theories. Their conceptual research offers a robust approach to improving the rationality and reliability of economic models, with significant implications for theory development and policy applications.

Finally, Constantinos Challoumis, from the National and Kapodistrian University of Athens, introduces the concept of Economocracy, a novel economic framework that integrates democratic governance with economic stability. Through quantitative analysis, the article illustrates how Economocracy can address global debt challenges and promote sustainable economic development while fostering equity and inclusion.

These articles collectively reflect the journal's commitment to fostering innovative research and interdisciplinary dialogue. We extend our deepest gratitude to the authors for their invaluable contributions and to the reviewers for their meticulous assessments, which ensure the high standards of this publication. We hope this issue will inspire further research and contribute to meaningful discussions among academics, practitioners and policymakers.

Yours faithfully,

Piotr Lis
Editor-in-Chief

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Natural resource funds, institutional quality and governance: A systematic literature review

Yanina Dymitrowska[1]

Abstract

In recent years, there has been an international debate on the effectiveness of resource funds in the context of the "resource curse". One aspect of assessing the effectiveness of these funds, which is receiving increasing attention, is determining the relationship between the funds and institutional quality and governance. The objective of this study is to systematically evaluate all available evidence regarding the relationship between the effectiveness of natural resource funds, institutional quality and governance in the context of countering the "resource curse". The study employed the SLR technique to examine 40 carefully selected articles for the period 1990–2023. In order to enhance the credibility of the analysis, an up-to-date information map derived from the literature was generated using the VOSviewer software. The study found that the analysed issue is both new and relevant, with many aspects lacking unanimous solutions. It was observed that the relationship between funds and institutional quality and governance exists, as indicated by both qualitative and quantitative research. The most significant studies on this topic emerged after 2005. The literature is largely concentrated on the significance of institutional quality and governance for fund effectiveness. An area that could be explored by future researchers is the relationship between savings resource funds (funds for future generations), investment resource funds and institutional quality and governance.

Article received 29 September 2023, accepted 6 September 2024.

Keywords

- natural resource funds
- governance
- institutional quality
- resource curse
- systematic literature review

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Introduction

Having substantial natural resource wealth can be a significant factor in a country's economic growth and development. However, many resource-exporting nations[2] face the paradox of the "resource curse". For many years, they have achieved worse economic development outcomes compared to countries that do not possess such resources. The "resource curse" has been extensively studied from various angles and is supported by the findings of both quantitative and qualitative research (including Arezki & van der Ploeg, 2007; Auty, 2001; Dymitrowska, 2015; Neumayer, 2004; Sachs & Warner, 2001; Sala-i-Martin & Subramanian, 2013; van der Ploeg, 2011).

In recent years, researchers, international organisations and governments of resource-rich countries have focused their attention on seeking ways to address the paradox of the "resource curse". One of the means that has sparked much discussion in the last decade for countering the "resource curse" is the natural resource fund. Resource funds, most commonly in the form of stabilisation funds, were predominantly introduced in resource-rich countries during the 1970s–1990s. Since then, they have seen significant development, with numerous funds established, each having varying forms and operational principles. Since 2010, there has been a noticeable trend of creating a new type of natural resource fund, known as future generation funds (also known as savings funds), in both advanced economies and emerging/developing economies. The importance of resource funds in the international financial market has also grown. They constitute over half of all sovereign wealth funds, with the current value of assets worldwide estimated at approximately USD 11.887 billion, according to 2023 data from the Institute of Sovereign Wealth Funds (SWFI, n.d.). Comprehensive multidimensional studies on the effectiveness of resource funds are, therefore, of significant importance, both for the development of resource-rich countries and for global development in general.

Within the framework of the new institutional economics, institutions are regarded as a crucial factor in economic development (North, 1990). Following this line of thought, the issue of the "resource curse" has taken on an entirely new dimension, with numerous studies dedicated to assessing the significance of institutional quality and governance for the development of resource-rich countries (Auty, 2001; Baland & Francois, 2000; Bhattacharyya & Hodler, 2010; Brunnschweiler, 2008; Karl, 1997; Leite & Weidmann, 1999). It has been noted that countries specialising in the export of natural resources, especially strategic ones (such as fuels

[2] In this research, the definitions of a resource-rich country, a resource-exporting country and an economy based on the extraction and export of natural resources are approached with clarity. These nations are categorised by meeting the following criteria: either the average annual revenues of the mining industry (as a percentage of GDP) exceed 25%, or natural resources account for at least 25% of the average annual exports (Dymitrowska, 2015).

and minerals), grapple with increased rent-seeking, corruption and deteriorating institutional quality. From this perspective, lower governance and institutional quality in resource-based economies are considered one of the significant causes of the "resource curse" phenomenon (Dymitrowska, 2015).

The importance of governance and institutional quality is also increasingly emphasised in research on the effectiveness of natural resource funds. Some scholars even point out that they are among the primary determinants of fund efficiency (e.g. Bacon & Tordo, 2006; Hjort, 2006; Le Borgne & Medas, 2007; Sugawara, 2014). The reverse perspective is also intriguing – namely, the impact of funds on the level of governance and institutional quality (Tsani, 2013, 2015). Unfortunately, the literature on this subject is fragmented and requires organisation.

The aim of this study is to systematically evaluate all available evidence regarding the relationship between the effectiveness of natural resource funds, institutional quality and governance in the context of countering the "resource curse".

The study employed the systematic literature review (SLR) method, through which 250 articles for the period 1990–2023 were examined. As a result of a detailed analysis, 40 publications most closely related to the research topic, according to specified criteria, were identified and subjected to further in-depth analysis. To enhance the credibility of the assessment, the VOSviewer program was utilised to create an up-to-date information map derived from the literature (Figure 2).

To the best of the author's knowledge, this is the inaugural study employing the systematic literature review technique to assess the literature concerning the effectiveness of natural resource funds, governance and institutional quality. The research encompasses both qualitative and quantitative literature published between 1990 and 2023. Furthermore, it organises all accessible evidence on this topic and highlights significant research areas requiring further exploration, which could be beneficial for both academics and policymakers.

The paper consists of three parts, preceded by an introduction and summarised by a conclusion. The first part of the research is dedicated to providing an initial brief overview of natural resource funds and their significance for the economic development of resource-rich countries. In the next part of the paper, the research methods used to achieve the research objectives have been elaborated upon in detail. The following sections present the results of the study and the discussion.

1. Natural resource funds: A brief overview

In the 1970s and 1980s, following a severe crisis in the international energy commodity market, a broad academic community, as well as international organ-

isations and policymakers, turned their attention to the issues surrounding the development of countries rich in natural resources. In 1993, Richard Auty (1993) presented a work titled *Sustaining development in mineral economies: the resource curse thesis*, in which he first described the phenomenon and presented the term "resource curse". Since then, the paradoxical relationship concerning the economic development of resource-rich countries has generated significant interest among researchers in economics, political science, international relations, development studies and other fields. The issue of the "resource curse" is interdisciplinary and multidimensional, encompassing economic, political, institutional, social, cultural, ecological and other aspects.

In the 1970s, a new economic policy tool was proposed to counteract the "resource curse", particularly aimed at protecting the domestic economy from the significant volatility of the global commodity market. This tool was the resource fund, initially taking the form of a stabilisation fund. These funds were introduced, with varying degrees of success, in many resource-rich countries, both in advanced economies and emerging/developing economies. The growing popularity of this instrument drew researchers' attention to the issue of assessing the effectiveness of resource funds.

In the 1970s, Norway discovered rich oil and natural gas deposits in the waters of the North Sea. In the early years of extraction and export, the country established a resource fund, initially named the Norwegian Oil Fund, but it changed its name in 2006 to the Norwegian Government Pension Fund Global to emphasise its innovative character and the role it should play in the Norwegian economy and society. Although the so-called savings resource funds (alternatively referred to as funds for future generations) and investment resource funds had been established earlier (e.g. Alberta Heritage Savings Trust Fund, Alaska Permanent Fund), it was the great success of the Norwegian fund that drew the attention of a broad spectrum of policymakers and researchers to this economic policy tool in the context of countering the "resource curse".

Initially, it was believed that funds for future generations, modelled after the Norwegian approach, where all proceeds from resource sales are accumulated in the fund's account and invested in a wide range of foreign long-term investments, using only a specified percentage of the fund's earnings domestically, could be effective exclusively in advanced economies (e.g. Dymitrowska, 2015). However, a new trend of establishing savings natural resource funds is now visible in both advanced economies and emerging/developing economies. There are 21 savings funds. Although the Texas Permanent University Fund, the oldest among the savings funds, was founded in 1876, more than 52% of them were established after 2005, with over 38% created after 2010 (Dymitrowska, 2023a). The effectiveness of savings funds operation has once again become the subject of extensive international discussions.

Given the multidimensionality of the "resource curse" issue, it should be emphasised that an important dimension of contemporary research in the context of the development of resource-rich countries is the institutional dimension. The aspect of the significance of institutional factors in the context of the "resource curse" was already noted in the 1990s. It has been recognised that significant revenues from natural resource exports lead to weakening of democracy (Bhattacharyya & Hodler, 2010; Karl, 1997; Ross, 2001), destruction of healthy competition, a reduction in economic freedom, a rise in corruption and rent-seeking (Baland & Francois, 2000; Leite & Weidmann, 1999). In current research, this dimension remains significant, and its inclusion in analyses holds substantial importance.

2. Methodology

To achieve the research objective, the study employed the Systematic Literature Review (SLR) method (Cooper et al., 2019; Tranfield et al., 2003). This method has been gaining popularity among researchers recently (sample articles: Deku et al., 2019; Garg & Shukla, 2021), offering several advantages such as: objectivity and systematicity, comprehensiveness and reproducibility, knowledge synthesis, minimising the risk of excluding essential sources, identifying inconsistencies and knowledge gaps, as well as enhancing the quality of the research.

According to the general guidelines for conducting SLR in the social sciences, in the first stage of the study, the following research tasks were defined:

1. Determining the relationship between the effectiveness of natural resource funds, institutional quality and governance.
2. Systematising all available research (both qualitative and quantitative) for the years 1990–2023 related to the effectiveness of resource funds, institutional quality and governance.
3. Identifying research gaps in the literature and determining directions for future research.

The study adopted a research period starting from the year 1990 due to the fact that, although the oldest resource fund, the Texas Permanent University Fund, was established in 1876 (Dymitrowska, 2023a), most of the initial resource funds were established in resource-rich countries during the 1970s–1990s. As in Ouoba (2020), this study assumes that it takes ten years for a fund to accumulate long-term capital and have a tangible effect after its establishment. After an initial review of the literature, it was also noted that the first significant research on

the analysed topic dates back to 1997 (Chalk et al., 1997). It was determined that the year 1990 should be the starting point of the research period. The individual stages of the SLR process are presented in Figure 1.

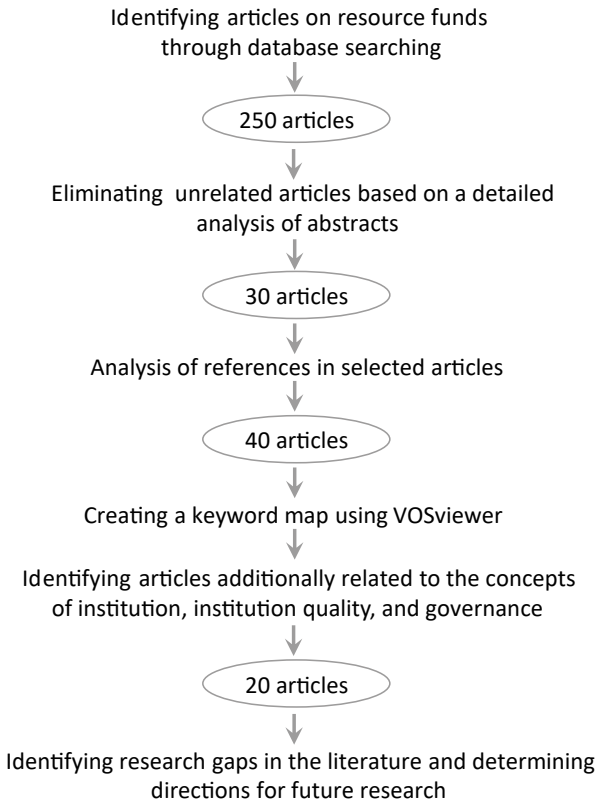


Figure 1. Stages followed in the systematic literature review

Source: own study.

The study was decided to begin with searching the data in the Web of Science database. This database is a respected source of scientific and research information with international coverage, containing millions of scientific articles, conference papers, reviews, books and other scholarly materials, providing access to a variety of information sources. Keywords "resource funds" and "oil funds" were employed. The first of the selected phrases best reflects the research direction. However, it was decided to add the keyword "oil funds" due to the attention drawn during preliminary analyses that it had been used in many publications.

In the study, it was decided to initially prioritise identifying studies related to the efficiency of resource funds, within which subsequent recognition was given

to research dedicated to the importance of institutional quality and governance. The efficiency of resource funds indeed holds a paramount significance in the chosen research topic. Additionally, when considering additional keywords "institutional quality" and "governance" in the initial stage of the study, the results displayed in the database significantly deviated from the chosen research theme.

Additional criteria were also applied. The "topic" filter was used instead of "title" because it provided more results, encompassing searches in title, abstract, author keywords and Keywords Plus. The second criterion was narrowing the research period to the years 1990–2023. As a result, 600 different publications were found. Following the suggestion from Web of Science, several additional keywords were added: "petroleum fund", "natural resource funds" and "oil fund", which increased the obtained result to 654 publications. The list of publications was narrowed down to those from the fields of economics, energy fuels, political science, international relations and development studies. The refined list provided 250 publications.

In the second stage of the study, based on a detailed analysis of the abstracts of individual publications, articles unrelated to the chosen research theme were eliminated. Thirty publications focusing on the analysis of the efficiency of resource funds in the context of the "resource curse" phenomenon were identified.

In the subsequent third stage, a detailed analysis of the reference lists of the individual works highlighted in the previous stage was conducted in order to identify omitted publications. In total, 10 additional articles were added to the research list, taking the final count of selected works to 40.

The selected articles were next exported into a Resource Information System (RIS) tab-delimited text file using the Mendeley reference manager. A tab-delimited text file was then imported into VOSviewer, which is a tool for visualising and analysing scientific data, particularly for examining relationships among keywords, authors and publications in scientific databases. VOSviewer allows the creation of graphical network representations of scientific data, facilitating the understanding of connections and patterns among various elements such as keywords, authors or publications. VOSviewer enabled the creation of an information map of the main keywords highlighted by the authors of the publications identified in the previous stages of the study. The information map was created to assess the position and importance of the concepts of "institutional quality" and "governance" within the context of the effectiveness of resource funds in the "resource curse" framework.

In the next stage, a detailed reanalysis of the abstracts of the 40 selected articles was conducted to identify those that are associated with the concepts of institution, institution quality and governance. A final list of 20 publications was identified, which were then thoroughly examined to identify research gaps in the literature and determine directions for future research.

3. Results and discussion

Table 1 presents a list of 40 articles identified in the third stage of the study, considering the following classification criteria:

- type of study: qualitative, quantitative,
- year of publication,
- source type: journal article, working paper, book, conference article,
- type of resource fund analysed: stabilisation, investment, savings.

In the study, the classification of resource funds was adopted as in Dymitrowska (2023a, 2023b). According to this classification, funds are divided into stabilisation funds, investment funds and savings funds (alternatively referred to as funds for future generations). Inclusion of this classification is significant due to the fact that stabilisation funds, which were created initially, differ significantly from investment and savings funds. In recent years, savings funds (funds for future generations) have gained increasing popularity in both advanced economies and emerging/developing economies. These funds make up a substantial share of all resource funds, with most of them being established after 2010 (Dymitrowska, 2023a).

Table 1. Research dedicated to the effectiveness of natural resource funds in the context of countering the "resource curse"

Authors and year	Type of study		Source type				Type of resource fund		
	qualitative	quantitative	journal article	working paper	book	conference article	ST	IN	SAV
Chalk et al., 1997	X			X			X	X	X
Engel & Valdes, 2000	X			X			X	X	X
Fasano-Filho, 2000	X			X			X		
Davis et al., 2001	X			X			X		
Clemente et al., 2002	X			X			X		
Eifert et al., 2002	X			X			X	X	X
Barnett & Ossowski, 2002	X			X			X		
Crain & Devlin, 2003		X				X	X		
Tsalik, 2003	X				X		X	X	X
Devlin & Titman, 2004	X		X				X	X	X
Kalyuzhnova, 2006	X		X					X	
Bacon & Tordo, 2006	X		X				X	X	X

cont. Table 1

Authors and year	Type of study		Source type				Type of resource fund		
	qualitative	quantitative	journal article	working paper	book	conference article	ST	IN	SAV
Hjort, 2006	X		X				X	X	X
Le Borgne & Medas, 2007	X			X			X		
Shabsigh & Ilahi, 2007		X		X			X		
Usui, 2007	X		X				X		
Ossowski et al., 2008		X		X			X		
Merlevede et al., 2009		X	X				X		
Gould, 2010	X		X				X	X	X
Villafuerte et al., 2010	X			X			X		
Lücke, 2011	X		X				X	X	X
Bagattini, 2011		X		X			X	X	X
Barma et al., 2012	X				X		X	X	X
Baena et al., 2012	X		X				X	X	X
Tsani, 2013		X	X				X	X	X
Sugawara, 2014		X		X			X		
Tsani, 2015		X	X				X	X	X
Koh, 2016		X	X				X		
Ouoba, 2016		X	X				X		
Asik, 2017		X				X	X		
Torvik, 2018	X		X				X	X	X
Allegret et al., 2018		X		X			X		
Bortolotti et al., 2020	X			X			X	X	X
Dymitrowska, 2020	X		X				X	X	X
Ouoba, 2020		X	X				X		X
Medina-Bueno et al., 2021	X		X				X	X	X
James et al., 2022	X		X				X	X	X
Taguchi & Ganbayar, 2022		X	X				X	X	X
Çiçekçi & Gaygisiz, 2023		X	X				X		
Dymitrowska, 2023b		X	X						X

Note: ST – stabilisation fund, IN – investment fund, SAV – savings (future generations) fund.

Source: own study.

While analysing the articles presented in Table 1, it is important to note a significant conclusion. The majority of these publications are dedicated to the study of stabilisation funds. When analysing each of the articles separately, it should be mentioned that in the case of most of the studies in which a reference to all types of funds was made in Table 1, the research mostly pertained to the entirety of funds without their division into individual categories. Investment funds, and especially savings funds (funds for future generations), received limited attention. There is, therefore, a significant disproportion between the number of savings funds, which have emerged in the last decade, and the number of studies dedicated to them, representing a significant research gap.

Based on the articles presented in Table 1, an information map of keywords most frequently highlighted by authors was created using the VOSviewer software, as shown in Figure 2.

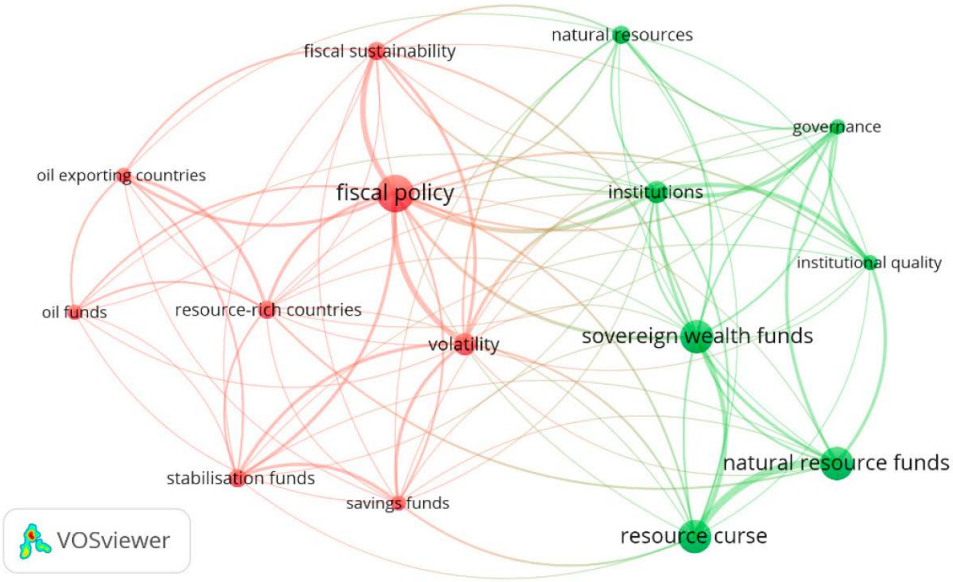


Figure 2. Information map of keywords referring to the topic of effectiveness of natural resource funds in the context of countering the "resource curse"

Source: own study using the VOSviewer software.

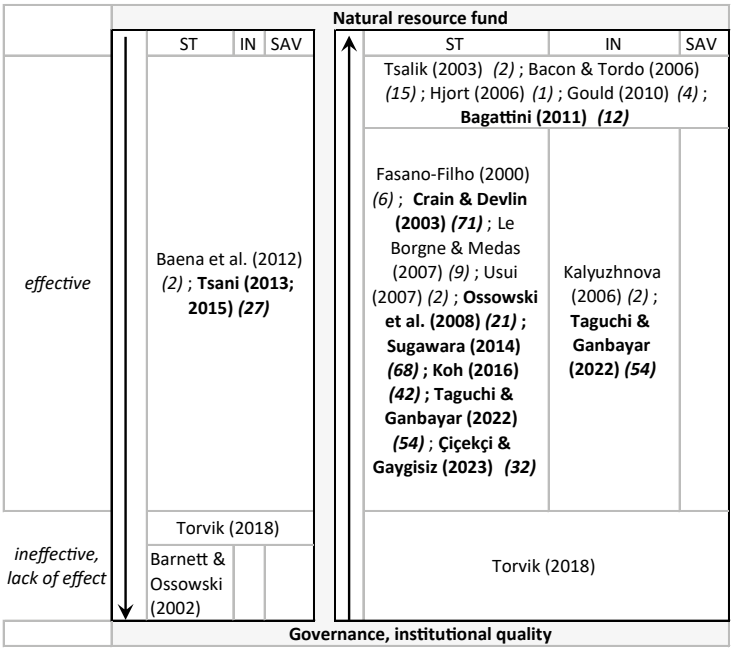
When analysing the results presented in Figure 2, it is important to note that the highlighted keywords reflect the essence of the "resource curse" problem (e.g. keywords: volatility, fiscal sustainability, natural resources, oil exporting countries, resource-rich countries), as well as the significance of research aimed at finding solutions to the "resource curse" (e.g. keywords: fiscal policy, natural

resource funds, stabilisation funds, savings funds). It is also worth noting the connection between the topic of natural resource funds and sovereign wealth funds. The results presented on the information map also confirm the previously stated conclusion that savings funds receive less attention in research. Although the keyword has appeared on the information map, its significance on it is not substantial.

The most significant conclusion drawn from Figure 2 is the importance of institution, institution quality and governance within the context of the effectiveness of natural resource funds in countering the "resource curse". All three keywords appeared on the information map, with the keyword "institution" being the most frequent. The obtained results confirm the significant importance of the institutional dimension in the examined topic.

Figure 3 presents a list of 20 articles identified in the fifth stage of the study, considering the following classification criteria:

- type of study: qualitative, quantitative,
- number of countries studied,



Note: Empirical studies are highlighted in bold. The number of analysed funds/countries is presented in parentheses marked in italics after each study. The arrow indicates the direction of influence. ST – stabilisation fund, IN – investment fund, SAV – savings (future generations) fund.

Figure 3. Research dedicated to natural resource funds, institutional quality and governance

Source: own study.

- type of resource fund analysed: stabilisation, investment, savings,
- effect: effective, ineffective, lack of effect,
- direction of influence: significance of institutional quality and governance in relation to the effectiveness of resource funds, as well as the inverse relationship – the importance of resource fund activities for institutional quality and governance in the context of countering the "resource curse".

Analysing the results obtained in the study, it is important to note that research has been conducted on two perspectives in the literature: the significance of institutional quality and governance concerning the effectiveness of resource funds, as well as the importance of resource fund activities for institutional quality and governance. However, the latter relationship has received significantly less attention. There are essentially only two important quantitative studies dedicated to this topic, both conducted by a single author (Tsani, 2013, 2015). In both articles, based on advanced quantitative analysis, the author found that policymakers could find resource funds to be valuable tools when addressing the deterioration of governance and institutional quality caused by resource abundance. The outcomes provide evidence supporting the perspective that resource funds serve as effective safeguards against the negative effects of the "resource curse", especially with regard to the deterioration of governance and institutional quality.

The vast majority of research is dedicated to the importance of institutional factors for the effectiveness of resource funds, with a clear predominance of stabilisation funds.

Analysing the examined articles, it should be noted that the majority of researchers confirm the effectiveness of stabilisation resource funds (Figure 3). There are also a few studies whose results confirm the effectiveness of investment funds (e.g. Kalyuzhnova, 2006; Taguchi & Ganbayar, 2022). In the case of savings funds, the effectiveness of their operation has not been confirmed to date. At the same time, it has not been justified that they are ineffective.

In the significant majority of studies listed in Figure 3, the crucial role of institutional quality and governance in the effective operation of stabilisation resource funds is emphasised. Taguchi & Ganbayar (2022) provide evidence that the operation of stabilisation funds reduces the volatility of government expenditure by 13.6%, and their operation under high governance reduces it by 33.2%. Meanwhile, the operation of investment funds increases the investment rate by 9.8%, and their operation with high governance increases it by 46.8%. Similar conclusions are presented by Sugawara (2014), who clearly states in his article that political institutions and fiscal rules in managing stabilisation funds are significant factors in reducing government expenditure volatility. In the latest study by Çiçekçi & Gaygisiz (2023), the authors concluded that for the desired countercyclical policy, adequately high institutional quality is needed to manage natural

resource funds and fiscal policy effectively. The importance of institutional capacity in the success of funds is highlighted in developing nations by Bacon & Tordo (2006), Le Borgne & Medas (2007) as well as Hjort (2006). It is also worth noting the emphasised importance of transparency for fund management in studies by Tsalik (2003), Gould (2010) and Kalyuzhnova (2006).

Conclusions

The aim of the article was to systematically evaluate all available evidence regarding the relationship between the effectiveness of natural resource funds, institutional quality and governance in the context of countering the "resource curse".

To achieve this objective, the study utilised the systematic literature review (SLR) method in order to analyse 40 carefully chosen articles for the period from 1990 to 2023. To bolster the reliability of the analysis, an updated information map derived from the literature was created with the assistance of VOSviewer software.

The research has shown that the issue of resource fund effectiveness is current and significant, with several aspects lacking consensus solutions. The results obtained confirm the substantial importance of the institutional dimension in the subject under examination. Institutional quality and governance are recognized by many researchers as a significant determinant of the effective operation of resource funds in resource-exporting countries in the context of countering the "resource curse".

It is important to note that the majority of studies are dedicated to the examination of stabilisation funds. In recent years, savings funds (funds for future generations), which differ significantly from stabilisation funds, have gained increasing popularity in both advanced economies and emerging/developing economies. These funds constitute a substantial share of all resource funds, with most of them being established after 2010. There is, therefore, a significant disproportion between the number of savings funds, which have emerged in the last decade, and the number of studies dedicated to them, representing a significant research gap. Limited attention in research has also been given to investment resource funds, which also constitute an important and interesting direction for future research.

It is also worth noting that in the examined topic, in addition to the aspect of the importance of institutional quality and governance for the effectiveness of the resource fund, the issue of the reverse relationship is also addressed, namely the significance of fund activities for the level of institutional quality and governance. This perspective also represents a significant direction for future research, as it has received very little attention in the literature.

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Development of innovation in the Polish banking sector

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Abstract

The rapidly developing market for new technologies is driving the introduction of innovative solutions in the banking sector. As a public trust sector, they are subject to numerous regulations. Supervisors and central banks are trying to support the development of new technologies in the sector by reducing regulatory uncertainty and support programs aimed at FinTech (Financial Technologies) companies. The purpose of the study is to analyse existing regulations and regulators' initiatives on new technologies in the banking sector. The author seeks to answer the research question of whether the introduced regulations support or limit the digital transformation of the banking sector in Poland. An important aspect in the sector is customer security, so regulations should focus on protecting the banking customer and ensuring the stability of the sector. They are analysed by regulators so that the relevant regulations enable the introduction of innovative yet safe solutions. The author points out possible synergies resulting from cooperation between banks and FinTech companies. In conclusion, dialogue between banking sector institutions, regulators, central banks and banks leads to the creation of an environment that allows the introduction of innovative solutions while maintaining customer protection and banking sector stability.

Keywords

- innovation
- banking sector
- new technology
- regulations
- FinTech

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Introduction

As a public trust sector, the banking sector is subject to numerous regulations. The definition of supervisory regulation indicates legal norms that aim to ensure the safety of banks at an appropriate level by limiting the risks that banks can take (Koleśnik, 2017). The purpose of regulation is therefore to protect the stability of the sector, but also to avoid the negative effects of possible crises. The scope of regulation covers areas ranging from risk management to capital protection to information obligations and banking products. The market for new technologies is developing rapidly, also within the financial sector. Emerging solutions using artificial intelligence, machine learning, robotization or biometrics allow the introduction of less costly and more efficient and attractive solutions for customers. The concept of innovation includes, among other things, introduction of new products (or new types of a particular product), opening of a new market, as well as introduction of a new organisation (Marcinkowska, 2012). The definition encompasses the entire process of activities related to the stages of idea generation, technology development and introduction to the market (Ślązak, 2023). Financial innovation can also be defined, especially in the finance sector, as "he act of creating and then popularizing new financial instruments, as well as new financial technologies, institutions, and markets" (Lerner & Tufano, 2011). Innovation can also be interpreted as a process in which new products primarily result from changes in the previous products (Hammad Naem et al., 2023).

With the rapid development of new technologies, banks are providing their customers with innovative solutions to meet their payment, financial management and banking interaction requirements. The development of banking is now linked to the use of artificial intelligence, robotisation, machine learning, bots, big data and new forms of payments (including biometrics). The rising share of innovative solutions is also increasing the emphasis placed on protecting customer data. The FinTech (Financial Technologies) community points to the need to support financial innovation through oversight, regulatory stabilisation and a friendly legal environment for testing innovations. Adequate regulation of solutions provides security but can also generate additional barriers and costs when implementing innovations.

Banking products, through strong regulation, are characterised by high security from the customer's perspective. Innovative solutions are sometimes considered to be exposed to higher risks. However, the cooperation of regulators and financial institutions that introduce such solutions can lead to increased security, both on the part of the customer and the financial system. Lack of regulation can negatively affect the stability of the banking sector, as well as the risks within it. It should be noted that greater regulatory requirements may result in higher costs of implementing solutions using new technologies. Hence, it becomes extremely

important to develop a compromise that will allow to meet the regulators' goals of preserving the stability of the system, but also allow banks to implement innovations without generating high costs, including the regulatory ones.

1. Literature review

Banks are carrying out digital transformation in the areas of customer service, big data processing, security and digitisation of processes. The main methods of implementing digital strategies include:

- launching a digital brand,
- digitisation of processes,
- streamlining digital customer service,
- release of new digital functions (Ostrowski, 2019).

Banks' activities are responding to the rapid changes taking place in the financial sector. In building their competitive advantage, they must respond to changing customer expectations, among other things. However, as highly regulated institutions implementing new solutions, they must meet supervisory requirements. Advances in digital technology are the changing factors of the very nature of banking (Broby, 2021). One of the fundamental issues in the strategic decisions of banking sector will be the attitude toward new technologies, as well as competition or cooperation with FinTech players (Miklaszewska & Folwarski, 2020). In addition, this poses a challenge for regulators to focus on bank profitability as a critical consideration (Klein & Weill, 2022).

In the Act on Financial Market Supervision of July 21, 2006 (Ustawa, 2006), one of the tasks of the Financial Supervision Commission is to "take measures to support the development of financial market innovation". Innovative solutions in the sector are supported through the establishment of entities aimed at supporting regulatory processes in the area of new technologies and supervision of institutions, i.e. FinTech. Countries where such organisations are being established include: Australia (Australian Securities and Investments Commission and Innovation Hub), Canada (OSC LaunchPad), China (National Internet Finance Association (NIFA)), Luxembourg (Commission de Surveillance du Secteur Financier (CSSF) Innovation Hub), Germany (BaFin Federal Financial Supervisory Authority), Japan (FinTech Support Desk) and France (Autorité de Contrôle Prudentiel et de Résolution (ACPR) Fintech Innovation Field and Autorité des Marchés Financiers).

In Poland, on December 9, 2016, a Special Task Force for the development of financial innovation (FinTech) was established. The initiators of the establish-

ment were the Office of the Polish Financial Supervision Authority (UKNF), the Ministry of Finance and the Ministry of Development, while the role of coordinator of the team is played by the UKNF. The broad composition of the Task Force includes, among others, representatives of the National Bank of Poland, the Office of Competition and Consumer Protection, the Polish Bank Association, the Stock Exchange, the National Clearing House and the FinTech Poland Foundation. The perspective of representatives of both banks, regulators and customers or FinTech companies can result in the development of solutions that favour the entire market. The team is tasked with identifying legal, regulatory and supervisory barriers that affect the opportunities for the development of financial innovation. The team's work results in proposals for legal or systemic solutions to enable the elimination of barriers. The positions promulgated by the Task Force are binding – it should be noted that this is an exception compared to the solutions introduced in other countries.

As a result of the Task Force's work, the following barriers were identified:

- availability of records,
- time of proceedings,
- issues of AML (anti-money laundering),
- paper forms,
- excessive regulation,
- digital identities,
- variable guidelines,
- unclear regulations,
- lack of capital,
- lack of barriers,
- other (UKNF, 2021).

The barriers can be divided into such areas as payment services, banking law, lending sector, payment sector as well as general. Figure 1 presents the distribution of the number of barriers by area.

One of the barriers is legal uncertainty, which limits development in the area of new technologies. Responding to the market need, the Polish Financial Supervision Authority has launched the Innovation Hub program to facilitate communication between institutions operating in the financial market and representatives of the UKNF. The subjects of meetings under the program are mainly issues related to payment services, mobile applications, crowdfunding, as well as video verification (UKNF, 2021).

Regulatory concerns raised by the banking sector included technical requirements in the area of cloud computing use or mechanisms to secure identity when providing services, i.e. disclosure of personal data in case of attacks. In response, the UKNF has the opportunity to, among other things, hold meetings to reduce

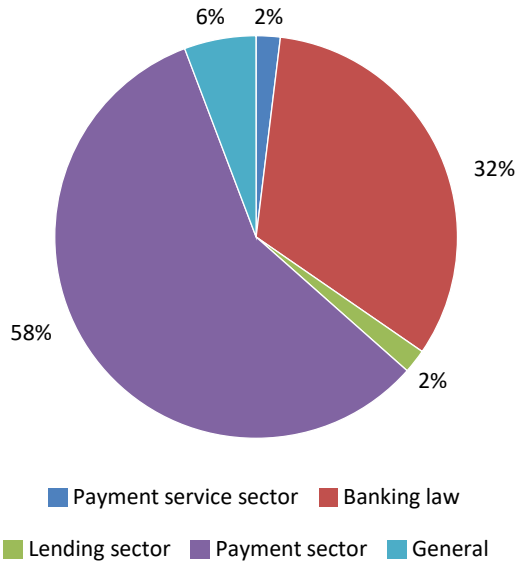

Figure 1. The distribution of the number of barriers by areas

Source: (UKNF, 2017).

legal uncertainty, publish standards that define the security of both supervised entities and customers. In order to reduce legal uncertainty, the Polish Financial Supervision Authority may issue interpretations in accordance with Article 11b of the Act on Financial Market Supervision of July 21, 2006 (Ustawa, 2006), regarding the scope and manner of application of regulations at the request of supervised entities and entities intending to perform activities in the financial market. The purpose of issuing interpretations is to raise the level of understanding in the legal area when new innovative products are introduced, which is expected to lead to increased innovation in both the banking sector and the financial market as a whole. However, the interpretations are not binding.

An important solution, from the point of view of ovality for new technologies in the sector, is the creation of regulatory sandboxes. In Poland, the Polish Financial Supervision Authority has introduced the Regulatory Sandbox project, which aims to support entities implementing innovative solutions. It is worth noting that access to the sandbox is available not only to supervised entities but also to those planning to enter the financial market. The regulatory sandbox can therefore accommodate both the testing of new services and the evaluation of existing innovative products or services. Entities using the testing environment and their solutions are monitored by the Authority. The progressive interaction between banks, FinTech entities and regulators has brought to light the need for effective testing of new solutions and their subsequent regulation (Gębski, 2021). The sandbox is also

designed to assist in the licensing of supervised activities. By monitoring sandbox activities, obtaining a license is supported by the UKNF, and the duration of the licensing process can be shortened. Entities can withdraw from sandbox testing without applying for a license. Requirements imposed by the UKNF to gain access to the sandbox include the following:

- solutions should be innovative in nature and have an impact on the development of the local financial innovation sector,
- solutions are related to the development and support of the activities of supervised entities,
- participation in the sandbox should be justified (high costs of traditional market implementation),
- the current legal framework does not clearly define the solution to be tested
- entities must demonstrate readiness for testing.

Only entities based within the territory of the Republic of Poland may participate in the Regulatory Sandbox.

The technology solution that banks are implementing as part of their digital strategies is cloud computing. In this area, requirements have been developed as part of the cooperation between the Financial Supervisory Authority, banks and technology companies. By meeting the requirements, the entities ensure safe operation in the area of cloud use. The UKNF published Communication dated October 23, 2017, regarding cloud computing services used by supervised entities. In order to use the services, according to the Communication, supervised institutions should develop a detailed analysis including risk assessment, the impact of implementation on operations, costs and benefits, as well as an exit plan.

IT infrastructure adjustments also remain a challenge for institutions. For cloud services, the issue of service providers, which is regulated by the Communication, should also be analysed. Supervised entities face the challenge of ensuring that the data required by the Authority is adequate and that they are aligned with the providers' offerings. The UKNF's proposal in the area of regulating cloud services was one of the first in Europe, but the requirements of supervision result in a long process of actual implementations of the service in banking sector institutions.

In the author's opinion, the development of UKNF initiatives in the area of innovation deserves a positive assessment. Based on European Banking Authority (EBA) data, regulatory sandboxes exist in only 8% of the European Union member states; additionally, it shall be noted that 17% of the EU member states have established innovation hubs, while 46% have made no attempts at dialogue between regulators and FinTech players (European Banking Authority, 2017).

Digital Development Agenda is the activities of the Office of the Financial Supervisory Authority in four designated areas:

- new phenomena in the financial market (including robo-advice),
- support for FinTech,
- cyber security,
- electronic office.

The Authority plans to issue supervisory positions to clarify legal aspects, as well as to initiate legislative work in this area. It will be necessary to introduce EU regulations into the Polish legal environment. Adequate control over implemented solutions, including the area of customer services, is particularly important because of the protection of customer interests. Raising the level of information security, especially information processed in the cloud, as well as IT risk management are UKNF's efforts to align regulations with market needs in the area of cyber security.

When analysing the impact of new technologies in the banking sector, it is essential to consider FinTech companies. In Europe, FinTech companies operate under fragmented regulations, which can facilitate easier market entry. According to EBA data, 31% of companies operating in the European Union are not subject to any regulation, PSD2 – 20%, MiFID – 11%, CRD – 9%, national authorisation requirements – 8% (European Banking Authority, 2017).

According to research, they also have lower regulatory costs than banks (Jourdan et al., 2023). They are becoming, especially in highly developed countries, competitors to supervised institutions in the banking sector. Products previously offered by licensed credit institutions (e.g. payment services) have become part of the portfolio of services offered by FinTech companies (European Banking Authority, 2017). The actions of regulators are also directed toward regulating this sector. Innovative FinTech products are emerging on the market, challenging as well as competing with traditional products offered by banks (Lee & Shin, 2018). On the one hand, the development of FinTech services modernises services and the financial architecture, while on the other hand, it disrupts the current business model and regulatory structures (Nicoletti, 2017).

Banks are working to promote innovation through accelerator activities, for example:

- Alior Bank S.A. created the RBL_START innovation laboratory,
- Bank Zachodni WBK supports innovation through startMEup,
- ING Bank Śląski created Akcelerator ING,
- mBank S.A. invests in technology start-ups through its mAccelerator company,
- Pekao S.A. drives innovation through its Innovation Laboratory,
- PKO BP S.A. has launched the Let's Fintech programme.

Creating such programmes is a part of cooperation strategy with FinTech companies (Folwarski, 2020). Banks can increase their profitability by collaborating with FinTech companies (Basdekis et al., 2022).

2. Methodology

To determine whether current regulations support the introduction of innovative solutions by banks in the Polish banking sector, this study utilises a review of relevant literature and an analysis of existing initiatives within the sector. The aim is to evaluate how current regulations and regulatory actions impact the adoption of new technologies in banking. The author examines whether the regulatory environment fosters innovation and highlights the role of FinTech companies in driving this innovation. Additionally, the study identifies desirable areas for regulatory improvement and proposes potential developments to enhance the innovation landscape in banking.

The main barriers and challenges for banks in the use of new technologies are identified. The statistics clearly indicate the large financial investment in the development of innovation in the sector, which helps to determine the direction of the banking sector and its focus on digital transformation. Key to formulating conclusions was the analysis of the evolving landscape of collaboration with the FinTech sector and the role of financial safety nets in supporting new technologies.

3. Results and discussion

The author claims that banks introduce innovative solutions based on functioning regulations, while regulators are late to adjust records and introduce new regulations. Banking sector players face barriers when implementing solutions, but supervisors try to identify and eliminate them. In addition, financial safety net institutions are creating space for new companies in the financial market that use new technologies in their operations. Laws and regulations do not always keep up with technological changes, which can result in slower development in the area of technology (Nowakowski, 2020). Collaboration between large banking sector players and small FinTech companies can lead to accelerating the digital transformation of the entire sector. Unsupervised institutions are able to innovate faster due to fewer regulatory hurdles. In contrast, banks benefit from an established customer base and the trust associated with their services, which can be a significant advantage in implementing new innovations (Zaleska, 2018). For regulators and lawmakers, the rapidly occurring digital transformation of the banking sector is a challenge. It is important that the regulations and requirements introduced meet the objectives of supervision, i.e. maintaining the stability of the sector, but also protecting the banking customer. However, these barriers should

not be so high that they impede the introduction of innovative solutions, which would hinder further development or lead to a situation where the innovations introduced would operate without adequate regulation. It should be noted that due to rapid changes in the environment of new technologies, new solutions are in fact often the first to appear on the market, and then the regulator issues appropriate recommendations, positions and laws. However, it should be highlighted that this approach is acceptable as long as the financial sector is stable (Arthur, 2017). A similar cycle occurred in other areas as well; for example, the multitude of regulations issued after the 2007+ crisis related to credit risk. Between 2008 and 2015, the number of supervisory regulations increased by 492% as a result of the 2007+ global crisis (in global terms) (FinTech Poland, 2023).

It is important to point out that banks in the Polish sector invest in innovative solutions. The National Bank of Poland conducted the 2019 survey to examine the scale of innovation, the resources allocated to innovative solutions and the impact of these solutions (NBP, 2020). The survey covered the years 2016–2019 and included 26 banks, accounting for approximately 79% of the sector's assets. According to the survey, banks are developing innovations to reduce costs, increase revenues and improve client experience. Digitisation of processes and operational support are also mentioned among the goals.

In response to the rapidly developing area of new technologies, it is their use that plays a large role in gaining a competitive advantage. In particular, developments in the area of customer service through mobile channels may affect competitiveness with the FinTech industry. It is worth noting that the goals of larger banks will focus on increasing the attractiveness of products and services to customers, while smaller banks will aim to reduce costs using modern technologies. The sources of acquiring innovative solutions include, among others: in-house development, acquisitions of FinTech companies, participation in accelerators (e.g. mAccelerator), purchasing external solutions and acquiring technologies from group companies. New technologies (including biometrics, Big Data, artificial intelligence and machine learning) have found their way into products and services, i.e. customer contact, remote customer identification. They are also used to implement the PSD2 directive or to mitigate fraud risks.

Figure 2 presents the distribution of the use of each technology indicated by the banks in the survey. Sources of innovative solutions in banks, according to the survey, include purchasing from external suppliers or building in-house solutions within the bank's structure. Implementing group solutions was identified as the third main source of acquiring innovations.

When analysing the development of innovation in the banking sector, attention should be paid to the development of the FinTech sector. FinTechs are often quicker to respond to customer needs, thus introducing attractive solutions earlier than regulated banking sector players. However, issues of trust in the bank-

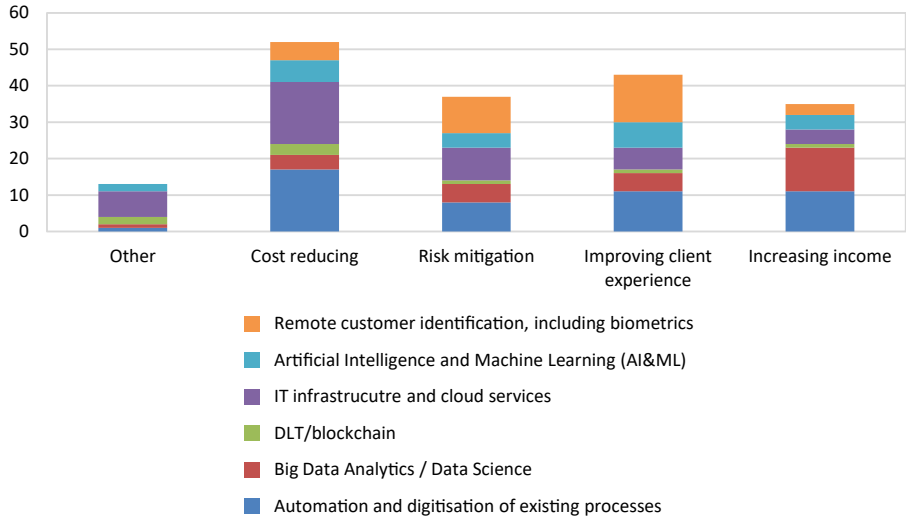

Figure 2. The distribution of the use of each technology indicated by banks in the survey (number of implementations)

Source: (NBP, 2020).

ing sector may cause customers to be reluctant to use these services. It is worth noting that security is one of the most important issues that customers pay attention to when using financial services offered by FinTech companies (Basdekis et al., 2022). However, it can be predicted that FinTech companies will force traditional banks to change both in the area of their strategies, business models and banking services (Miklaszewska & Folwarski, 2020).

FinTechs usually offer a service or product in a narrow area. Therefore, it can be concluded that the "gap" of entry for FinTech companies is so narrow in the Polish market that the functioning of innovative companies does not threaten the position of banks. This is confirmed by the ranking of The Financial Brand, which indicates the most popular digital banks in countries around the world (Reich, 2021). While in countries such as Norway, Sweden, Portugal and Hungary the most popular digital bank is Revolut (FinTech, which received a European banking license in 2018), in Poland mBank S.A. is preferred choice (as well as in Slovakia and the Czech Republic). It should be noted that innovative market entrants that do not have an established reputation and credibility will not threaten the functioning of banking in the traditional area (Zaleska, 2018). Banks that invest in innovation and develop paths for its implementation not only strengthen their position in the market but also build their competitive advantage (Zaleska & Kondraciuk, 2019).

With the rapid digital transformation in the sector, there may be an accumulation of regulations, so it is worth paying attention to the digitisation aspect of regulatory and reporting processes. The dynamics of regulatory change is a challenge

for both leading banks and smaller institutions. The application of new technologies for regulatory purposes introduces the concept of RegTech. A broad definition of RegTech indicates the use of modern technology to meet supervisory requirements, but also the use of innovative solutions by the supervisor and as part of communication between supervisors and supervised entities.

They support the collection, reporting and interpretation of data for supervisory purposes, using big data, machine learning and process automation. An analysis in the RegTech report on the importance of regulatory innovation for the financial sector and the state showed that the share of regulatory and supervisory costs in technology implementation budgets ranges from 7% to 23% (FinTech Poland, 2023). The use of new technologies could lead to a reduction in regulatory implementation costs. The author claims that this would ensure the safety of the sector through adequate regulation, yet it would not burden banks with excessive regulatory costs. Banks have a positive view of cooperation with the supervision authority in the area of new technologies, but they expect a reduction in regulatory costs as well as greater consistency and synergy in the activities of the supervisors (FinTech Poland, 2023). Banks also request the possibility to apply solutions using new technologies to fulfil supervisory requirements. Business digitisation should be implemented with an accompanying digitisation of regulatory and reporting processes (Nowakowski, 2020).

A characteristic feature of banks is having a broad customer base, often maintaining long-term relationships with the bank and using a wide range of products. Banks must therefore take into account the changing needs of their customers in the process of creating innovations. Customer expectations in the area of new products and services that provide speed, convenience, low costs and user-friendliness are driving the development of technology, big data and mobile applications on the one hand, but also changes in regulations and supervisory requirements on the other hand. The increase in the number of mobile app users has led to developments in the area of payment services, among others. This is a segment where the FinTech sector is introducing solutions, responding to customer needs. Services deployed in this area may pose the greatest threat to banks. The sector's response to the growing payment services included the introduction of the BLIK mobile payment system, created in cooperation with 6 banks operating in Poland. The innovations being implemented enable democratisation of access to financial services, but they also create challenges in terms of privacy, regulation and law enforcement (Carbó-Valverde, 2017).

The author claims that banks should make greater use of technological solutions offered by FinTech companies. These companies are flexible and agile, and their products can boost innovation and competition (Barroso & Laborda, 2022). Positive aspects can be seen in such a solution from two perspectives. From the banks' side, it will allow them to support digital transformation. Banks use FinTech activities as

part of a provider of specialised services or software, among other things. FinTech companies specialise in particular solutions, which banks would be able to deploy in relevant areas of their product portfolio or infrastructure solutions. From the perspective of the stability of the financial sector, such cooperation would be subject to relevant regulations that banks must fulfil when introducing new solutions. This would ensure that the products offered by FinTechs would be correspondingly safer and aligned with existing regulations. It is also beneficial for FinTechs to cooperate with banks, which have a broad customer base (Zaleska, 2018).

Conclusions

With rapid digital development, regulations for innovative products are emerging ex post. Thus, regulatory uncertainty is cited as one of the main barriers in the area of digital transformation. Banks currently incur high regulatory costs, which may result in slowing down the implementation of new solutions at the prospect of additional costs. Adequate regulation of banks' cooperation with FinTech companies, according to the author, would allow earlier indication of the development directions of the introduced solutions, and thus regulatory needs.

The author states that in Polish conditions banks are so innovative that FinTech companies do not threaten their position. However, FinTech can be a "driving force" for banks, showing the direction of customer needs. In addition, it should be noted that banks offer a range of products in their portfolio to meet customer needs in different areas. For the FinTech sector, cooperation with banks will benefit due to access to a broad customer base, but also payment infrastructure. It also allows for increased credibility, or the ability to finance further development (Leżoń, 2019). However, it is important to properly regulate the operation of FinTech companies. In their documents, the European Commission emphasises the need for national market supervisors to constantly monitor the activities of these innovative companies (Folwarski, 2020).

The fact that customers' preferences are changing, including their attitudes toward participating in innovative solutions in the financial sector, prompts discussions on the safety of the innovations being implemented. Thus, appropriate regulation is essential to maintain confidence in the banking sector. However, it is necessary to develop a level of control that does not slow down the sector's digital transformation. Regulating cooperation with the FinTech sector, and thus the ability to implement solutions developed by FinTechs, will allow the sector to further develop, ensuring its stability.

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Investor demand for stocks in Initial Public Offerings and their price behaviour after debut. Evidence from Poland

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Abstract

This article investigates the relationship between investor demand during an IPO and the long-term behaviour of share prices following a company's stock market debut. Specifically, the study examines the impact of the demand observed during the public offering and the size of the offering on abnormal return rates for a sample of 116 IPOs on the Warsaw Stock Exchange between 2012 and mid-2022. The primary research hypothesis tests whether the medians of abnormal return rates, influenced by these factors, are statistically significant over several time intervals ranging from 3 to 12 months after the debut. The findings confirm that certain information from the completed public offering, particularly the relatively low number of new shares offered, plays a significant role in predicting abnormal changes in share prices during these periods. This research offers valuable insights for investors, emphasising the key factors within the IPO process that can influence the trajectory of share prices following a company's market debut.

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Keywords

- IPO
- demand for IPOs
- stock
- individual investors
- capital market

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Introduction

A new company stock exchange debut combined with a public offering of its shares is a major event and an opportunity to explore the wealth of company information. Thanks to the knowledge a prospectus carries, as well as numerous media statements of the executives and analysts, both during the debut and offering process, institutional and individual investors are provided with the basis to value the company and its development prospects. At the same time, the company's executives and owners provide their own company valuation and information on how many funds they expect the company to raise in issuing shares, as well as how many funds (if any) will go to the existing shareholders selling their shares in the public offering process. Valuations from both sides (the company and investors) come together in the book building and subscription process.

It is typically only after these stages are completed that the company executives may come up with the final price per share and the final number of offered shares: new shares as well as those offered by the existing shareholders. In this manner, the actual demand for shares in a public offering can be determined. In preparing for the analysis, a handful of public offerings for shares were examined, and a Demand Index was calculated for each of them. The Index was defined as an Index of funds actually raised in the offering versus the expected proceeds from the sale of new shares and those offered by company owners.

$$\text{Demand Index} = \frac{P_f \cdot S_f}{P_m \cdot S_m} \tag{1}$$

where: P_f is the final price for shares offered and S_f is the actual number of shares offered (new and existing shares sold by their existing shareholders), determined following the book building process; P_m is the maximum price for shares offered and S_m is the maximum number of shares offered (new and existing shares sold by their existing shareholders), determined before the book building process and provided in the prospectus.

From an observer's perspective, very high values of the Demand Index may indicate high interest in the shares in the public offering, which may show the investors' belief in the company's further development. On the other hand, low values of the Demand Index (issue price being markedly lower than the maximum and/or sale of fewer shares than the offerors expected) may show the investors' interest in the offering was low. Therefore, information on the Demand Index value may motivate observers to decide to buy shares after the offering is completed, when the stock exchange trading of company shares begins.

Another interesting index, the value of which may also be an argument for buying shares from the market after the offering is completed and trading in shares

begins, is the Offering Size Index. It is the ratio of newly issued shares under public offering versus the total number of shares in the company.

$$\text{Offering Size Index} = \frac{\text{NS}_m}{\text{TS}} \tag{2}$$

where: NS_m is the maximum number of newly issued shares as per the prospectus; TS is the number of all the shares of the company before the issue of new shares.

A low value of the Offering Size Index may demonstrate that the company does not intend to largely dilute the existing shareholding but rather intends to raise capital (in most cases, to accelerate its growth and, consequently, to boost its future value). The lower the Index value, the lower the company's capital needs. In turn, high values of the Index show the company is willing to raise relatively ample funds to foster development while ignoring a significant dilution of the existing shareholding.

This paper aims to examine the relations between information from the completed public offering and the long-term share price behaviour after the offering is completed and the shares become publicly traded, that is to say, following the debut.

This study holds significant practical implications for investors considering purchasing shares after the debut, when they already possess information about how the IPO has unfolded. Investors can make decisions to buy shares during the company's first trading session based on publicly available information regarding the IPO itself and assess the likelihood of achieving returns in the medium to long term, up to one year following the debut.

The decision-making process for investors immediately after the company's public debut is facilitated by information about demand during the public offering, which is a key factor in the subsequent valuation of shares on the stock market. Three studies were conducted to examine the relationship between the value of the Demand Index and the Abnormal Return Rate of share prices. This analysis looked at price changes from the end of the first trading session to intervals of three months, six months, nine months, and one year post-debut. The abnormal rate is understood as being higher or lower than the expected return rate, whereby the expected return rates are equated with changes in stock market indices at the same time. Additionally, the study explored the relationship between share price change and the value of the Offering Size Index. Ultimately, various combinations of both the indexes were analyzed to assess their combined effect on share price fluctuations.

An overall hypothesis, examined in three variants, assessed whether the information provided by the company following its public offering significantly impacts share price behaviour over time. This analysis covered the period from the

end of the first stock exchange session to selected intervals ranging from three months to one year.

Interest was taken in abnormal, higher or lower than expected, return rates on shares and their correlation with the type of information derived from the public offering. The studies were conducted using the event study method, including statistical analysis.

The subsequent sections of the paper present a literature review, a description of the data used and the timeframes covered, along with an explanation of the research methodology. Following that, the three studies, their results and the conclusions drawn are presented.

1. Literature review

IPOs have been the focus of extensive research, with most studies examining first-day return rates and the occurrence of underpricing. Numerous authors (Khurshed et al., 2009; Kim et al., 1995; Sullivan & Unite, 1999; Vong, 2006) have confirmed the existence of this phenomenon. Several theories have been proposed to explain IPO underpricing, such as the signaling hypothesis by Leland and Pyle (1977), Rock's information asymmetry model (Rock, 1986), as well as theories related to institutional reasons and deliberate underpricing (Taranto, 2003). In the context of the Polish market, Śliwiński et al. (2022) conducted notable research demonstrating that the issuer's industry influences the level of underpricing. Additionally, Żyła (2022) provides a comprehensive literature review on IPOs, further enriching the understanding of this topic.

Share price behaviour following the very stock exchange debut is yet another issue. Two areas of study can be identified here. The first one concerns shares listed at a significant premium to the issue price. In this way, investors are capable of reaching an abnormally high rate of return versus the benchmark (Kuklinski & Schiereck, 2007; Purnanandam & Swaminathan, 2004; Ritter, 1984). The second study shows that underpricing of IPO companies persists in the long term. In their studies, Hoechle and Schmid (2008) showed that return rates on the shares of companies making their IPO are much worse in the first year following the debut (although this phenomenon does not occur after that year). Jaskiewicz et al. (2005) found that worse performance normally holds for three to five years post-debut.

It is precisely long-term lower return rates on shares following IPO that were given vast coverage in the literature (Bessler & Thies, 2007; Firth, 1997; Megginson et al., 2000; Omran, 2005; Sohail & Nasr, 2007). Certain researchers, e.g. Hensler et al. (1997) also examined the determinants for weak IPO performance. It was found

that characteristics of companies at the moment of issue have a predictive impact on the later price curve. In turn, Jaskiewicz et al. (2005), analysed 153 German and 43 Spanish IPOs in the years 1990–2000 and they found that three years following IPO, the return was on average –32.8% in Germany and –36.7% in Spain. They also proved that the size and age of the company going public, as well as the family influence, largely affect worse performance over the long term. Bhabra and Pettway (2003) found that prospectus information, e.g. pre-IPO profitability, R&D, relative size of the offering, company size and the number of risk factors named in the offering document, helps to anticipate post-IPO long-term performance. They also evidence that weaker post-debut returns are more severe for smaller and younger businesses than for big and mature companies. The size of the offering, level of underpricing, insider retention, industry affiliation and IPO period are statistically significant (and positive) in accounting for long-term share price behaviour (Hensler et al., 1997). Houge et al. (2001) found that, in the long term, IPOs exhibit low performance and higher uncertainty.

Furthermore, Aggarwal and Rivoli (1990), along with Aggarwal et al. (2008), presented an intriguing study demonstrating that IPOs with high pre-debut investor demand tend to experience lower long-term returns on their shares. This suggests that strong initial demand can negatively impact a company's stock performance over time.

This paper complements the literature with studies on return rates over various periods following the IPO, taking into account information from the subscription summaries made by investors on the Polish market.

2. Data and methods

The period from early 2012 to mid-2022 was analysed, during which a total of 119 cases of public offerings were examined that resulted in a debut on the main market of the Warsaw Stock Exchange (WSE). Both new companies entering the WSE main market with equity offerings and companies migrating from the WSE's alternative market, known as NewConnect (NC), to its main floor with simultaneous equity offerings were taken into account. The selection of IPOs was made based on the following criteria:

1. The IPO company has completed the offering.
2. The IPO had to be successful and the company's shares had to be admitted to trading on the WSE main (regulated) market.
3. The equity offering could include new shares but also existing shares belonging to existing shareholders, or only existing shares.

4. In the second and third studies, scenarios where only existing shares were offered were excluded, as it is not possible to calculate the value of the Offering Size Index in such cases.
5. The company's quotation may not have been considerably distorted throughout the analysed period due to factors such as tender offers, trading suspensions or other events that withhold trading activities or force certain behaviours of stock trading investors.

A total of 116 research cases that met the aforementioned criteria were identified. The sample examined includes nearly all companies that initiated an IPO on the Warsaw Stock Exchange between 2012 and mid-2022. The period was selected due to the availability and reliability of data. Prior to 2012, gathering consistent and trustworthy data for IPOs on the Warsaw Stock Exchange proved to be problematic. It is also important to note that companies transitioning from NewConnect to the main market with a new share offering were considered just as relevant as those launching an IPO for the first time. This is because the characteristics of the NewConnect market previously made it difficult for the majority of large institutional investors, particularly investment funds, to purchase shares in these companies. The study also lacks data on the actual demand from investment funds and the extent of any reductions, as this information is unavailable.

Information derived from completed public offerings may affect the post-debut share price over the following months to a year or more. Thus, a hypothesis was analysed to corroborate the statistical significance of this information on abnormal post-debut share price changes.

In this way, a null hypothesis H_0 and an alternative hypothesis H_1 were formulated.

H_0: The medians of abnormal return rates on investment in the shares of companies, irrespective of the demand observed during the public offering or the size of the offering, are not statistically significantly different from zero in the studied intervals of several to a dozen or so months after the debut.

H_1: The med+-ians of abnormal return rates on investment in the shares of companies, influenced by the demand observed during the public offering and the size of the offering, are statistically significantly different from zero in the studied intervals of several to a dozen or so months after the debut.

With the hypothesis formulated in this manner, return rates were examined in relation to three types of information derived from completed public offerings: the Demand Index, the Offering Size Index, and a combination of the two. Additionally, the study explored their relationship with abnormal return rates, defined as the

actual positive or negative differences in share price changes compared to the expected price changes indicated by index fluctuations at that time.

Return rates were calculated from the moment of buying shares at the end of the company's first trading session to the point of selling them at 3, 6, 9, and 12 months after the debut. The expected rates of return, referred to as the benchmark, were defined as the rates of return on investment in particular stock indexes during the same period. For each case, one of four indexes was selected for comparison:

- WIG20 for big companies,
- mWIG40 for medium-sized companies,
- sWIG80 for smaller companies,
- and WIG for the remaining companies.

The size of each company was determined and assigned to the appropriate index by comparing its capitalisation at the time of debut with the average capitalisation of companies in the respective indexes.

On the other hand, information was taken into account from the two Indexes studied separately and jointly. Therefore, whether the hypothesis was confirmed or rejected was tested in three configurations: studies A, B and C.

Study A

Auxiliary hypothesis: high values of the Demand Index have a statistically significant effect on the return on investment in the shares of post-debut companies over selected periods ranging from several to a dozen or so months.

In this study, all the research cases were included (a total of 116). In turn, the Demand Index values were divided into 4 groups:

1. up to 50% (the final value of the public offering was lower than half of the value the company and its owners expected). Sample size: 30 research cases.
2. 50–75%. Sample size: 24 research cases.
3. 75–90%. Sample size: 32 research cases.
4. 90–100% (the final value of the public offering was the same or almost the same as the value the company and its owners expected). Sample size: 30 research cases.

For each of the ranges, the statistical significance of abnormal return rates was examined for the periods running from the end of the first trading session to the end of sessions after the 3rd, 6th, 9th and 12th month following the debut. Thus, a total of 16 variants were analysed for this study.

Study B

Auxiliary hypothesis: low values of the Demand Index have a statistically significant effect on the return on investment in the shares of post-debut companies over selected periods ranging from several to a dozen or so months.

In this study, only research involving offerings with newly issued shares was included, as the Offering Size Index is calculated as the ratio of newly issued shares under public offering versus the total number of the company's shares. Out of the 116 companies in the sample, 91 had offerings with newly issued shares, while the remaining companies offered only existing shares.

In turn, the Offering Size Index values were divided into 4 groups:

1. up to 16% (the number of shares of the new issue was lower than 16% of the number of total shares of the company before the issue). Sample size: 22 research cases.
2. 16–25%. Sample size: 24 research cases.
3. 25–35%. Sample size: 22 research cases.
4. from 35% (the number of shares of the new issue was greater than 35% of the company's total shares before the issue). Sample size: 23 research cases.

For each of the ranges, the statistical significance of abnormal return rates was examined for the periods running from the end of the first trading session to the end of sessions after the 3rd, 6th, 9th and 12th month following the debut. Thus, a total of 16 variants were analysed for this study.

Study C

Auxiliary hypothesis: high values of the Demand Index combined with low values of the Offering Size Index have a statistically significant effect on the return on investment in the shares of post-debut companies over selected periods ranging from several to a dozen or so months.

In this study, only research cases being equity offerings with newly issued shares were included. Out of the 116 companies in the sample, a total of 91 such cases were identified, as the remaining companies offered only existing shares, making it impossible to calculate the Offering Size Index, similarly to the limitation applied in Study B. In turn, the values of the two indexes were classified into 9 joint ranges which is presented in Table 1 for clarity.

Case three was not examined (up to 20% of the Offering Size Index value combined with up to 60% of the Demand Index value) as the sample size of research

Table 1. Classification into ranges of values of the Demand and Offering Size Indexes

Range of Offering Size Index value (%)	Range of Demand Index value (%)	Sample size of research cases
up to 20	from 90	10
up to 20	60–90	15
up to 20	up to 60	5
20–33	from 90	10
20–33	60–90	13
20–33	up to 60	9
from 33	from 90	7
from 33	60–90	9
from 33	up to 60	13

Source: own analysis.

cases was very low (5 cases). For each of the ranges, the statistical significance of abnormal return rates was examined for the periods running from the end of the first trading session to the end of sessions after the 3rd, 6th, 9th and 12th month following the debut. Thus, 32 variants were analysed for this study.

All of the studies and their variants were conducted in a similar fashion. In order to arrive at a result that enables rejecting the null hypothesis H_0, the Wilcoxon matched-pair test was employed. Additionally, an analysis was conducted to explore the relationships between the Demand Index, Offering Size Index and abnormal return rates over the selected time intervals. This analysis aimed to determine how changes in these indices relate to post-IPO share price behaviour, allowing for a deeper understanding of the factors affecting abnormal returns beyond just their statistical significance. Corroboration was opted at $\alpha = 5\%$ and $\alpha = 10\%$ significance levels.

In each of the three studies (A, B and C), Abnormal Return Rates for all the research cases (companies making their debut) were first calculated with respect to each study variant (that is, for each combination of the range of index, or indexes, and each of the four periods determined in months from the debut date). Abnormal return rates follow the equation:

$$\mathrm{AR}_{i,t} = \mathrm{SR}_{i,t} - \mathrm{IR}_{i,t} \tag{3}$$

where: $\mathrm{AR}_{i,t}$ is the abnormal return rate on the shares of the company i over the analysed period t; $\mathrm{SR}_{i,t}$ is the return rate on the shares of the company i from between the end price of the first trading session P_{i,t_1} and the company's i share price following the analysed period t $P_{i,t}$.

Thus, the return rate $\mathrm{SR}_{i,t}$ was determined as follows:

$$\mathrm{SR}_{i,t} = \frac{P_{i,t} - P_{i,t_1}}{P_{i,t_1}} \tag{4}$$

In turn, $\mathrm{IR}_{i,t}$ from Equation (3) is the rate of return based on the index relevant to company i over the same period. It is determined similarly to $\mathrm{SR}_{i,t}$, except that instead of the price, the value of the index at the end of the day of the first trading session t_1 of company $I_{i,t}$ and following the period t under analysis ($I_{i,t}$) are taken into account. The rate of return based on the index is expressed by the following equation:

$$\mathrm{IR}_{i,t} = \frac{I_{i,t} - I_{i,t_1}}{I_{i,t_1}} \tag{5}$$

Next, the research case groups were analysed using the Wilcoxon matched-pair test. In almost all of the variants studied, the sample size of research cases did not exceed 30, so after assigning ranks and calculating the test statistic, tables were used for this test to show the critical value. For the only case comprising 32 companies, a Z test statistic was used. The statistic does not include corrections for tied ranks, as none were identified for the case.

The aim of this operation was to demonstrate statistical significance at the levels of $\alpha = 5\%$ and $\alpha = 10\%$ of abnormal return rates.

3. Results

The research work was classified into three studies. The research regards the abnormal return rates being dependent on indexes describing the completed public offering. Thus, the results will also follow such a classification.

Study A

The first analysis examined whether demand for shares during the IPO, as indicated by the Demand Index, influences the emergence of abnormal return rates after 3, 6, 9, and 12 months. The demand for shares was measured under 4 ranges of the Demand Index value. The data are included in Table 2.

Table 2. Identification of abnormal return rates depending on the value range of the Demand Index

Range of Demand Index value (%)	Time from the debut (in months)	Sample size for the N variant under analysis	Greater rank sum	Test statistic	Limit for the critical region $\alpha = 5\%$	Limit for the critical region $\alpha = 10\%$	Reject the null hypothesis	Median of abnormal return rates (%)
90–100	3	30	negative	$T = 206$	137	152	no	–1.7
90–100	6	30	negative	$T = 209$	137	152	no	–2.2
90–100	9	30	negative	$T = 184$	137	152	no	–5.1
90–100	12	30	negative	$T = 184$	137	152	no	–6.5
75–90	3	32	positive	$Z = -2.1317$			no	4.4
75–90	6	32	positive	$Z = -0.4114$			no	3.6
75–90	9	32	positive	$Z = -0.4114$			no	1.0
75–90	12	32	positive	$Z = -0.2431$			no	3.6
50–75	3	24	negative	$T = 108$	81	92	no	–4.5
50–75	6	23	negative	$T = 102$	73	83	no	–6.2
50–75	9	22	negative	$T = 75$	66	75	yes for $\alpha = 10\%$	–12.8
50–75	12	22	negative	$T = 63$	66	75	yes for $\alpha = 5\%$	–24.7
up to 50	3	30	negative	$T = 152$	137	152	yes for $\alpha = 10\%$	–6.0
up to 50	6	29	negative	$T = 177$	127	141	no	–7.2
up to 50	9	29	negative	$T = 175$	127	141	no	–5.2
up to 50	12	28	negative	$T = 140$	112	130	no	–11.7

Source: own analysis.

The null hypothesis H_0 could only be rejected in three of the tested variants in favour of the alternative hypothesis H_1. In two of these three cases, the value of the test statistic was equal to the critical value for the weaker significance level of 10%. Moreover, for the variants with the rejected hypothesis, in the remaining periods (months) the null hypothesis could not be rejected.

For these reasons, the conclusion is that it would be too hasty to draw any conclusions about the correlation of abnormal returns with the values of the Demand Index. Therefore, the assumption is that, regardless of the range of the Demand Index values, the null hypothesis cannot be rejected within the analysed periods, ranging from a few to a dozen or so months from the debut.

Study B

In the second study, an examination was conducted to determine whether the ratio of the number of new issued shares offered to the number of all company shares, expressed by the Offer Size Index, affects the occurrence of abnormal rates of return after 3, 6, 9 and 12 months. The said ratio of the number of shares was presented in 4 ranges of the Offer Size Index.

For the value of the Offer Size Index not exceeding 16%, in all analysed periods, i.e. 3, 6, 9 and 12 months from the debut, abnormal rates of return were statistically significantly different from zero. Therefore, the null hypothesis is rejected for these tested values and periods.

In addition to the Wilcoxon test, further analysis was conducted to explore the relationship between the Offering Size Index and abnormal return rates. The analysis confirmed a negative relationship between the size of the new share offering (up to 16%) and abnormal returns in the periods studied. Comparing the sums of negative and positive ranks, it can be concluded that in these cases, the median abnormal returns were negative.

Significantly statistically abnormal rates of return also occurred for an isolated case of the Bid Size Index values ranging from 25% to 35%, but only for a period of 12 months. Due to the fact that similar relationships have not been confirmed for shorter periods, this result is not taken into account in the general conclusions presented below.

The following conclusion can be stated: the low ratio of the number of newly issued shares (up to 16%) to all company shares before the debut is important information for investors, as it has a significant impact on achieving negative rates of return calculated from the purchase of company shares at the end of the session on the debut day to their sales after 3, 6, 9 or 12 months. The data are included in Table 3.

Table 3. Abnormal rates of return depending on the Bid Size Index range

Range of Offer Size Index (%)	Time from the debut (in months)	Sample size for the N variant under analysis	Greater rank sum	Test statistic	Limit for the critical region $\alpha = 5\%$	Limit for the critical region $\alpha = 10\%$	Reject the null hypothesis	Median of abnormal return rates (%)
up to 16	3	22	negative	41	66	75	yes for $\alpha = 5\%$	–11.6
up to 16	6	20	negative	39	52	60	yes for $\alpha = 5\%$	–22.8
up to 16	9	21	negative	47	59	68	yes for $\alpha = 5\%$	–26.2
up to 16	12	21	negative	53	59	68	yes for $\alpha = 5\%$	–32.7
16–25	3	24	negative	138	81	92	no	1.8
16–25	6	24	negative	125	81	92	no	–3.5
16–25	9	23	negative	112	73	83	no	–6.0
16–25	12	22	negative	108	66	75	no	–4.0
25–35	3	22	negative	104	66	75	no	–1.8
25–35	6	22	negative	93	66	75	no	–2.6
25–35	9	21	negative	70	59	68	no	–10.9
25–35	12	21	negative	44	59	68	yes for $\alpha = 5\%$	–15.5
over 35	3	23	negative	129	73	83	no	1.8
over 35	6	23	positive	128	73	83	no	–2.5
over 35	9	23	positive	114	73	83	no	7.9
over 35	12	23	negative	122	73	83	no	–5.0

Source: own analysis.

Study C

In a recent study, an examination was conducted to test whether the combination of the Bid and Demand Quantity metrics contributed to the occurrence of abnormal returns at 3, 6, 9 and 12 months. The data are included in Table 4.

For the value of the Offer Volume Index not exceeding 20% and, at the same time, the value of the Demand Index above 90%, in all analysed periods, i.e. 3, 6, 9 and 12 months from the debut, abnormal rates of return were statistically significantly different from zero at a significance level of at least 10%. Therefore, the null hypothesis is rejected for these tested values and time periods. Comparing the sums of negative and positive ranks, it can be concluded that in these cases, the median abnormal returns were negative.

Similarly, abnormal rates of return that were statistically significantly greater than zero occurred in the 9- and 12-month periods studied for the combination of the Bid Size Index ranges from 20% to 33% and the Demand Index values above 90%. For these test variants, the null hypothesis can also be rejected, with the proviso that for the remaining periods (3 and 6 months) such a rejection cannot be made.

Conclusion: significant demand for shares in the public offering, combined with a low ratio of the number of new issue shares to all company shares before the debut, is important information for investors as it has a significant impact on achieving negative rates of return calculated on the purchase of company shares at the end of the session on the debut day for sale after 3, 6, 9 or 12 months. In addition, in the case of the two longest periods (9 and 12 months), it can be concluded that the significant demand for shares in the public offering combined with the average ratio of the number of new issue shares to all shares (up to 33%) also has a significant impact on achieving negative rates of return.

It is also worth noting that in the case of lower values of the Demand Index, below 90%, the relationship could not be confirmed and the null hypothesis cannot be rejected in such cases. This proves the importance of achieving high values of the Demand Index in the offering process, but only together with a combination of a relatively low value of the offering of new shares.

Conclusions

The research conducted in this paper confirms the importance for investors watching the public offering of some information from the completed public of-

Table 4. The occurrence of abnormal rates of return depending on the combination of the Bid Size Index and Demand Index ranges

Range of Offer Size Index (%)	Range of Demand Index value (%)	Time from the debut (in months)	Sample size for the N variant under analysis	Greater rank sum	Test statistic	Limit for the critical region $\alpha = 5\%$	Limit for the critical region $\alpha = 10\%$	Reject the null hypothesis	Median of abnormal return rates (%)
up to 20	90–100	3	10	negative	7	8	11	yes for $\alpha = 5\%$	–12.9
up to 20	90–100	6	10	negative	9	8	11	yes for $\alpha = 10\%$	–12.8
up to 20	90–100	9	10	negative	11	8	11	yes for $\alpha = 10\%$	–12.5
up to 20	90–100	12	10	negative	10	8	11	yes for $\alpha = 10\%$	–28.6
up to 20	60–90	3	15	negative	42	25	30	no	4.3
up to 20	60–90	6	14	negative	31	21	26	no	–9.4
up to 20	60–90	9	15	negative	33	25	30	no	–13.5
up to 20	60–90	12	15	negative	39	25	30	no	–13.1
20–33	90–100	3	10	negative	13	8	11	no	–2.6
20–33	90–100	6	10	negative	12	8	11	no	–5.0
20–33	90–100	9	10	negative	10	8	11	yes for $\alpha = 10\%$	–13.4
20–33	90–100	12	10	negative	8	8	11	yes for $\alpha = 5\%$	–14.6
20–33	60–90	3	13	negative	39	17	21	no	–0.1
20–33	60–90	6	13	negative	43	17	21	no	3.5

cont. Table 4

Range of Offer Size Index (%)	Range of Demand Index value (%)	Time from the debut (in months)	Sample size for the N variant under analysis	Greater rank sum	Test statistic	Limit for the critical region $\alpha = 5\%$	Limit for the critical region $\alpha = 10\%$	Reject the null hypothesis	Median of abnormal return rates (%)
20–33	60–90	9	11	negative	30	11	14	no	0.4
20–33	60–90	12	11	negative	22	11	14	no	–15.5
20–33	up to 60	3	9	negative	21	6	8	no	–2.4
20–33	up to 60	6	9	negative	18	6	8	no	–12.8
20–33	up to 60	9	9	positive	22	6	8	no	–10.9
20–33	up to 60	12	8	negative	17	4	6	no	–20.5
over 33	90–100	3	7	positive	12	2	4	no	1.8
over 33	90–100	6	7	negative	14	2	4	no	–4.3
over 33	90–100	9	7	negative	12	2	4	no	–22.1
over 33	90–100	12	7	negative	8	2	4	no	–26.7
over 33	60–90	3	9	positive	16	6	8	no	2.1
over 33	60–90	6	9	positive	18	6	8	no	13.4
over 33	60–90	9	9	positive	18	6	8	no	8.3
over 33	60–90	12	9	negative	20	6	8	no	–6.1
over 33	up to 60	3	13	negative	26	17	21	no	–7.3
over 33	up to 60	6	13	negative	34	17	21	no	–4.6
over 33	up to 60	9	13	positive	45	17	21	no	–0.4
over 33	up to 60	12	13	negative	34	17	21	no	–5.0

Source: own analysis.

fering and has an impact on the abnormal declines in share prices in the period of several months from the debut.

Information from Study A regarding the demand for shares during the IPO suggests that the correlation between demand and abnormal return rates is weaker than anticipated. Despite isolated cases where the null hypothesis was rejected, the significance was marginal, and no consistent pattern emerged across the analysed timeframes. This indicates that, contrary to expectations, the demand for shares during the IPO does not appear to have a statistically significant impact on achieving abnormal return rates over a period of 3 months to a year from the debut. Therefore, it can be concluded that investor interest measured by the Demand Index does not reliably predict post-debut share price behaviour within the studied timeframe.

Information from Study B on the relatively low number of new issue shares offered correlates with the achievement of rates of return lower than the benchmark (i.e. the appropriate index) within 3 months to a year from the debut. Similarly, combined with the above information, information regarding high demand for shares also correlates with achieving rates of return below the benchmark. Such conclusions contradict our predictions. The assumption was that the relatively low number of new issue shares offered would have a positive impact on the share price within a year of the debut. Similarly, high demand for shares could suggest investors' interest in the debuting company, and thus a further increase in the share price after the debut.

Demonstrating a statistically significant impact on negative rates of return may be due to the specificity of this type of public offerings, in which a relatively small number of shares are offered for sale. The small size of the offer also translates into small amounts to be obtained in relation to the total value of the company. Entities entering the stock exchange, deciding on a limited issue of shares, in most cases need relatively small funds from the issue for further development. This proves the stability of their business, but also shows plans that assume a relatively slower development in time, due to small recapitalisation, compared to companies that raise significant funds from the share offering. Obtaining significant funds is usually needed in the case of acquisition plans or quick entry into new areas of activity, i.e. for rapid business development. Thus, companies that raise more funds develop relatively faster than those that decided to issue small shares. The latter may therefore seem less attractive to investors, precisely because of the relatively slower development. This may explain the statistically significant drop in their share price in the year following their IPO. However, the reverse correlation could not be confirmed in these studies – the increase in the share price for companies offering a large number of shares in relation to the total number of shares was not shown.

If we combine the information about the relatively low number of newly issued shares offered with the demand for shares (defined as the ratio of the funds ac-

tually received from the share offering to the funds assumed to be obtained from the sale of new shares and those offered by the owners of the company before the offering), we obtain a relationship that is also important information for investors (Study C). Offerings with fewer new shares and strong demand from institutional and individual investors were found to correlate with lower rates of return compared to the benchmark, up to a year after the debut.

Intuitively, one might expect that the high demand in the public offering would be correlated with an increase in the future share price, not a decrease. However, the significance of the demand for shares in the offer was demonstrated only in the case of a low number of new shares in relation to all shares. Considering the arguments regarding the relatively slower development of low-issue companies, it can be concluded that the high demand for shares before the debut only makes the situation worse. The lack of a rapid increase in the value of the company causes the desire to get rid of shares purchased at a price close to the maximum price, which is another argument explaining the decline in the share price.

The conducted study may serve as a basis for further research by focusing on additional explanatory factors, such as the role of investor sentiment or macroeconomic indicators, which could influence abnormal returns. It is also worth exploring how varying levels of market liquidity or company-specific characteristics impact the correlation between IPO-related information and post-debut share price performance. Additionally, future research could address the limitations of this study, including the specific market conditions and the time frame analysed, to offer a more comprehensive understanding of these relationships.

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The significance of tax risk for Polish companies based on the findings of an empirical study

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Abstract

Discussion of the problem of tax risk based on the empirical study. The paper explains the main aspects of tax risk, tax risk areas and its assessment. Critical analysis of existing literature and tax laws. Conclusions are formulated using a deductive method in the framework of tax theory and based on the analysis of tax laws and the author's survey into the problem of tax risk conducted in the Wielkopolskie voivodeship in 2020. The survey results show that managers are increasingly aware of the tax risks associated with the activities of their companies and the industries in which they operate. They also indicate that, regardless of their size, companies should use tax risk management systems aligned with their tax strategies and managed by qualified staff. The article contributes to the analysis of tax risk.

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Keywords

- tax risk
- sources of tax risk
- tax risk management
- level of tax risk
- tax law

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Introduction

Although risk is an inevitable part of business activity, monitoring and analysing its sources, structure and the potential damage it can cause can significantly reduce its impact. A good illustration of how important these activities are for companies is the increasing role of training in risk management for managers and employees. A study by Ernst and Young has found that Europe is the region where

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tax risk is highest, not only due to the pandemic but also because of legal uncertainty, tax reforms and tax collection methods (*Badanie EY*, 2021).

In this study, the author attempts to analyse the problem of tax risk, based on her own empirical research and a review of the existing literature. Source analysis and deductive and inductive reasoning are used as the research methods. Due to the importance of the issue of tax risk, the main objective of the study is to attempt to identify this process based on the survey conducted among companies located in the Wielkopolska region in various organisational forms in 2020. The research made it possible to indicate the types of risk identified by companies, their level of awareness in this area, internal and external sources of tax risk according to the respondents and the method of managing tax risk. The article consists of an Introduction, five Sections and Conclusions. Three of these sections are theoretical (The concept and classification of risk; Identification of risk areas in corporate tax management; Determination of revenue, tax and non-tax costs from the perspective of tax risk), two are empirical in nature (Legislative instruments reducing tax risk; Assessment of tax risk faced by Polish companies based on the findings of an empirical study).

1. The concept and classification of risk

Risk and uncertainty are inherent in every economic activity. Their unavoidability causes companies to develop appropriate risk management strategies to maintain their position in the competitive market. A lack of such a strategy entails increased vulnerability to risk (Ostrowska 1999, pp. 28–29).

The literature provides different definitions of risk that are more or less successful in explaining its complexity and ambiguity. Moeller (2011, p. 157) has observed that two experts investigating the same area of a company's operations may differ in interpreting the risks they involve. In the Business Lexicon, risk is defined as the probability of incurring losses as a result of a particular decision and a phenomenon where some variables cannot be estimated using probability calculus (Penc, 1997, p. 388).

Duliniec (2001, p. 3) understands risk as a situation whose outcomes may be better or worse than expected, while Rowe (1977, p. 24) defines it as the possibility of an undesirable reality, a negative consequence of a certain event. Therefore, two basic concepts of tax risk are distinguishable: a neutral concept presenting risk as the probability of achieving a result other than expected, and a negative concept identifying risk with a threat (Jajuga, 2007, p. 13).

The concept of risk describes its nature as follows (Tarczyński & Mojsiewicz, 2001, pp. 14–15):

- the heterogeneity of risk makes it difficult to define it precisely,
- risk has an objective and subjective side,
- risk is volatile.

The literature offers various criteria for classifying risks faced by companies. Because of their sources, they are divided into internal risks (associated with human resource problems such as employee failures or inappropriate personnel policies and corporate governance) and external risks (political risks, legal risks, interest rate risks, currency risks and liquidity risks) (Iwaszczuk, 2021, p. 17). There are also static and dynamic risks following from technical, economic and organisational changes (Kufel, 2007).

The risk of running a business is usually divided into business risk and financial risk (Zeliaś, 1998, p. 62). The former is related to insufficient or missing internal control measures, information system errors or damage caused by force majeure or human action (Holliwell, 2001, p. 14).

On the other hand, the source of financial risk is excessive debt financing. Over-borrowing followed by problems with repaying principal and interest may lead to a lack of liquidity or even cause a company to file for bankruptcy (Smaga, 1995, p. 14).

Financial risk consists of several specific risks, namely (Nowak, 2010, p. 15):

- currency risk,
- interest rate risk,
- inflation risk.

For some reason, none of the classifications takes account of tax risk, which should be treated as operational risk because it is directly related to business activities and entails sanctions that increase business costs.

In the literature, tax risk is defined as a potentially adverse event that may negatively affect an entrepreneur's reputation in the eyes of the tax authorities, investors, employees and the public (Wiśniewski, 2009, p. 60) or cause uncertainty as to the outcomes of the completed and future business activities (Poszwa, 2007, p. 11). There is also a definition describing tax risk as the probability of an entrepreneur misinterpreting a tax liability, especially by misjudging its amount or base, potentially entailing financial and criminal consequences for the entrepreneur (Jachira, 2018, p. 301). According to the author of this paper, tax risk can be defined as the probability that the company's tax liability will exceed the forecasted amount or that an unforeseen tax liability will occur. It is important to note that the materialisation of tax risk may have undesirable consequences, both financial and non-financial.

Researchers distinguish between broad tax risk and narrow tax risk. The former is the risk that the state will collect less taxes than it needs to finance its functions, which is an inherent feature of withholding tax collection, tax management, tax policies and tax law enforcement. The latter is the risk that taxpayers will not comply with tax laws and regulations at all, underpaying their tax liabilities or delaying their payment (Firmansyah & Muliana, 2018).

Therefore, the main focus of risk management is on creating business conditions that will minimise the probability of an unforeseen loss and improve a company's financial performance.

2. Identification of risk areas in corporate tax management

As tax risk may prevent companies from achieving their tax policy objectives, they should be aware that it has external and internal sources.

The external (exogenous) sources of tax risk are beyond the control of companies because they lie in their macro-environment. These include market volatility, frequent changes to tax regulations, fiscal orientation of tax authorities and the intricacy of tax legislation (Hajduga, 2020, p. 47).

The internal (endogenous) causes of tax risk are part of the micro-environment of companies. Their range includes employees' insufficient knowledge about taxes, unclear assignment of responsibilities to personnel, poor communication between tax and legal departments, lack of formal internal regulations and problems with IT systems (Nowak, 2010, p. 284). Companies use different IT systems to handle their tax liabilities, many of which are developed by programmers without insufficient knowledge of taxes, which increases the risk of incorrect settlement of taxes (Burchart & Bagieńska, 2019, p. 421).

It should be noted that the sources of risk presented above are interrelated. Frequent changes and inconsistencies in tax law often lead companies to file inaccurate tax returns, resulting in financial penalties. The taxability of an agreement and the applicable tax rate depend largely on its specific terms. Unfortunately, these agreements are typically drafted without the involvement of accountants, which further heightens the risk of tax-related problems (Nadolska, 2006).

The causes of tax risk can be formal, related to procedures involved in the assessment, control and collection of taxes, as well as material, arising from the very construction of individual taxes. Accordingly, in the first case, tax risk is closely related to control over entrepreneurs, and in the second case, to the construction of a tax (Biernacki, 2017, p. 21).

However, it should not be understood that the only source of tax risk is tax irregularities and the probability of penalties imposed by tax authorities. Another source is the actions taken by companies to reduce their tax liabilities and the poor management of tax costs (Sachs, 2005, C3).

Tax risks can be divided into specific risks (transactional, operational, compliance and financial accounting risks) and generic risks (portfolio, management and reputational risks).

Transactional risk is understood as the probability that some unusual or complex transactions will necessitate the structuring of commercial arrangements to avoid the payment of tax or the misapplication of tax laws.

Operational risk is explained as the risk of incurring a loss due to poor or inefficient internal processes, human resources, systems or external events. To be effective, transactional, compliance and operational risk management must be accompanied by risk awareness in financial accounting. A material source of tax risk is when transactions, events and conditions are treated differently for financial reporting and tax purposes (Segal & Maroun, 2014, p. 376).

The literature also classifies tax risk by source. Thus, there are risks arising from (Elgood et al., 2008, p. 11):

- strategic activities and atypical transactions,
- financial reporting,
- handling of tax obligations,
- business operations.

Whether occasional or regular, business operations involve tax risk. In the first case, its source is personnel's lack of knowledge and skills necessary to process them for tax purposes. In the second case, the personnel may tend to process them in a routine manner, which may result in incorrect calculation of taxes, etc.

The need for each company to have an appropriate tax strategy consistent with its overall corporate strategy and addressing all aspects relating to the payment of taxes is very obvious. Inadequate tax risk management entails many negative consequences for companies, including a decrease in financial liquidity, deterioration of the public image and the risk of management being held liable under the Financial Penal Code. According to Nadolska (2006), companies with tax risk management systems benefit from them in many ways, for instance by:

- running a lower risk of tax errors,
- staying compliant with tax regulations,
- increasing the company's value,
- eliminating areas where tax risk may occur or reducing their number,
- finding new ways to lower their tax liabilities,
- reducing the risk of prosecution under the Penal and Fiscal Code (Ustawa, 1999).

It is also important that risk managers are aware of the existence of tax risk and have the skills necessary to identify it. Compliance with the tax law and proper management of tax liabilities can significantly reduce the level of risk.

3. Determination of revenue, tax and non-tax costs from the perspective of tax risk

The level of tax risk largely depends on the correct calculation of revenues as well as tax and non-tax costs. This may be challenging for companies due to unclear, frequently amended legislation.

Tax law does not provide a definition of revenue but only indicates taxable and non-taxable sources of it. The Accounting Act describes revenues as probable economic benefits in a given reporting period, such as an increase in assets or making up for their deficiency, obtained in a way other than the contribution of funds by shareholders or owners and reliably valued (Ustawa, 1994, Article 3, Section 1, p. 30).

The analysis and determination of whether an entity has achieved economic benefits must be conducted during the financial year and reported at the balance sheet date. The process must take into account the uncertainties in the legal and market environment of the entity (Gierusz, 2005, p. 64).

Revenues in the profit and loss account are presented by type of source. In this way, a distinction is made between basic operating activities, other operating revenues and financial revenues (Kondratowicz, 2006, p. 25). A comparison of revenues reported under the balance sheet rules and tax rules points to the following groups of revenues (Poszwa, 2013, p. 141):

- accounting revenues (from the sale of products, goods and materials), which are classified as tax revenues,
- revenues indicated in the profit and loss account but excluded from tax revenues (e.g. derived from agricultural activities),
- revenues excluded from the profit and loss account but included in tax revenues (e.g. benefits received free of charge).

In addition to sales revenues, which constitute the main category of revenues in the Corporate Income Tax Act, there are also tax revenues such as positive exchange rate differences, the value of goods or rights received, including those received wholly or partially free of charge, part of liabilities that have been redeemed or written off as uncollectible, or have expired (and whose impairment

losses were previously classified as revenue costs), as well as the value of cancelled or reduced reserves.

Because of the risk of revenues being inaccurately identified or valued, every company should have procedures to keep this risk as low as possible. The amount of revenue that should be reported in the profit and loss account is determined by identifying economic operations from source evidence. The process should be performed according to the rules governing the valuation of assets for balance sheet and tax purposes.

In determining taxable revenues, one has to bear in mind that Article 12, Section 4 of the Corporate Income Tax Act (Ustawa, 1992) exempts some types of revenues from taxation. These are:

- amounts collected or received due to the delivery of goods and services in future reporting periods, as well as loans (credits) granted or returned, including those repaid in kind, except for capitalised interest on these loans (credits),
- accrued, but not received, interest on receivables, including on loans (credits) granted,
- returned shares or voting stock in cooperatives, redeemed shares or stocks in companies, including amounts from the sale of shares or stocks to their issuers for redemption, equivalent to the cost of their purchase or subscription,
- value added tax payable,
- revenues that the act on the company social fund indicates as increasing the fund.

The Corporate Income Tax Act links the moment of generating revenue with the date of delivery of the item or provision of the service or with the transfer of property rights, but states that it cannot fall later than the date of invoice issue or payment (Ustawa, 1992, Articles 12, 3a).

Tax liability is calculated based on revenues and costs determined according to the accounting law. It must be borne in mind, however, that the tax law treats some revenues and costs as tax-deductible while other revenues and costs must be taxed. It is noteworthy that tax law constitutes a separate element of the legal system governing the economy, which points to the autonomous status of the balance sheet law and tax legislation (Litwińczuk, 2000, p. 156).

There are three steps in calculating companies' tax costs: 1) identifying tax-deductible costs, 2) evaluating costs, and 3) allocating costs to the appropriate billing period (Poszwa, 2014, p. 461).

While companies are interested in having possibly large tax costs, many of them lack the knowledge to determine which costs are legitimately tax-deductible. This relevance of observation is confirmed by numerous interpretations issued on behalf of individual taxpayers and Supreme Administrative Court rulings.

The Corporate Income Tax Act defines tax-deductible costs as costs incurred to generate revenue or maintain or secure a source of revenue, other than costs listed in Article 16, Section 1 (Ustawa, 1992, Article 15, Section 1). Under the Act, an expense is a tax cost when it was necessary to generate revenue and when it is not specifically disqualified by the tax law.

It is also important to remember that only costs incurred in a given tax year in relation to the same year revenues are deductible from the tax base. An exception to this rule is costs paid in previous tax years to earn revenues in the current tax year.

Beger and Liss (2012, p. 41) point to a long-standing dispute between taxpayers and the tax administration over which costs are tax-deductible. According to the taxpayers, an expense is tax-deductible when its association with revenue can be demonstrated, whether or not the latter actually occurred. The tax authorities claim, however, that an expense is not legitimately tax-deductible unless it leads to revenue. Court rulings have shown that it is the taxpayers who are right in this matter.

The catalogue of non-taxable costs is provided in Article 16 of the Corporate Income Tax Act (Ustawa, 1992) and includes four main groups (Olchowicz, 2009, p. 123):

- expenses for the purchase and increase of the value of those non-current assets that do not constitute tax-deductible costs,
- penalties,
- cost of irregularities in settlements, e.g. such as untimely payment of public law liabilities,
- costs that are unjustified or unnecessary under the law.

Good business practice requires setting maximum limits on non-deductible costs (by type and period), because regardless of their size, they always increase the tax base and tax liability; consequently, they deteriorate the net financial result and lower dividends for the shareholders. Companies deciding to invest in land or acquire the right of perpetual usufruct of land must therefore be aware that such transactions will have an impact on their financial results.

A major group of costs is sanction fees, including (Ustawa, 1992):

- the costs of tax enforcement proceedings in cases of non-compliance with obligations (Articles 16, 17),
- fines and penalties imposed following criminal, fiscal, administrative and misdemeanour proceedings, as well as interest thereon (Articles 16, 18),
- penalties, fees and damages, as well as interest thereon, for a failure to comply with the environmental regulations in force and with the decisions of supervisory or inspection authorities in charge of health and safety at work (Articles 16, 19),

- interest on the late payment of public and other liabilities regulated by the Corporate Income Tax Act (Articles 16, 21).

There is also a category of costs that are not tax-deductible, although many of them are essential from the business perspective and unavoidable. For example, the legislature has decided that corporate expenses made on behalf of the members of supervisory boards, audit committees or the constitutive bodies of legal persons and companies are not tax costs.

A particularly controversial issue is the so-called representation costs. As the tax law does not provide a definition of "representation costs", the tax authorities have felt free to interpret them on their own. The possibility of arbitrary interpretations of the term has recently been limited by an increasing number of court rulings that explain representation costs as expenses incurred in relation to various activities undertaken by companies to present themselves as trustworthy organisations.

In the rulings by the Voivodship Administrative Courts and individual interpretations issued to taxpayers, representation costs are defined as expenses incurred (Beger & Liss, 2012, pp. 50–51):

- to purchase gifts for contractors,
- to invite a contractor to a festive dinner,
- to provide an event for persons other than company employees,
- to provide entertainment for contractors while in training.

A sensitive issue is the tendency of companies to overstate their financial results so that they appear stable and growing organisations, with the strategy (Micherda, 2010, p. 80). By hiding their true financial situation, companies can manipulate estimates, and it should be noted that the valuation of many balance sheet items needs to be more or less estimated.

4. Legislative instruments reducing tax risk

Legal instruments reducing external and internal risks are necessary to increase taxpayers' confidence in the interpretation and application of tax regulations. There are a number of such instruments in Poland that companies should use to protect their tax position. The author has selected and presented only the most important legal instruments of this type.

One of the major legal provisions aimed at protecting the tax base and countering aggressive tax optimisation practices is the General Anti-Avoidance Rule,

introduced in July 2016 (Ustawa, 1997, Section IIIA, Chapter I) and amended on 1 January 2019, which defines the legitimate scope of tax optimisation.

The clause applies to the actions of taxpayers whose main objective is to obtain a tax advantage, or when one of the main objectives was to achieve such an advantage, if it contradicts the substance or purpose of the Tax Ordinance Act or its provisions (Ustawa, 1997).

Such a tax advantage does not occur if the action was "artificial", i.e. if it had not been used by an entity acting reasonably and with legitimate aims for predominantly sound economic reasons. The reasons exclude attempts to gain a tax advantage challenging the substance or purpose of the Tax Ordinance Act or its provisions. It is notable that the General Anti-Avoidance Rule is criticised by some as unclear and ambiguous (Gomułowicz, 2020, p. 9).

The clause is general in the sense that it concerns all actions taken to gain a tax advantage. It applies when successive transactions are combined in such a way that their primary and common objective is to avoid paying a tax (Gomułowicz, 2020, p. 16).

It is worth noting, however, that the Tax Code does not define the concept of "tax advantage" but only provides a list of cases where such an advantage may occur (Ustawa, 1997), including:

- non-occurrence of a tax liability or its postponement in time,
- reduction of tax liability,
- excess tax payment or overstatement of its amount,
- creation of the right to a tax refund,
- overstatement of the amount of tax refund.

In the case of tax avoidance, the Head of National Revenue Administration issues a decision specifying the consequences for the taxpayer, based on a hypothetical scenario where the transaction or activity was carried out with legitimate objectives other than obtaining a tax advantage.

The applicability of the General Anti-Avoidance Rule in individual cases is assessed by the Council on Tax Avoidance. The opinion of the Council is issued at the request of the Head of NRA in the course of proceedings or at the request of a party included in an appeal against a decision issued while the General Anti-Avoidance Rule was applied.

The tax avoidance provisions contain several instruments protecting taxpayers' interests, such as:

- protective opinions issued by the Head of National Revenue Administration (NRA) at the request of the taxpayer concerned, indicating whether a given action amounts to tax avoidance. An application for the opinion involves a fee

of PLN 20,000 and should contain a detailed description of the action, its aims and economic rationale. The NRA may refuse to issue a protective opinion if the main transaction to which it relates was carried out primarily for the purpose of obtaining a tax advantage, which is contrary to the substance and purpose of the provisions of the Tax Ordinance Act;
- opinions on the applicability of the clause issued by the Council on Tax Avoidance at the request of the Head of National Revenue Administration. If the Council does not issue an opinion within three months, the clause is deemed applicable (or inapplicable, if an opinion was requested by the taxpayer);
- the suspension of immediate enforceability of decisions issued under the clause;
- the right of the taxpayer to correct the tax return within a 14-day period designated by the tax authority before the first instance decision is issued in the proceedings concerning the tax avoidance clause. All corrections to be made to the tax return should be well thought out in advance, because correcting it again after the tax proceedings have ended will not protect the taxpayer from the consequences of tax avoidance.

The Anti-Avoidance Rule does not apply to:

- entities to which a protective opinion has been issued (within the scope of the opinion and until the decision amending or repealing that opinion is delivered),
- entities that have concluded a tax agreement – within the scope of the agreement,
- goods and services tax and fees and non-tax liabilities to the budget.

The last point is very important – the Anti-Avoidance Rule does not apply to the goods and services tax, as these issues are covered by a special anti-abuse solution (pursuant to Article 5, Section 4 of the Polish VAT Act (Ustawa, 2004), the abuse of law is understood as performing activities as part of a transaction which, despite meeting the formal conditions specified in the provisions of the Act, is in fact aimed at obtaining a tax advantage, the granting of which would be contrary to the purpose of these provisions).

The amendment of 1 January 2019 has made it possible for taxpayers to apply to the HNTA to issue a decision specifying the terms of annulment of the consequences of tax avoidance, which the taxpayer may use when filing a tax return or a corrected tax return within 14 days of its reception. The decision protects the taxpayer from a punitive increase in tax liability for an attempt to avoid the payment of taxes. Another advantage of the decision is that no interest is charged on outstanding tax liability constituting an illegitimate tax advantage in the period between the filing of an application for the decision and the annulment of the consequences of tax avoidance.

Another legal solution aimed to protect the taxpayers' interests is the Individual Tax Interpretation that they may seek to make sure whether they correctly understand tax rules applying to past and projected transactions. Taxpayers may also apply for individual interpretations of laws that have been enacted and published but have not yet come into force (see the ruling of 3 June 2014 by the Provincial Administrative Court in Białystok, file no. I SA/Bk 157/14; Wyrok, 2014). There should be stressed that this tool provides protection only to the entity that requested the ruling.

Taxpayers who act in compliance with the tax interpretation they have received are protected against the adverse effects of its change, expiry, repealing by the administrative court, or omission in settlement of tax proceedings in such a way that no tax proceedings are instituted in relation to a tax crime or fiscal offense and those ongoing are terminated, and no interest is charged on overdue taxes. If the tax consequences of the event being interpreted will occur after an interpretation is served, the taxpayer who receives it is exempted from the obligation to pay tax to the extent indicated in Article 14m § 2 of the Tax Ordinance Act (Ustawa, 1997).

The Tax Ordinance Act specifies a number of situations when individual tax interpretations are not issued (Journal of Laws of 2005, No. 8, item 60, as amended, Article 14a; Ustawa, 1997). Taxpayers may not seek them in cases:

- involving binding rate information,
- resolved by the tax authority,
- covered by tax (or investment) agreements,
- involving elements that are an object of ongoing tax or control (tax, customs and fiscal) proceedings.

To encourage large organisations to comply with tax rules, new regulations have been introduced (section IIB "Cooperation" of the Tax Ordinance Act; Ustawa, 1997), which allow them to enter into the so-called Tax Cooperation Agreements with the National Revenue Administration. The agreements are civil-law contracts that offer many benefits to companies, including exemption from tax audits and limited sanctioning for VAT irregularities in some circumstances. Companies interested in such agreements are required to meet several conditions to conclude them, the most important of which is the implementation of the so-called Internal Tax Supervision Framework that Article 20u, paragraph 2, defines as "an effective and adequate set of identified and described processes and procedures governing responsibilities resulting from the tax law and ensuring the proper fulfilment thereof" (Ustawa, 1997).

The Internal Tax Supervision Framework can be seen as an extension of the Tax Compliance Management Systems used in other countries.

5. Assessment of tax risk faced by Polish companies based on the findings of an empirical study

All companies need to accurately identify tax risk areas and implement measures to reduce them. Due to the constantly changing tax law, organisations must carefully monitor for the emergence of new, previously unknown risks in order to avoid or minimise their consequences. Knowledge of the probability of an adverse event allows them to take necessary precautions (Godman, 2006, p. 4).

Tax risk studies draw on concepts such as tax risk, tax risk management, tax risk identification and tax big data. The term "big data" denotes the massive, large-scale and full-scale data that can be acquired, collected and aggregated on a unified processing platform. Big data is also a management tool for managers and users to make decisions through professional computer processing (Brojo et al., 2021).

This study on tax risk management in Polish enterprises and its ethical aspects is based on a survey conducted in 2020. Its results presented in this article utilise only a portion of the data collected but provide a solid foundation for further research into tax risk, including its psychological facets. The survey aimed to assess awareness of tax risk, identify its internal and external sources, and explore how companies manage this risk.

The survey employed a purposive sample of 48 enterprises located in the Wielkopolskie voivodeship, which was selected for having one of the best developed economies in the country and a large number of business organisations.

Because all enterprises in the survey were to be Polish owned, their ownership status was verified through the National Court Register and the Central Register and Information on Economic Activity.

The actual respondents were chief executives (CEOs) of enterprises, of which 21 were limited-liability companies, 22 were sole proprietorships, 3 were civil-law partnerships and 2 were joint-stock companies (Table 1).

Table 1. The organisational and legal form of enterprises included in the survey

Organisational and legal form	Number of enterprises	%
Total	48	100.00
Limited liability companies	21	43.75
Sole proprietorships	22	45.83
Civil law partnerships	3	6.25
Joint stock companies	2	4.17

Source: own analysis.

With regard to the business sectors of the surveyed organisations, 32 operated in the production and trade sector, 9 were trade organisations, and 7 were engaged in trade and provision of services.

The tax regime applying to a taxpayer depends above all on their organisational and legal status. Legal and natural persons fall under different tax regimes and pay different tax rates. Their tax risk is also dissimilar, because the property of a legal person is legally separated from the personal property of its stakeholders.

According to Figure 1, the surveyed companies[2] believed that the risk of escalating pandemic and the risk of increasing operating costs (indicated by almost 80% and 67% of the respondents, respectively) are greater than tax risk (more than 50% of responses). The least important factors were uncertainty about economic growth and the risk of staff shortages.

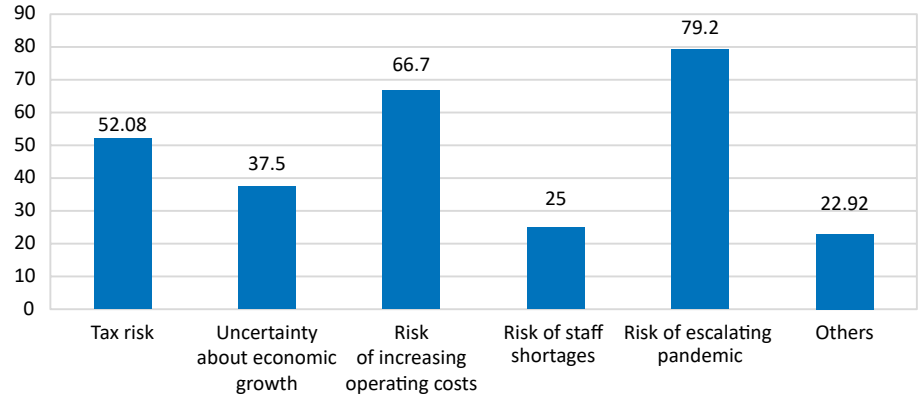

Figure 1. Types of risk indicated by companies (in %)

Source: own analysis.

Therefore, risk related to tax settlements was the third most serious business risk in the opinion of the surveyed companies.

An analysis of the frequency of tax audits initiated by the tax administration shows that although the companies' risk of being audited has markedly decreased in recent years, mainly because of tax audits concentrating on taxpayers suspected of tax irregularities, the risk of a tax audit resulting in tax proceedings has increased. The data below show the numbers of tax audits conducted in Poland in the years 2018, 2019 and 2020 (Koślicki, 2022):

- 2018: 26,102 tax audits (effective in 90% of cases),
- 2019: 22,995 tax audits (effective in 94% of cases),
- 2020: 17,337 tax audits (effective in 86% of cases).

[2] The respondents could choose a maximum of 3 types of risk.

Nonetheless, the likelihood of avoiding a tax audit is low, so every company should prepare for it and make sure that its accounting and tax department can identify tax risks and implement appropriate procedures beforehand.

The fact that more than 85% of the surveyed organisations are aware of the existence of tax risk and a risk of a dispute with the tax administration shows the importance of taxes for business operations. Currently, tax lawsuits account for the greatest proportion of cases filed with administrative courts in Poland (*Badanie EY*, 2021). There are also fears among entrepreneurs that large transfers from the budget to social and anti-crisis programs may increase their fiscal burden in the future.

When asked to indicate the main internal sources of tax risk, one in four of the surveyed managers pointed to insufficient knowledge and skills of employees. Therefore, having tax experts in the team seems to be the right way to reduce the tax risk of companies, as well as providing employees with specialist training, courses and literature to expand their knowledge, so that they can correctly interpret tax regulations and handle the financial aspects of operations. Knowledge of taxes is a prerequisite for managing company taxes (Stępień, 2015 p. 37).

Employee involvement in their responsibilities was rated as low by 16.7% of respondents (Figure 2). More than one in five pointed to a lack of formal internal rules regulating tax strategy as one of the internal sources of tax risk. This may indicate that although companies are aware that tax risk exists, they tend to manage it intuitively instead of establishing formal rules for dealing with it.

This is rather surprising, given that formal risk management procedures can ensure the proper functioning of the tax department and efficient cooperation

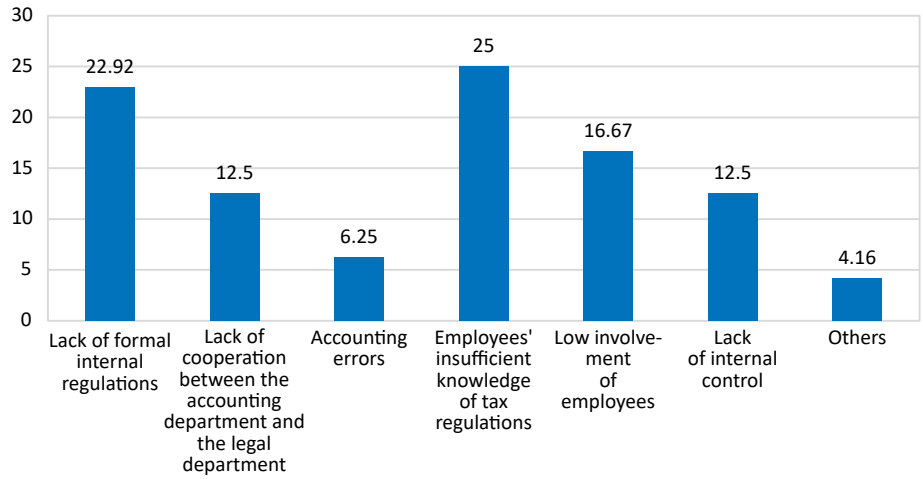

Figure 2. Internal sources of tax risk according to the respondents (in %)

Source: own analysis.

between the department and the rest of the company. Lack of internal control and co-operation between accounting and legal departments was a problem for one in eight respondents.

Internal control procedures are important in that they designate the scope and means of control, the amount of information to be made available to auditors, audit principles, control regulations, post-control regulations, and name staff members responsible for monitoring the implementation of the procedure.

For almost half of the respondents, the main source of external tax risk was the complex tax system (Figure 3). Every third respondent was critical of the frequent changes in tax regulations, which cause interpretation problems for taxpayers. A response to the variability of tax legislation rules should be systematic training of the tax accounting staff, which would ensure that the staff possess the necessary legal knowledge to minimise tax risk and understand regulations related to both tax and non-tax costs. Practice shows that most disputes between taxpayers and the tax administration concern tax costs. There seems to be a problem not only with the correct calculation of tax liabilities but also with understanding the potential consequences of tax-related decisions.

The fiscal orientation of the tax authorities was indicated by 12.5% of respondents, which emphasises the need for taxpayers to keep appropriate documentation of their key transactions and tax calculations. It is also important to foster cooperative relations between taxpayers and the tax administration. They are particularly important in the case of tax audits, during which taxpayers should carefully explain all facts and refrain from actions that might obstruct their course.

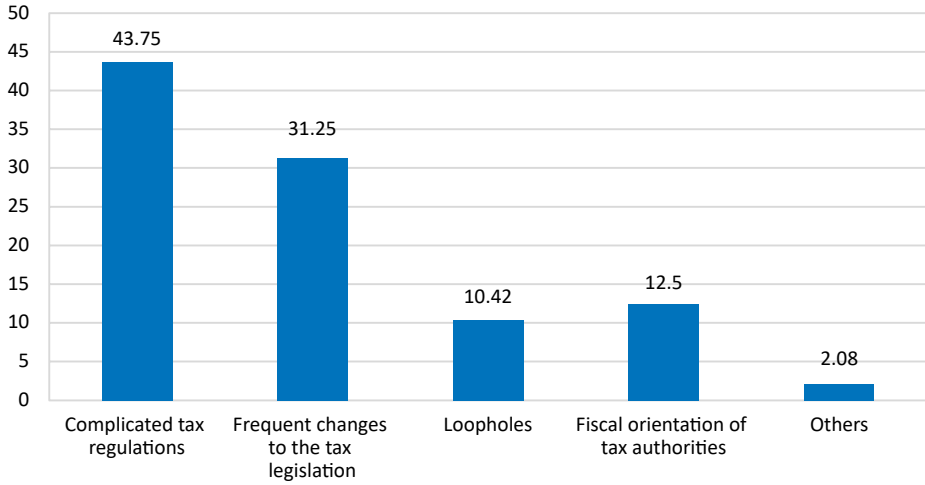

Figure 3. Major external sources of tax risk indicated by the respondents (in %)

Source: own analysis.

Proper tax risk management involves careful planning and systematic implementation of measures aimed at its minimisation.

Figure 4 shows that more than half of the respondents knew that tax risk should be managed on an ongoing basis. Systematic monitoring of potential risk areas is necessary to ensure that all tax risk control procedures in a company closely follow developments in its internal and external environments. The procedures are not only a prerequisite to efficient functioning of the risk management system and its instruments (e.g., methods for risk identification, measurement and control, etc.), but they also protect companies from irregularities in tax settlements and problems with the tax administration.

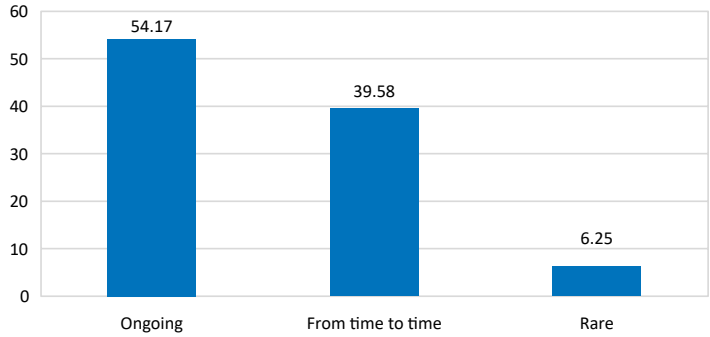

Figure 4. Tax risk management in the surveyed companies (in %)

Sources: created by the author.

Conclusions

As there are no universal tools allowing tax risk to be managed effectively and efficiently, companies should devise their own ways of managing tax risk. Accepting the existence of risk is the first step toward adopting measures that can mitigate its potential consequences. Successful tax risk management largely depends on how much a company knows of this process and tax risk itself. It also requires constant monitoring of changes in tax regulations and tax interpretations as well as providing employees with specialist training.

The presented empirical findings show that tax risk is a recognisable phenomenon. It is undoubtedly very important for the existing state of art. It is worth conducting the research in the future on a larger research sample to check the extent to which changes have occurred in the method of tax risk management in Polish companies. The surveyed companies made efforts to manage it, being aware that wrong interpretations of tax rules or employee incompetence might expose them

to financial, business or even criminal consequences. Because they may affect the entire organisation, not only the financial department personnel but also all employees influencing costs and sales should be responsible for dealing with tax risk. This approach emphasises the need for appropriate internal tax procedures and processes, including effective communication between the tax department and other departments, overseeing decision-making and ensuring the consistency of tax information circulating within the organisation.

It should be natural for organisations to have a tax risk management system underpinned by a well-thought-out tax strategy fitted to their goals and business activity. In all organisations, seeking ways to minimise their tax risk should be an essential element of corporate management.

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Evaluation of the impact of the COVID-19 pandemic on the financial health of commercial insurance companies in the Czech Republic

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Abstract

This article focuses on assessing the impact of the COVID-19 pandemic on the insurance operations of commercial insurance companies in the Czech Republic. The aim of the article is to determine the impact of the pandemic on the financial health of commercial insurance companies in the Czech Republic. In order to achieve this, ratio indicators suitable for measuring the financial health of commercial insurance companies, such as the growth rate of premium income, cost-effectiveness, profitability or solvency, have been employed. Because insurance activities in non-life and life insurance differ and show different values of ratio indicators of financial health, insurance companies have been divided into two groups: those with a predominance of life insurance and those with a predominance of non-life insurance. The impact of the pandemic on the financial health indicators of individual commercial insurance companies has been monitored. The period from 2016 to 2021 has been selected to determine the impact of the pandemic. The authors have used data from the statistics of the Czech Association of Insurance Companies and annual reports of insurance companies.

Keywords

- pandemic
- insurance companies
- non-life and life insurance
- financial ratios
- Czechia

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Introduction

The published results of various scientific studies confirm that the pandemic has had a significant impact on the functioning of financial institutions and the financial market as a whole. It is not just the impact on the performance of financial institutions and their financial health. The COVID-19 pandemic has affected various areas of the functioning of financial institutions and has shown not only the threats to them but also the new opportunities associated with the introduction of innovations in communication with clients and in the conclusion of contracts, as well as in the settlement of claims in the case of insurance companies. During the pandemic, financial institutions were forced to quickly and operationally introduce new elements into established business models and distribution channels. The new pandemic risk tested the preparedness of financial institutions in their business operations. The crisis triggered by the COVID-19 pandemic has become a hot topic for identifying the impact on business results. It is undoubtedly important to pay attention to the insurance industry and, in particular, to focus on the performance of commercial insurance companies. Therefore, this paper centres on analysing the performance of commercial insurance companies.

The aim of the article is to determine the impact of the pandemic on the financial health of commercial insurance companies in the Czech Republic. To achieve this goal, the authors address the following research questions: In which areas of financial health did the COVID-19 pandemic have an impact? What variations in the impact of the pandemic on financial health can be observed in individual commercial insurance companies? The research shall contribute to the analysis of the current state of the financial management of commercial insurance companies in the Czech Republic and shall highlight the impacts of possible new risks due to the pandemic.

The health crisis caused by the COVID-19 pandemic had a significant impact on the operations of almost all insurance companies in the Czech insurance market. The pandemic negatively affected their financial health, particularly in terms of cost-effectiveness, performance and solvency. It also influenced the growth rate of gross written premiums. Additionally, the crisis accelerated the introduction of digitalisation elements into various insurance processes, such as contract signing and claims settlement. This health crisis has underscored the importance of the financial stability of insurance companies and the entire financial system. The significance of the insurance industry cannot be overlooked, and addressing similar risks in the future is essential. Pandemics will always pose a significant risk to the stability of the financial market, underscoring the need for proactive measures by regulators in this sector.

To achieve the objective and answer the research questions, a literature review of studies focused on the impact of the health crisis on the financial health of in-

surance companies was first conducted. The conclusions of these studies were used to select appropriate ratio indicators for the assessment. A time series from 2016 to 2021 was chosen, as it covers the period of the pandemic and no other significant influences on the development of the insurance market in the Czech Republic were observed during this time. However, in 2022, the insurance market began to be affected by significant factors – inflation started to rise in 2022, and in 2023, the war crisis in Ukraine broke out. The study includes insurance companies operating in the Czech market, providing information on their market shares and shares in non-life and life insurance. Finally, the development of financial ratio indicators in the selected period is evaluated separately for insurance companies both with a predominance of non-life insurance and those with a predominance of life insurance. The time series analysis also highlights the deterioration of selected indicators due to the pandemic at individual insurance companies.

1. Literature review

The impact of the COVID-19 pandemic on the insurance market and the operations of commercial insurers is significant. Although it has not been long since the pandemic, several research studies can be found that identify the impact on the insurance sector. As Puławska (2021) reports, specifically German and Italian insurance companies experienced a decline in return on assets (ROA) during the pandemic, while the Belgian, French and German insurance sectors experienced a decline in solvency ratios. Puławska (2021) points to a possible future solvency problem for insurance companies and stresses that this is a signal to regulators. A study by Stojkoski et al. (2021) examined the short-term effects of COVID-19 on insurance operations, revealing that the pandemic led to a decline in insurance activity among companies in Macedonia. The study by Kirti and Shin (2020) also highlights the impact of COVID-19 on insurers due to large-scale financial dislocations and focuses on the issue of bond ratings. The COVID-19 pandemic has caused considerable uncertainty in the pricing of risk in life insurance. Amid this uncertainty, government interventions and measures were implemented, which reduced the number of casualties. As seen in the findings of Harris et al. (2021), there has been no increase in life insurance premiums or decrease in the supply of life insurance in the US. Przybytniowski et al. (2022), based on an analysis of the insurance market, highlighted the threats that arose in the insurance market as a result of the pandemic, such as pressure to change premium levels and to set technical reserves correctly. In addition, Preda et al. (2021) noted the increased costs associated with facilitating telework. They point out that with business con-

tinuity, there is pressure on the profitability of some insurance companies and that the COVID-19 crisis affected the solvency and profitability of the insurance sector in particular. In the area of growth rates of written premiums, it is worth mentioning the results of studies by Kočović et al. (2023) as well as Kašćelan et al. (2023), who focused on the development of the insurance industry on a global and European scale.

The study by Kočović et al. (2023) presents results on the global growth rate of insurance premiums. According to their results, the economic crisis caused by the COVID-19 pandemic led to a reduction in the growth rate of real GDP. In 2020 (as compared with 2019), there was a sharp decline, and the value reached –3.3%. This had a negative impact on the global insurance industry and insurance market. The growth rate of total premiums in 2020 (as compared with 2019) was –0.2%. Life insurance in particular was negatively affected by the decline in economic activity. In 2020, life insurance premiums had a negative growth rate of –4.2% compared to the previous year. The global growth rate of non-life insurance premiums was 3.1%, indicating that the global non-life insurance market demonstrated considerable resilience during the year in crisis conditions. In their study, Kočović et al. (2023) also present the results of premium growth in various Central and Eastern European countries (Serbia, Croatia, Slovenia) in 2020. They note that the evolution of premium growth rates in the selected countries was different. They also point out that the measures introduced by almost all countries affected by the pandemic have led to a significant economic recovery, which was unfortunately interrupted by the economic crisis caused by the war in Ukraine. In turn, Kašćelan et al. (2023) focused on the analysis of the EU insurance sector. In the year 2020, which was marked by the global COVID-19 pandemic, there was a decline in income based on premiums realised, especially in life insurance. Non-life premiums increased during this period, which did not negatively affect the overall solvency of insurance companies in the EU. The research suggests that there is a very delicate balance between profitability and solvency for insurance companies in the EU. In general, the insurance system in Europe appears to be quite resilient considering the challenging conditions of 2020 for businesses as a whole.

2. Methodology and data

The aim of the article is to determine the impact of the pandemic on the financial health of commercial insurance companies in the Czech Republic. The research was conducted in the following manner: insurance companies operating during the period of 2016–2021 were included in the assessment (see Table 1)

Table 1. Insurance companies and their average share of non-life insurance, average share of life insurance, average market rate (2016–2021) (in %)

Insurance company	Abbreviation	Share of non-life insurance (average)	Share of life insurance (average)	Market share (average)
Predominance of non-life insurance				
Allianz pojišťovna, a.s.	**ALLIANZ**	76.86	23.14	9.46
AXA pojišťovna, a.s.	**AXA**	100.00	0.00	1.38
BNP Paribas Cardif Pojišťovna, a.s.	**BNP**	100.00	0.00	1.66
Colonnade Insurance S.A., organizační složka	**COLLONADE**	100.00	0.00	0.48
Česká podnikatelská pojišťovna, a.s.	**CPP**	76.98	23.02	6.48
Česká pojišťovna ZDRAVÍ, a.s.	CP ZDRAVI	100.00	0.00	0.32
ČSOB Pojišťovna, a.s., člen holdingu ČSOB	**CSOB**	53.50	46.50	8.57
D.A.S. Rechtsschutz AG, pobočka pro ČR	**DAS**	100.00	0.00	0.24
DIRECT pojišťovna, a.s.	**DIRECT**	100.00	0.00	1.03
ERGO pojišťovna, a.s. (SV pojišťovna, a.s. since 2022)	**ERGO**	68.03	31.97	0.33
ERV Evropská pojišťovna, a.s.	**ERV**	100.00	0.00	0.37
Generali Česká pojišťovna, a.s.	**GCP**	72.92	27.08	21.54
HALALI, všeobecná pojišťovna, a.s.	**HALALI**	100.00	0.00	0.02
Hasičská vzájemná pojišťovna, a.s.	**HVP**	99.62	0.38	0.41
HDI Versicherung AG, OS	**HDI**	100.00	0.00	0.26
Kooperativa, pojišťovna, a.s.	KOOP	70.24	29.76	24.25
MAXIMA pojišťovna, a.s.	**MAXIMA**	85.96	14.04	0.38
Pojišťovna Patricie, a.s.	PATRICIE	68.51	31.49	5.99
Pojišťovna VZP, a.s.	**PVZP**	100.00	0.00	0.46
Slavia pojišťovna, a.s.	**SLAVIA**	100.00	0.00	0.58
UNIQA pojišťovna, a.s.	UNIQA	80.91	19.09	5.04
Predominance of life insurance				
AEGON Pojišťovna, a.s.	AEGON	0.00	100.00	0.89
AXA životní pojišťovna, a.s.	**AXA ZP**	18.46	81.54	1.09
Komerční pojišťovna, a.s.	**KP**	7.12	92.88	4.41
MetLife Europe d.a.c., pobočka pro ČR	**METLIFE**	6.37	93.63	1.86
NN Životní pojišťovna N.V., pobočka pro ČR	NN	0.00	100.00	2.91
Pojišťovna České spořitelny, a.s.	PCS	8.20	91.80	5.13
Simplea pojišťovna, a.s.	SIMPLEA	0.00	100.00	0.13
YOUPLUS Životní pojišťovna, pobočka pro ČR	YOUPLUS	10.77	89.23	0.06

Source: own calculations based on data from CAIC.

and they were divided into two groups – insurance companies predominantly engaged in non-life insurance and insurance companies predominantly engaged in life insurance. In the subsequent step, the development of selected indicators was evaluated within the specified period. Changes between the years 2019 and 2021 were examined in the trends of indicators, as these years mark the onset of the COVID-19 pandemic. Finally, the authors addressed the research questions.

To assess financial health, several indicators were selected, as outlined by Vávrová (2014, pp. 159–167), including growth rate of written premiums (GWP), cost (expense ratio), return on assets (ROA) and solvency (solvency ratio). GWP is calculated as the change in gross written premiums between two consecutive years. Expense ratio (ER) is the ratio of operating costs and gross premiums written. Return on assets (ROA) is the ratio of net profit/loss and assets. Solvency ratio (SR) is the ratio of equity and net premiums earned. All the ratio indicators are expressed in percentages. Data from the statistics of the Czech Association of Insurance Companies (CAIC, 2023) as well as insurers' annual reports were used for indicator calculations.

Table 1 presents insurance companies (including their abbreviations) along with their life and non-life insurance ratio and market share in the insurance market of the Czech Republic (CR). Insurance companies highlighted in bold were included in the assessment, and the rationale for their selection is provided in the text below the table. Market share and the life/non-life insurance ratio represent the average value for the analysed period, i.e. 2016–2021. In the event that an insurance company did not operate in the insurance market throughout the entire selected period, the calculation of the average value was based on its actual operating period. For instance, the insurance company Patricie ceased operations in 2020, so the average values were calculated only for the period 2016–2019. The insurance company Patricie was an auxiliary transfer structure for the changes that occurred in 2019 (see explanation Table 1).

Various organisational changes (such as mergers and acquisitions of insurance portfolios) occurred within the period 2016–2019 and might have influenced the indicator trends. For this reason, these changes have now been briefly described (CAIC, annual reports, websites – as of 2023):

- Česká pojišťovna a.s. (CP), as of December 21, 2019, acquired, almost entirely, the insurance portfolio of Generali Pojišťovna a.s. (GP) and Česká pojišťovna ZDRAVÍ a.s. (CP ZDRAVI). Simultaneously, Česká pojišťovna a.s. was renamed to Generali Česká pojišťovna a.s. (GCP), and Generali pojišťovna, a.s. was renamed to Pojišťovna Patricie, a.s. (PATRICIE). In July 2021, a fusion occurred by combining GCP, CP ZDRAVÍ, and PATRICIE.
- In 2019, a merger combined the insurance companies PCS and KOOP.
- The new insurance company SIMPLEA started operating in the Czech insurance market in 2019.

- On August 31, 2021, a merger combined the insurance companies AXA ZP, AXA, and the Slovak insurance company UNIQA with the Czech insurance company UNIQA. Czech AXA ZP and AXA, and Slovak UNIQA ceased to exist, and the Czech UNIQA became the sole successor company.
- On November 4, 2021, the German company S.V. Holding AG became the new and sole owner of the insurance company ERGO. As of October 28, 2022, the insurance company ERGO changed its name and became SV pojišťovna, a.s. (SV).
- On October 1, 2019, a merger took place and the insurance companies AEGON and NN were combined. The insurance company AEGON ceased to exist in the Czech Republic and the insurance company NN became the sole successor company.
- The insurance company YOUPLUS (formerly BASLER) has been operating under this name in the Czech insurance market since 2016.

Because the insurance companies CP ZDRAVÍ, PATRICIE, AEGON, and PCS did not operate during the years 2019–2020, they were not included in the assessment. Due to the mergers that took place between 2019 and 2021, the following insurance companies were also not included in the assessment: GCP, KOOP, UNIQA and NN. The evaluation would be impacted by these changes. Furthermore, the insurance company YOUPLUS was not included in the assessment due to incomplete and unavailable data (branch in another country). The insurance company SIMPLEA was also not evaluated because it was established only in 2019, and results for newly established insurance companies always tend to be on a different level compared to insurance companies with a longer history of operations (e.g. a faster pace of prescribed premium growth).

3. Results and discussion

Changes in selected indicators within the chosen time frame of 2016–2021 are evaluated in this chapter. The assessment specifically focuses on the interval of years 2019–2021, as the influence of the COVID-19 pandemic can be anticipated during this time period. The indicator trends are presented in Tables 2–4 for each selected insurance company. Values are highlighted in bold in the tables when indicators worsened.

The first assessed indicator is the Gross Written Premium (GWP) growth rate, the development of which is presented in Table 2. This indicator should exhibit growth as time progresses. While this indicator is frequently used, it should be emphasised that on an emerging insurance market, it has to be treated as mar-

ginal (Vávrová, 2014, p. 167). With the exception of the insurance companies HDI and AXA ZP, most insurers recorded a decrease in the GWP growth rate during the monitored period. Some insurers experienced a decline in the GWP growth rate (negative values). Most insurance companies saw a slowdown in growth rates between 2019 and 2020. For some insurers, the slowdown occurred in the following period, between 2020 and 2021 (e.g. ALLIANZ, AXA, BNP, COLONNADE, ČPP, DAS, ERGO, ERV, MAXIMA, PVZP and KP). Insurance companies DIRECT, HVP, SLAVIA and METLIFE showed a decline in GWP values throughout the entire period of 2019–2021. The insurance companies ČSOB and HALALI recorded a decline in GWP values only during the 2020–2021 period. The values shown in Table 2 vary. The most significant decrease in written premiums is evident in the case of ERV, with a decrease of nearly 55 percentage points. This is undoubtedly the result of ERV's specialisation in travel insurance, which inevitably experienced a decline due to the COVID-19 pandemic. Similarly, the insurance company ERGO (decrease of

Table 2. Valuation of GWP growth rate (in %)

Insurance company	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
Predominance of non-life insurance					
ALLIANZ	–0.87	3.76	**16.40**	**3.33**	8.22
AXA	14.74	26.88	**37.35**	**22.57**	MERGER
BNP	2.00	10.83	**8.15**	**3.40**	6.99
COLLONADE	856.18	83.78	**6.17**	**3.59**	9.38
CPP	6.26	8.68	**11.55**	**7.01**	9.71
CSOB	1.43	4.57	0.42	**2.64**	**–0.43**
DAS	6.18	5.69	**6.13**	**5.20**	6.88
DIRECT	64.98	30.68	**27.26**	**26.19**	**13.91**
ERGO	45.51	30.46	**16.27**	**–10.95**	2.34
ERV	27.41	19.80	**5.84**	**–48.86**	88.47
HALALI	2.67	11.55	11.08	**35.25**	**13.64**
HDI	–5.40	–3.51	4.40	10.48	15.41
HVP	5.29	4.27	**18.93**	**9.77**	**–2.78**
MAXIMA	49.51	41.75	**18.07**	**–0.16**	3.84
PVZP	6.25	29.29	**25.92**	**4.03**	40.89
SLAVIA	9.64	6.92	**21.45**	**5.60**	**0.22**
Predominance of life insurance					
AXA ZP	–7.64	–9.35	–8.83	–4.74	MERGER
KP	–7.66	–16.31	**61.46**	**–9.75**	–2.10
METLIFE	8.00	4.32	**6.77**	**6.15**	**3.49**

Source: own calculations based on data from CAIC.

Table 3. Valuation of ROA (upper value) and SR (lower value) (in %)

Insurance company	2016	2017	2018	2019	2020	2021
Predominance of non-life insurance						
ALLIANZ	2.31	2.40	5.28	**4.18**	**3.24**	4.06
	38.50	45.12	50.78	52.63	**54.80**	**48.28**
AXA	3.20	0.51	4.60	4.42	7.48	–
	44.29	42.06	41.43	39.51	42.62	–
BNP	3.78	4.62	5.62	**5.84**	**4.06**	**3.32**
	73.35	72.24	68.49	66.69	**71.72**	**61.01**
COLLONADE	–68.58	–6.27	10.42	**9.28**	**6.43**	**3.31**
	–346.57	–13.59	15.52	**12.49**	**9.76**	**5.84**
CPP	2.81	3.05	2.83	**3.57**	**3.08**	3.70
	45.34	44.48	40.86	36.55	**42.72**	**32.92**
CSOB	2.09	1.97	1.98	2.43	2.83	3.48
	40.71	36.72	32.98	37.35	50.29	60.22
DAS	4.48	3.26	9.84	11.42	**13.65**	**13.49**
	87.87	89.58	40.65	44.13	**50.13**	**47.64**
DIRECT	0.71	–14.39	–3.43	0.57	**5.12**	**4.84**
	57.01	23.26	37.64	30.77	34.63	34.71
ERGO	0.66	0.38	0.66	–0.99	**–0.13**	**–0.34**
	156.45	158.36	154.77	**132.13**	**113.36**	**87.84**
ERV	20.88	7.07	9.94	**8.95**	**–0.60**	16.22
	73.66	55.07	40.28	39.43	**89.39**	**54.49**
HALALI	0.03	0.71	0.37	**1.14**	**0.76**	**–0.67**
	642.68	947.18	889.16	**886.33**	**660.34**	**617.84**
HDI	2.61	2.43	6.34	0.78	**5.82**	**1.31**
	–25.50	–6.67	34.90	43.68	**75.95**	**31.72**
HVP	2.05	0.35	1.43	–1.52	**2.14**	**1.22**
	93.94	94.40	92.90	**80.28**	**75.68**	78.20
MAXIMA	–1.43	0.49	2.19	3.66	**3.74**	**1.77**
	185.78	169.96	159.24	**107.21**	**80.53**	**75.33**
PVZP	2.54	2.50	1.36	1.32	**1.70**	**0.44**
	111.07	101.79	88.08	74.81	**80.50**	**74.40**
SLAVIA	1.72	4.37	0.44	0.26	**0.95**	**0.18**
	36.65	50.56	49.55	**41.42**	**38.44**	**37.90**
Predominance of life insurance						
AXA ZP	2.22	1.69	3.29	2.60	0.69	–
	117.32	144.21	133.88	154.96	192.47	–
KP	1.01	0.90	1.15	**1.17**	**0.73**	1.26
	42.79	29.57	39.31	27.63	**44.85**	**18.26**
METLIFE	1.79	–0.29	2.31	**1.51**	**2.02**	**1.58**
	93.62	85.17	39.69	35.68	**44.86**	**27.72**

Source: own calculations based on data from CAIC.

27 percentage points) and PVZP (decrease of 22 percentage points) experienced a decrease, as they also specialise in travel insurance and health insurance for foreigners. These insurance companies experienced a decline in GWP between the years 2019 and 2020 and growth between the years 2021 and 2022. This trend is discussed by such authors as Stojkoski et al. (2021), Kočović et al. (2023), as well as Kašćelan et al. (2023).

Table 3 presents the development of the Return on Assets (ROA) and Solvency ratio indicators. The ROA indicator is one of the most closely monitored indicators when assessing a company's performance. It reflects how the total assets have been utilised irrespective of the structure of financing sources and serves as a measure of overall efficiency. The Solvency Ratio (SR) indicator expresses the equity capital adequacy of an insurance company. A higher value indicates a greater availability of safety capital, which enables the insurance company to effectively withstand negative impacts stemming from its business activities (Vávrová, 2014, pp. 164–165).

Table 4. Valuation of ER (in %)

Insurance company	2016	2017	2018	2019	2020	2021
Predominance of non-life insurance						
ALLIANZ	26.13	24.98	24.90	**24.97**	**26.36**	25.58
AXA	30.16	30.07	27.92	**28.26**	**29.28**	–
BNP	69.22	72.74	69.65	**66.80**	**67.06**	63.90
COLLONADE	53.14	37.57	33.44	**36.40**	**41.91**	**41.96**
CPP	33.13	32.23	32.09	**32.36**	**33.08**	**34.31**
CSOB	20.72	23.39	24.85	**25.87**	**27.01**	**29.34**
DAS	57.68	56.00	51.42	50.21	49.35	46.48
DIRECT	38.70	35.51	32.38	31.35	**31.21**	**32.40**
ERGO	41.56	27.50	24.85	**23.86**	**36.00**	**53.98**
ERV	46.19	45.36	47.21	**46.94**	**50.55**	48.57
HALALI	39.94	46.06	63.58	56.93	**50.48**	**50.85**
HDI	17.17	17.96	18.76	**19.22**	**20.50**	19.39
HVP	36.99	36.24	36.04	31.69	**30.49**	**32.07**
MAXIMA	49.59	53.55	53.13	**55.66**	**61.05**	**61.32**
PVZP	51.39	54.38	49.30	**43.95**	**48.89**	34.94
SLAVIA	39.06	40.22	38.05	**38.53**	**39.10**	**42.23**
Predominance of life insurance						
AXA ZP	39.51	44.11	40.37	**42.62**	**48.79**	–
KP	9.30	10.72	13.45	**9.00**	**10.74**	**12.15**
METLIFE	32.18	31.54	29.23	**35.85**	**36.87**	**40.91**

Source: own calculations based on data from CAIC.

The ROA and Solvency ratio (SR) indicators are also observed in the aforementioned studies (Kašćelan et al., 2023; Preda et al., 2021; Puławska, 2021). A significant conclusion can be found in the work of Kašćelan et al. (2023), who emphasise the delicate balance between profitability and solvency among EU commercial insurance companies. Table 3 presents both indicators and confirms the above-mentioned relationship in the indicator trends. In the case of all insurance companies except for AXA, AXA ZP, DIRECT and CSOB, a decline in both ROA and SR is evident during the period of 2019–2021. Only in the case of the insurance company DIRECT, it was only the ROA indicator that exhibited a decrease. These results corroborate the findings of Kašćelan et al. (2023).

Last but not least, Table 4 presents the development of the Expense Ratio (ER), which is used to evaluate the level of operational costs in insurance companies. The increase in expenses during the COVID-19 pandemic, particularly related to the need for remote work, has been noted by Preda et al. (2021). With the exception of DAS, all monitored insurance companies experienced an increase in operational expenses. The most significant rise in expenses occurred at the insurance company ERGO (by 12 and subsequently by 18 percentage points).

Conclusions

The aim of the article is to determine the impact of the pandemic on the financial health of commercial insurance companies in the Czech Republic. The impact on financial health has been assessed using the selected indicators: GWP, ROA, SR, and ER, within the time frame of 2016–2021. It has been determined that the crisis caused by the COVID-19 pandemic influenced the financial performance of insurance companies in the Czech Republic. The findings corroborate the results of the previously conducted studies described in the introductory section of this article. The findings make it possible to answer the formulated research questions related to the stated aim.

In which areas of financial health did the COVID-19 pandemic have an impact?

It has been found that there was a deterioration in the financial health indicators in the case of almost all insurance companies. During the monitored period, there was a decrease in the pace of prescribed premium growth, capital profitability and solvency ratio. However, the operational cost efficiency of insurance companies increased.

What variations in the impact of the pandemic on financial health can be observed in individual commercial insurance companies?

With the exception of HDI and AXA ZP, all insurance companies experienced a decrease in the pace of GWP growth. For most insurance companies, there was

a decline between the years 2019 and 2020, followed by growth between the years 2020 and 2021. The insurance company ERV exhibited the most substantial decrease in written premiums, most likely because of its specialisation in travel insurance. ERGO and PVZP, which also specialise in travel and health insurance for foreigners, exhibited significant declines in GWP growth as well. These insurance companies exhibited a decline in GWP between the years 2019 and 2020 and growth between the years 2021 and 2022.

Except for AXA, AXA ZP, DIRECT and CSOB, all insurance companies experienced a decline in both ROA and SR indicators during the period of 2019–2021. In the case of the insurance company DIRECT, only the ROA indicator exhibited a decrease. The results confirm the relationship between profitability (ROA) and the Solvency Ratio (SR).

With the exception of DAS Insurance, operational costs associated with the insurers' activities increased across all insurance companies. The insurance company ERGO experienced the largest rise in costs. This increase is linked to the fact that insurance companies began to increase costs in order to facilitate remote work during the crisis caused by the COVID-19 pandemic.

As the results of this research demonstrate, the impacts of the COVID-19 crisis on the operations of insurance companies and the insurance market are both timely and relevant. Given that this issue is still in its early stages of exploration, there is significant room for further analysis. The COVID-19 crisis has introduced new challenges that have not yet been fully addressed and that affect various activities of insurance companies. These challenges could potentially jeopardise their operations and extend to the broader financial system, influencing the financial stability of insurance companies. Due to globalisation, these challenges could also rapidly spread to other countries. The conclusions drawn in this paper pave the way for additional research, not limited to the Czech Republic alone.

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Insurability of cryptocurrency wallets

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Abstract

This article concerns the possibilities of insuring cryptocurrency wallets using various assumptions and characteristics of perfectly insurable risk. The main goal of this article is to examine if and how cryptocurrency wallet risk fulfils the requirements of an ideally insurable risk. The research topic is important looking at the latest trends in financial markets and the growing number of cryptocurrency investors. The paper presents the authors' approach to a part of cryptocurrency risk in the insurance industry. The authors analysed the requirements of an insurable risk. They applied these requirements to a specific risk, i.e. the cryptocurrency wallet risk to further check if it is possible to insure such a risk. By introducing and defining cryptocurrency wallet risk, the authors found an element of cryptocurrencies which shows traits of a non-speculative risk and possibly fulfils insurability characteristics.

Keywords

- cryptocurrency
- insurability
- cryptocurrency wallet risk
- ideally insurable risk
- insurance industry

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Introduction

With the growing dissatisfaction of residents with the actions of governments and central banks, as well as growing fees for monetary institutions' services, there was a growing need of many to create a more borderless, decentralised and digital currency that would keep up with the extremely high development rate of the internet solutions. That is why, in 2009 a developer Satoshi Nakamoto introduced a fully virtual, secured by cryptography, cryptocurrency called Bitcoin. Many years have passed since it all started, and today, the cryptocurrency market capitalisation is estimated to be around 3.5 trillion US dollars, with Bitcoin accounting for more than half of this value (Forbes, 2024). Can such a figure still be ignored by the modern world? Neither the European Union nor a single country has developed any way to approach this novelty from a governmental, institutional and legal point of view.

The topic of this paper concerns the possibilities of insuring cryptocurrency wallets using standard assumptions and characteristics of perfectly insurable risk. The topic is significant looking at the latest trends in financial markets. The ultimate aim of undertaken research is to develop a way to insure a part of cryptocurrency risk which concerns cryptocurrency wallets. However, first, we need to check if that risk is insurable. Thus, the purpose of this paper is to examine how well the risk associated with cryptocurrency wallets meets the criteria for an ideally insurable risk. This study offers a pioneering analysis of the potential for insuring cryptocurrency wallet risk and contributes to the existing literature by evaluating whether this risk fulfils the necessary insurability requirements. The intention of this paper is to encourage further discussion on this topic.

The paper is structured as follows. First, it provides a brief overview of cryptocurrencies along with the relevant legal context in the literature review section. Next, it defines cryptocurrency risk and outlines the fundamental characteristics of cryptocurrency wallet risk. Finally, the authors discuss the requirements of an ideally insurable risk and apply these requirements to a specific risk, i.e. cryptocurrency wallet risk.

1. Literature review

Cryptocurrency is a set of binary data developed to be a medium of exchange, using cryptography. The currency is stored in a database, which secures transaction details, overlooks the creation of new coins and checks ownership rights

(Greenberg, 2011). It is also worth mentioning in this context two important terms that should be distinguished: an "object", which is an asset that can be exchanged, and a "process", which is a technique to transfer the asset to the new user (Lee & Martin, 2020). In the light of the above definition, cryptocurrency, as an "object", has characteristics similar to the national currency since it is exchangeable, it has a set value and online form. It is not new, as there are currencies like the euro or dollar that have the same properties. The extraordinary thing about cryptocurrencies is the "process", since the exchange is fully digital, independent from any third party and decentralised. The mechanism of currency creation and running is purely independent and decentralised, which means that it is not ruled by any government or third party like a central bank. The first decentralised cryptocurrency emerged with the creation of Bitcoin, initially developed by a person or group of people working under the cryptonym Satoshi Nakamoto to be used as a payment system (Skwarek, 2023). However, cryptocurrencies are also treated as an alternative currency, a store of value (Polasik et al., 2015), or a speculative investment (Hileman & Rauchs, 2017, p. 24). Exchanged through blockchain (see wider: Islam et al., 2021, 2022; Rosic, 2018), cryptocurrencies are highly volatile compared to world fiat currencies. As they are not backed by any commodity, basic supply and demand laws do not hold, and the value depends massively on the overall trust of users in this ledger technology (Ilter, 2022).

At the beginning of existence, there were some articles promoting cryptocurrencies. According to Greenberg (2011), Bitcoins have the potential to fully replace state-backed currencies with a digital alternative that is more difficult to counterfeit, transcends international borders, can be stored on personal hard drives rather than in banks, and is not vulnerable to inflation driven by the decisions of Federal Reserve officials to print more money. Taking the perspective of Bitcoin users, we have a fully digital coin that seems to be secure, independent from any country's fiscal or monetary policy and perhaps even resistant to economic fluctuations. This raises the question of why, then, Bitcoin has not become more popular than traditional national currencies. Theoretically, we could use cryptocurrencies to pay for groceries or housing, since it is accepted in payments for goods or services. However, the main obstacle is the fluctuation of value, which influences the purchasing power of cryptocurrency. Based on this we should identify factors which can impact Bitcoin price. The economic literature suggests the following factors: macroeconomic and financial sources, technical contributors as well as speculation (Balcilar et al., 2017; Bouoiyour & Selmi, 2015; Ciaian et al., 2016; Dyhrberg, 2016; Greenberg, 2011; Urquhart, 2018). The first factor is supported by Greenberg (2011) who suspects that Bitcoin price is related to the availability of limited resources and with the increase of mined Bitcoins their price will rise. This approach is followed by Bouoiyour and Selmi (2015) and Balcilar et al. (2017) by adding that the price is highly dependent on an interaction between demand

and supply on the market as well as mined volumes. A key underlying factor here is the predetermined maximum supply of 21 million Bitcoins, which imposes a structural constraint on market dynamics. Ciaian et al. (2016) suggest that the cryptocurrency market exhibits similarities in behaviour to the equity market, implying that Bitcoin prices may show correlations with equity indices and oil prices. Meanwhile, Dyhrberg (2016) argues that cryptocurrencies possess hybrid characteristics, combining traits of both equity and commodity (technical contributors factor). The final factor, speculation, is supported by Bouoiyour and Selmi (2015), as well as Urquhart (2018), who claim that the value of Bitcoin is also very volatile due to the noise of traders and speculators and the so-called market attention. However, we can also take a more psychological approach shown by Luther and White (2014), who suggest that it depends on the eagerness of speculators to hold Bitcoin as an asset, and the willingness of transactors to hold Bitcoin as a medium of exchange.

After the success of Bitcoin through tremendous price appreciation, many investors wanted to invest in the crypto ecosystem. Anyfantaki et al. (2021) proved that the optimal portfolio based on such indexes as the S&P 500 or the Russell 2000 could give in the period 2016–2020 very small returns compared to a portfolio augmented with cryptocurrencies, which gets up to even 200% returns, but because of its volatility, the higher risk connected with owning cryptocurrencies in investor's portfolio exists. Researchers have found that investing in Bitcoins can be treated as a diversification plan since it is not correlated with other investments and can act as a counterbalance for economic risk and market fluctuations in stocks and commodities (Akhtaruzzaman et al., 2019; Anyfantaki et al., 2021; Bakry et al., 2021; Baur et al., 2018; Bouri et al., 2017). However, Bakry et al. (2021) warned that the cryptocurrency risk is far more visible than in any known portfolio of shares, commodities or currencies. There is a massive outflow of investors from riskier portfolio elements like cryptocurrencies. This trend is mainly correlated with recession looms and soaring inflation as well as rising living costs; all in all, regular private investors have less to invest in anything and even more so in cryptocurrencies (BBC, 2022).

Having a basic knowledge of cryptocurrency structure, mechanisms and prospects we can now analyse their legal aspect. Cryptocurrencies in most countries have become a popular online exchange, alongside fiat money. They are slowly becoming a part of the market economy, changing the international legal system to cover this novelty. It seems quite necessary to define the nature of cryptocurrencies, and their legal status and functions to allow the development of regulations in that field. Cryptocurrencies are legal in almost all countries; in simple terms, it is not prohibited to pay using cryptocurrencies.

Since the digital money market has developed and the first cryptocurrency emerged in 2010, in 2018 the European Parliament placed a directive that pro-

vided the first clear definition of virtual currencies as "a digital representation of value that is neither issued by a central bank or a public authority, nor necessarily attached to a fiat currency, but is accepted by natural or legal persons as a means of payment and can be transferred, stored or traded electronically" (Directive, 2018). Additionally, this Directive introduced a definition of custodian wallet provider, who is "an entity that provides services to safeguard private cryptographic keys on behalf of its customers, to hold, store and transfer virtual currencies". We can see that it is a clear indication that the legal side of the industry is being developed; now we have not only virtual money but also service-connected with the maintenance of the currency. It is also worth adding that there is a visible trend of extending money laundering and terrorism financing laws with the increase in the popularity of cryptocurrencies. In addition, all providers of services in the virtual money industry are obliged to "identify any suspicious activity" and they should allow the authorities to be able to monitor the use of such currencies according to the Anti-Money Laundering (AML) and Countering the Financing of Terrorism (CFT) regulations. Additionally, the EU wants to ensure that all exchanges for virtual money are registered. (Directive, 2018, Article 47, paragraph 1). As there is a real danger of money laundering, the system seems unsafe. The European Union has not yet specified the aspect of taxation of virtual money, so the regulations are now created only at the country level, but it is a popular phenomenon to develop laws regarding cryptocurrency together with taxation issues for this kind of investment. The taxation of cryptocurrencies varies based on their classification in a given country. If recognized as a commodity, they are taxed under goods and services tax; if classified as electronic money, they are subject to capital gains tax.

2. Methodology

In this part, we examine the risks associated with cryptocurrencies and cryptocurrency wallets. Finally, features of an ideally insurable risk will be introduced. That gives us a basis to examine in the result and discussion section if cryptocurrency wallet risk meets all these criteria.

First and foremost, it is essential to define cryptocurrency risk (abbreviated as crypto risk). Crypto risk refers to the potential loss faced by an individual, characterised by breaches in confidentiality, integrity or control over data, private keys to a crypto wallet or cryptocurrency assets. An increase in crypto risk can erode user trust and diminish the value of their portfolio. The main traits connected with crypto risk include:

- criminal activity, which occurs when our IT system or crypto wallet is invaded,
- confidentiality loss, which can happen once our data is exposed to the general public,
- integrity loss, which refers to the disconnection of our PC or crypto wallet from the general system which provides security,
- control loss, which occurs when a user is unable to access, log into or change anything on their computer or wallet due to a hacker taking control over it,
- data loss, which involves the disappearance of stored data following an attack,
- value loss, which is connected with losing valuable data from our PC or having our cryptocurrencies sent to the hacker's wallet.

The crypto risk is related to personal users. Due to the characteristics of this risk shown above, two types of risk can be introduced: market risk and wallet risk. For this paper, we will use cryptocurrency market risk and cryptocurrency wallet risk to distinguish between those two sets of risks. Cryptocurrency market risk is connected with:

- a criminal activity, which includes actions such as money laundering, black market transactions, or financing terrorism through the misuse of cryptocurrencies,
- the erosion of users' trust, which refers to the decline in confidence in the security and profitability of the crypto market,
- value loss, which refers to significant value fluctuations and instability in the cryptocurrency market.

Cryptocurrency wallet risk involves:

- confidentiality loss, such as wallet hacking, which makes private keys visible to the hacker,
- integrity loss, including changes to the configuration or destruction of the cryptocurrency wallet,
- control loss, such as changes to the password or access key that prevent the rightful user from accessing the wallet,
- data loss, such as the physical loss of content of the crypto wallet or loss of the private key.

It is obvious that cryptocurrencies are extremely volatile, so any type of market protection and hedging is difficult. On the other hand, wallet risk invented and defined for this paper is a part of the crypto risk that has the potential to be secured or even insured by individual users. One can treat access to a crypto wallet similarly to having the key to their car, as both grant control and ownership – without it, access is restricted, and the asset becomes inaccessible. While we cannot insure ourselves against a vehicle's value change, we can still insure it against theft, accident or third party liability. In the same sense we can think of

our crypto wallet – we can have it stolen by a hacker who steals our access credentials or the wallet itself, when it is a hard wallet. Additionally, we can have an accident related to losing our transferred coins due to the wrong key provided, or other unforeseen errors.

Cryptocurrency wallet risk seems to be, partially, similar to cyber risk, against which insurance is already provided on the market. Biener et al. (2015), Eling and Wirfs (2016) and Strupczewski (2017) discuss the insurability of cyber risk. In brief, they found some problems with meeting all criteria of insurability, yet they confirmed the insurability of cyber risk.

Based on this, we are going to examine whether cryptocurrency wallet risk can also be insurable. While many may think there is nothing to insure in this industry, an insurability analysis can be a valuable starting point for developing insurance products since the blooming market of cryptocurrencies is not yet well-explored by the insurance industry.

Rejda at al. (2022, pp. 45–47), along with Berliner (1985, p. 325), who introduced nine features of insurability (which are quite similar), as well as Vaughan and Vaughan (2008, pp. 42–44), proposed several characteristics of an ideally insurable risk:

- there must be a large number of exposure units,
- the loss must be accidental and unintentional,
- the loss must be determinable and measurable,
- the loss should not be catastrophic,
- the chance of loss must be calculable,
- the premium must be economically feasible.

3. Results and discussion

This section discusses if and how the above insurability criteria are met in cryptocurrency wallet risk. First, we have a large number of exposure units, which means that we need to have a large number of items of a similar kind which are prone to the same perils. This requirement is important since it provides the fundament of the law of large numbers, which enables the insurer to collect loss data over time, increase the accuracy of loss prediction and, most importantly, spread the loss of one over the whole group of insured during underwriting (Rejda et al., 2022, pp. 45–46). In our case, there would be several people willing to insure their wallets, particularly as medium to large companies increasingly need to secure their systems with such services due to the increasing number of cyber incidents year

after year. Crypto wallet risk also has the potential to have many exposure units, since the number of cryptocurrency investors rises, and each needs a crypto wallet to manage their keys. Therefore, insurance of certain wallet kinds would surely find its buyers, and possible collaborations with crypto-exchanges could make it a possible add-in while creating the wallet, giving the insurer a large number of users and popularity.

Secondly, the loss must be accidental and unintentional, which means it is unforeseen and purely random for the law of large numbers to apply. Crypto wallet risks are purely accidental and beyond the user's control, as they involve external criminal actors attempting to breach corporate systems or steal wallet credentials. The challenge with cryptocurrencies lies in their decentralised nature and the underdeveloped legal framework. This can make it difficult to report crimes to the police and provide sufficient proof for insurers, complicating the process of filing claims.

The third requirement which states that the loss must be measurable and determinable indicates that the loss should have a clearly defined cause, time, place and amount to allow the insurer to assess whether the loss is coverable under the policy and determine the appropriate payout for the insured. For the crypto wallet risk, we can often define the cause of the loss, such as a lost USB stick containing a hard wallet or a hacked cloud in the case of an online wallet. We can also identify the time and place of the incident, for example, on Monday, 19th of March 2022, on Coinbase. However, determining the exact amount of the loss can be more challenging due to fluctuating cryptocurrency values and the difficulty of tracking all assets within a wallet. However, underwriters can cope with volatility risk by indicating that the compensation (loss coverage) cannot exceed, for example, 125% of the portfolio value at the time the insurance is accepted. This ensures that the coverage is based on the portfolio's value on the specific day it was insured, mitigating the impact of market fluctuations.

The fourth requirement is that the loss should not be catastrophic. This means that while the number of users of insurance should be high, the number of losses should be low, since the pooling of losses is the essence of insurance and provides profits to the insuring company. In the case of crypto wallet risk, we need to have some reinsurance in place, since there is a possibility of massive hacking of crypto-exchange-linked wallets or online wallets provided by a particular cloud.

The fifth requirement is that the chance of loss must be calculable, which means that it needs to be possible to calculate the average frequency and severity of future losses with the accuracy required by the insurer. The ultimate goal is to calculate the premium that will cover the costs and yield a profit for the insuring company. In crypto risk, the frequency can be understood as the number of wallets of a particular kind stolen compared to all wallets held, or the num-

ber of private keys exposed compared to the number of keys generated. It is, however, harder to estimate the severity of loss, since it is a true or false statement – either the wallet key was stolen, or it was not. To determine the wallet value, we would need to evaluate the cryptocurrencies linked to the wallet and owned by us. Thus, the severity of graduation is a challenge for an insurer. The problem here lies in the valuation of cryptocurrencies, given their high volatility. If the insurer bases the severity measurement on the current market value of the lost wallet's cryptocurrency, the insurer assumes the same volatility risk as the cryptocurrency owner. A lost wallet would mean that the insurer compensates based on the market price at the time of the loss, which could significantly differ from the cryptocurrency's intrinsic or real value, leading to potential discrepancies in compensation. That is a speculative risk which no underwriter should accept. Similarly, providing compensation in cryptocurrency does not resolve the issue, as the volatility in its prices still persists. The insurer would still face the same risk, with the value of the compensation fluctuating according to the market price of the cryptocurrency at the time of payout. However, underwriters can manage volatility risk by specifying that compensation (loss coverage) will not exceed, for example, 100% or 125% of the portfolio value at the time the insurance is accepted, in the event of price increases. Alternatively, in case of a price decrease, the wallet value could be indemnified based on the current market price at the time of the incident. Insurers can also set the maximum value of indemnification, similar to cyber risk policies, where coverage typically covers only a small maximum loss (Eling & Wirfs, 2016, p. 26). In this case, the policy would cover a portion of the real portfolio value, allowing the insured to recover some of their portfolio's value in the event of a lost wallet.

The sixth and last requirement is an economically feasible premium, which means that the premium must make the insurance an attractive offer compared to the possible loss. It is indicated that the chance of loss should be less than 40% for the insurer to propose an economically feasible premium (Mehr & Cammack, 1976). In the case of cyber risk, the premium varies depending on the size of the systems and the corporation's tailored insurance offer. However, since companies decide to buy insurance, we can assume that the premium is economically feasible; otherwise, they would think of another possibility to reduce the cyber risk. We can check the cryptocurrency wallet risk by calculating the ratio of the value of stolen crypto wallets to the global market capitalisation of cryptocurrency wallets. As of February 2022, criminal wallets store over $25 billion worth of cryptocurrencies compared to $1.98 trillion of the global cryptocurrency market capitalisation (Hollerith, 2022), thus the chance of loss is as low as 1.26%.

$$\text{Chance of loss} = \frac{\$25}{\$1980} = 0.0126 = 1.26\%$$

We can argue that, even if the chance of loss is close to 40%, it may still seem low enough for some individual users to believe it is unlikely to happen to their wallets. The market for purchasing insurance can be stimulated by offering an economically feasible premium, increasing awareness through the dissemination of information about criminal cases of wallet hacks, as well as raising user awareness based on the type of wallet they use. All in all, we can say that crypto wallet risk complies with all requirements at least partly. Some of the criteria appear to be fully met, while others are met to a limited extent, as illustrated in Table 1.

Table 1. Cryptocurrency wallet risk as an insurable risk

Requirements	Cryptocurrency wallet risk compliance
A large number of exposure units	yes
Accidental and unintentional loss	yes, proof needed
Determinable and measurable loss	partially yes
No catastrophic loss	yes, reinsurance against crypto exchange wallets
Calculable chance of loss	partially yes, a method to determine the severity needed
Economically feasible premium	yes

Source: own research.

As may be seen, the biggest challenge seems to be the valuation of the real value of a portfolio held in a wallet, given the high volatility of cryptocurrencies. Additionally, the value of this asset is influenced by various factors such as market price, investor interest and the amount of currency mined. It looks quite similar to the results of the insurability tests for cyber risk. Eling and Wirfs (2016, pp. 25–26) identified three most problematic aspects of insurability of cyber risks: the randomness of loss occurrence, information asymmetry and the threat of adverse selection, as well as difficulties in measuring losses. However, these authors followed Berliner's (1985) nine-features concept of the insurability of risks.

While many may believe this type of risk cannot be insured, there are ways to provide coverage, even though it is not a perfectly insurable risk. Providers can develop estimation models and incorporate such insurance into their offerings. Therefore, based on meeting the insurability requirements, we can expect the possibility of creating such an insurance product to be quite high. In 2022, such insurance was not available; however, later the first solutions began to emerge, marking the beginning of insurance products tailored to cover cryptocurrency wallet risks.

Thus, at the final stage of this research, we examined the current state of cryptocurrency insurance on the market. Coverage for virtual assets lost or stolen under specific circumstances has become available. However, cryptocurrency insurance providers typically offer these services primarily to institutions such as exchanges,

rather than individual users. Customers can count on compensation only if they are affected by a company's hardware, software or service failures. For instance, compensation may only be available if the exchange where a user stores their private keys is hacked and loses all funds, provided the exchange has insurance coverage for such an occurrence. However, if an individual uses a wallet that the exchange supports but did not create or maintain to store their private keys, they may be out of luck. In such cases, the exchange's insurance may not cover losses, leaving the individual without compensation. Furthermore, no policy protects consumers holding their private keys themselves (Lodge, 2024).

The insurance industry is making some progress. Companies such as Canopius and Evertas have studied the cryptocurrency industry and started offering more relevant insurance for businesses involved in this area. They provide tailored coverage options to meet the evolving needs of their clients, offering a range of policies for different types of wallets. The coverage can include mining hardware and plants against physical loss or damage to mining hardware, as well as theft, loss or damage to both digital and physical assets. This coverage applies to incidents caused by external threats, such as cyber-attacks and criminal activities, as well as risks from insiders (fidelity) (Canopius, n.d.; Evertas, n.d.).

However, insurance for retail cryptocurrency users and investors is still lacking. Some exchanges, like Gemini (n.d.), maintain commercial crime insurance to cover breaches or failures of their systems or applications. Some companies offer plans that cover lost or stolen crypto if the keys are held in a custodial wallet, such as an exchange's cold wallet. However, there are very few, if any, insurance providers offering coverage for crypto users who store their keys themselves or use third-party wallets (Lodge, 2024).

Conclusions

The paper considers the possibility of cryptocurrency wallet risk insurance. It examines if and how well cryptocurrency wallet risk fulfils the requirements of an ideally insurable risk. The aim of the work has been fulfilled and the main problem of the insurability of cryptocurrency wallet risk has been covered. The characteristics of cryptocurrencies presented in the first part led to the conclusion that cryptocurrencies are highly speculative and volatile, thus it is hard to evaluate their intrinsic value, as well as omit financial bubbles around this industry. In the second part, the authors have introduced and defined terms of cryptocurrency risk, cryptocurrency wallet risk and features of insurability. Finally, cryptocurrency wallet risk has been discussed as an insurable risk.

The authors confirm the possibility of insuring this type of risk. The research has eventually led to formulating the following conclusions: cryptocurrencies are too volatile for insurers to take on the risk of covering lost coins. However, other elements of cryptocurrency wallets show, at least partially, the traits of a perfectly insurable risk, which makes it possible to create broker professional insurance extension for crypto wallets. Such insurance can cover basic liability, business interruption and attack mitigation risks, serving as a safety net for financial businesses in the cryptocurrency sector.

Future research in that area could involve comparing crypto wallet risk with similar types of risk, such as cyber risk, for which insurance offers already exist. Based on this, we can consider whether the perils associated with both types of risk are similar or not. That could be a way to develop a proposition or design for a specific insurance cover tailored to crypto wallets.

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The economic activity of women in families from different cultures

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Abstract

The presented analysis uses data from time-use surveys which were conducted in India and Poland in the late 1990s and early 2000s. The calculations made use of statistical information describing individual households and their members. The applied method of multiple regressions for cross-sectional data made it possible to take into account selected socio-demographic and economic characteristics of the analysed members of the population. The results obtained served for assessing the impact of such characteristics as marital status as well as children presence on the production activity of women. We present the time allocation of individuals with similar characteristics, but at different stages of their life cycles. Performing analogous estimations for Poland and India made it possible to directly compare the situation of women in these countries. Despite considerable differences in terms of social and cultural norms between the analysed societies, the situation of women living in them is in some respects similar. However, marked differences were also observed such as those related to economic activity depending on the level of education. Also, the influence of marriage on the allocation of time is different, as illustrated by comparing the situation of married women to those without a partner.

Keywords

- Polish and Indian families
- time allocation
- economic activity of women
- developing countries

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Introduction

People's use of time is an interesting source of data for both economists and sociologists. Representatives of these sciences usually have different goals when analysing time allocation and they use different methodologies; however, the demarcation lines are sometimes blurred, as exemplified by this article. The time use survey is a very powerful ally in the movement to value unpaid care work, which is the work done primarily by women around the world (Benhabib et al., 1991; Bridgman, 2013, p. 3). The significance of time use data for developing social policies increases many fold with the realisation that the wellbeing of people depends not just on money or market consumption, but also on how they spend their time.

The first scientific introduction to social analysis using statistics on the allocation of time is deemed to be the study by Sorokin and Berger, published in 1939, entitled "Time budgets of human behaviour" (Gershuny, 2011, pp. 5–6). Economic time budget analyses began with research into households' money budgets and living conditions (Niemi, 1995, p. 2). Mincer (1962, p. 65, 1963, pp. 71–72) focused on activity of women in his works, and the author presented the process of decision making in which the allocation of time between housework and market work is decided. In his analysis, he referred to non-market activity of a productive nature.

The present study uses data from time use surveys which were conducted in India during 1998–1999. These results are currently the only available source of such statistical data in the country. The main aim of the paper is to analyse the situation of women using data about their activities and the amount of work which takes place outside the market, i.e. for which they are not remunerated. The significance of this study lies in the fact that the Ministry of Statistics and Programme Implementation (n.d.) of the GOI conducted the first fully-fledged time use survey in India in 2019, which is first of its kind for a developing economy. It will be possible to compare the data with the newest wave of TUS in Poland, which took place in 2023, and the database will be prepared and accessible soon.

A complementary aim was a comparison of the situation of women in two different countries from various parts of the world. For this purpose analogous estimations for Poland and India were carried out. For a comparative analysis, such databases were selected which were created only a relatively few years apart. That is why the present study uses data from time use surveys which were conducted in Poland and India in the years 2003–2004 and 1998–1999, respectively. In the first half of the 2000's, Poland was still considered to be a developing country. India is also striving for the status of a developed country, and insights from this paper, especially with regard to women, could be helpful in understanding household as well as individual level determinants that facilitate the entry of women into the sphere of economic activities. Furthermore, this study could serve as a baseline

analysis for subsequent comparative studies between India and other countries, which could be possible once the Polish Central Statistical Office (CSO) completes the preparation of data from the latest time use survey, conducted in 2023. Thus, at this juncture, the paper can only shed some light on the situation of women in India at the time of the first pilot survey. However, it also seeks to bridge a gap, as there have been no other attempts to compare India's time use survey data with that of another country.[4]

Gender roles in a country which is governed by the socio-cultural milieu of the region have a huge impact on women's allocation of time between household work and market work. In various ways India and Poland are countries located in two entirely different worlds, but when it comes to women's gender roles both countries have various similarities. In both India and Poland (Narkowicz & Kumar, 2021), there are strong patriarchal social values which influence every aspect of women's life, whereby the man is responsible for providing a source of monetary income, and the woman is responsible for taking care of the family and running the house.

A strong role is played here not only by tradition and culture but also by religious teaching (Catholics are the largest religious community in Poland; while in India there are two big religions, Hindusin and Islam). The choice of Poland for comparison is dictated by the fact that such traditional values and attitudes are most apparent in this country among the countries of Central and Eastern Europe (new EU members). India, on the other hand, is a significant country (not only demographically) because of its highly patriarchal orientation representing a completely different cultural and social conditioning. A comparison of the two countries thus provides the opportunity to describe and assess to what extent the position of women in a traditional society based on the so-called Catholic values is similar to the role they play in a multicultural and multi-religious society. Due to limited space in the article, we focus on economic aspects, and more specifically on production activity.

Although Poland is a much smaller country than India (both in terms of the population and area), it is one of the largest EU countries. In addition, Poland is characterised by the special position of its agricultural sector in comparison with other EU members. It has the greatest fragmentation of agriculture and the largest percentage of the population which depend on agriculture (GUS, 2013, p. 169). Therefore, it is a good candidate for comparison with India, which is demographically still an agro-based economy with two-thirds of the population directly depending on agriculture for their livelihood.

[4] One of the most important reasons is, among others, that it is difficult to compare India with any other country, e.g. in terms of population. Only China may be considered similar.

In order to create the best conditions for comparison, and at the same time to capture certain phenomena more accurately, only nuclear families and single persons were taken into account. In this way, the focus was on the impact of selected characteristics of individuals and households on their productive activity in the market and beyond. This was achieved, inter alia, by eliminating from the analysed samples such families where the activity of a woman (for example, the amount of her household work) could be influenced by the presence of additional adults other than the partner, like older parents or grandparents. Distinguishing in the databases those families in which there were children, their impact on the allocation of a woman's time was also taken into account.

The study focused on showing the differences and similarities in terms of the position and activity of women in societies with significant differences in the tradition, culture and influence of religion on the lives of their members. The analysis was based on the assumption that improvements in women's position are mainly achieved through activation in the labour market, financial independence and socialisation (contact with other members of society). In pursuing the goal described, a working hypothesis was adopted that in countries where women are more active in the labour market, inequalities in the total work done by women and men are lower. Putting it differently, professional activation contributes to levelling inequalities in the scope of production activity (regardless of whether it is paid or not). The phenomenon of large scale home production in developing countries has long been recognised in the literature on the subject (Goldin, 2006; Jankiewicz, 2018, p. 147).

Despite considerable differences in terms of social and cultural norms between the analysed societies, the situation of women living in them is in some respects similar. However, marked differences were also observed, such as those relating to economic activity depending on the level of education. Additionally, the influence of marriage on the allocation of time is different, as illustrated by comparing the situation of married women to those without a partner. The general characteristics of the samples considered in the analysis indicate significant differences between the societies of Poland and India. Although these differences hamper direct comparisons between the results of the calculations, they lead to formulating interesting conclusions at the same time.

The calculations made use of statistical information describing individual households and their members. The applied method of multiple regressions for cross-sectional data made it possible to take into account selected socio-demographic and economic characteristics of the analysed members of the population. The results obtained served as a basis for assessing the impact of such characteristics as marital status, children and family size on the production activity of women. The characteristics of the analysed women's partners as well as their material status were also considered significant.

1. TUS data

1.1. India

In 1998, the government of India conducted the first pilot time use survey in six states. In order to make the sample representative, the survey tried to cover the length and breadth of the country by selecting six states from six different regions; namely, Haryana in the north, Madhya Pradesh in the centre, Gujarat in the West, Orissa in the East, Tamil Nadu in the South and Meghalaya in the north-east of the country. The total number of households surveyed was 18,591 and the survey was coordinated by the Social Statistics Division of the Central Statistical Organisation. The geography of India is extremely diverse; thus, with a view to capturing seasonal variations in the actives, the field work was spread over one year, from July 1998 to June 1999.

The study had two main objectives: 1) to quantify the economic contribution of women in the national economy and 2) to study gender discrimination in household work. A three-stage stratified sampling design was adopted to collect data; where the first stage was the district, the second stage was the village/urban block, and the third stage was the household. Due to various methodological lacunae, such as low literacy levels, restrictions on women, etc., the interview method rather than a diary or observation method was deemed best to collect data. Data was collected for three types of days; viz. normal, weekly and abnormal days; and the recall period was one day.

An analysis of the data showed that the level of labour force participation was 47.5%, with 51.7% found to be outside the labour force, and the proportion of unemployed being less than 1%. The other significant finding highlighted by the survey was the difference in the way male and female populations of the country spent their time on SNA (System of National Accounts) and Non-SNA activities. Each week males spent around 42 hours on SNA activities while females spent only 19 hours on SNA activities. However, females spent more time on extended SNA activities (34.6 hours), as compared to their male counterparts (3.6 hours). Unpaid labour was another dimension underscored by the survey. The data revealed that in India there were various economic activities for which no payment was made and in most cases these activities were performed by the females of the household. The proportion of unpaid activities by females was 51%, while for males the percentage was 33%.

In 2013, the Ministry of Statistics and Programme Implementation (MOSPI) of the Government of India announced a plan for conducting a country-wide time use survey.

1.2. Poland

In Poland, the first time budget study was carried out in the 1950s. Adamczuk (1990, pp. 22–26), among the first significant studies in terms of methodology, included research carried out in 1962–1963 on a sample of railway drivers. The first nationwide survey was conducted in 1968–1969, with subsequent ones in 1975–1976 and 1984 (Wnuk-Lipiński, 1971).

Since the beginning of systemic economic transformation in Poland, only two full editions of time budget research have been carried out on a representative sample of households. The first one was organised by the Polish Central Statistical Office (CSO) in the period from 1 June 2003 to 31 May 2004, at the very moment of the country's entry into the European Union structures (the information from that database is used in this analysis). The methodology recommended by Eurostat was used for this purpose, thanks to which the statistics obtained are highly comparable to similar information that is published in other European countries. The aforementioned survey comprised a sample of 10,256 households (GUS, 2005, p. 11).

The statistical and econometric estimations presented in the article were prepared from microeconomic data on the time structure of individual people who were selected to keep records in their diaries. Such persons were asked to record their activities for two days; one weekday (Monday to Friday) and one weekend day (Saturday or Sunday). The database also contained diaries filled in on holidays. The agents selected for the survey were aged 15 and above. When filling out the diaries, respondents recorded their activities (main and secondary) by describing them in fixed 10-minute intervals, which meant that they chronicled their daily activities in a diary with 144 rows. At the same time their task was to provide information about accompanying persons as well as places where the activities were carried out as well as any means of transport that were used.

In order to enable this form of information to be used in the planned calculations, it had to be transformed. To begin with, the detailed list of 198 activities used by the Polish CSO was divided into 36 categories. Finally, these categories were assigned to four main groups of activities: market work, home production, leisure and personal care.

2. Methodology

The interest of researchers in the time use of agents increased significantly after Becker (1965) published his theory regarding the household production function (HPF) and time allocation. Critical remarks about the original Becker proposal are

often supplemented with a plea for treating non-market time as homogeneous (Mattila-Wiro, 1999, p. 11). Due to the fact that in this version of the theory there is no division into the various categories of activity, it is difficult to use it for time use survey data analysis. Such types of statistics offer detailed information on the activities performed by the agents throughout the day. Juster and Stafford (1991, p. 505) emphasise that the need to distinguish between leisure and work done at home had already been noticed by Reid (1934); hence, her proposed criterion of a "third person". Such a division is also necessary from the point of view of analysis, which, taking into account data on time use, serves to give a better description of changes in the quality of life and the well-being of individuals.

Gronau (1977, 1986), perceiving this significant drawback in Becker's theory, introduced a significant modification into the model. He argued that the HPF theory may offer more accurate predictions about consumer decisions if activities in the non-market sphere were clearly divided into production and consumption (leisure). The proposed modification created the possibility of using household time use data and significantly facilitated the empirical verification of predictions obtained using the modified version of the HPF model.

In the concept of Gronau, only the effects of home production have close substitutes in the form of goods and market services. The time allocation for consumption (leisure) has few, if any, market equivalents (Gronau, 1986, p. 282). Thus, according to an additional formulated assumption, domestic production can be seen as a close substitute for market work.

The economic analysis of decisions made by agents, performed using TUS data, requires that daily activities should be allocated to three or four basic time categories (depending on the adopted methodology). The most basic units from which to start any analysis of activities and their division are the so-called episodes. They can be defined as activities in which the respondent is involved in particular circumstances at a specific place and time (Harvey, 2002, p. 27).

The assignment of particular activities to specific categories of time is a key task preceding any analysis of the decisions made by household members. This translates into the final results of calculations and conclusions drawn on their basis. That is why it is worth mentioning the methods and criteria for such categorisations that appear in literature.

For instance, Gronau (1977, p. 1114) presents the consumption time as the difference between the total number of hours per year (365 × 24 h = 8,760 h) and the sum of time declared by respondents for market and household work. Activities undertaken to satisfy physiological needs do not explicitly appear here as a separate category. This is not an isolated way of presentation, Graham and Green do the same (1984, p. 278). However, some authors see the validity of distinguishing a fourth category of activities. For example, Benhabib, Rogerson and Wright (1991, p. 1167), isolate consumption (leisure), market work and home production

from the time resource, which they describe as discretionary time. In their view, a person may more or less freely dispose of only that part of the day which is left after the depletion of time intended for sleep, personal hygiene and several other activities (personal care).

Additionally, Hawrylyshyn (1974, p. 29), who refers to the HPF theory, lists four categories of time: biological needs, market activity, production in the non-market sphere and activities that bring pleasure and relaxation. Aas (1978, pp. 133–134), in his recommendations regarding the methodology of collecting data on time use, suggests that in the most basic terms, activities should be divided into four main aggregates:

- essential time, when basic physiological needs are satisfied,
- contracted time, under which the person fulfils their obligations arising from employment contracts, or more generally from paid work,
- time of duty, which must be spent on keeping the household, bringing up children, providing food, cleaning, etc.,
- free time, the remaining part of the day that one has after allowing for the three categories listed above.

In this article, the activities recorded in the Time Use Survey (TUS) are categorised into four primary groups: market work time (*M*), home production time (*H*), leisure (*L*) and self-care (*P*). Tables A1 and A2 in the Appendix provide a detailed breakdown of the specific activities included in each category. The method of encoding the EDU characteristics for individual countries is described in Tables A3 and A4.

The estimations of the parameters that are presented in the further part of the article were obtained by performing regression estimations for cross-sectional data, where the general form of the model can be written:

$$T_{(M,H)} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_N X_N + \varepsilon_{(M,H)} \tag{1}$$

where:

$T_{(M,H)}$ – market work or household work time
X_n – variables describing the socio-economic characteristics of people, $n = 1, \ldots, N$
β_n – parameters of the equation, $n = 1, \ldots, N$
$\varepsilon_{(M,H)}$ – random component.

The analysis includes the characteristics that are most often indicated in the literature as the determinants of domestic and market work (Connelly & Kimmel, 2009; Giménez-Nadal et al., 2010; Gimenez-Nadal & Molina, 2013; Kalenkoski et al., 2017; Sevilla-Sanz, 2009). In addition, the authors tried to use those factors which were captured in both databases in the same way.

In the case of the Polish time use survey, completed activity diaries were obtained for 25,204 persons (only adults were taken into account). Using the same criterion for India, there were 28,086 persons chosen for further calculations.

3. Samples

When examining production activity, both market and non-market spheres were taken into account, which is particularly important in developing countries. The calculations presented are based on information about persons assigned to two separate populations – people living within a relationship and those living without a partner. Table 1 presents descriptive statistics for the samples consisting of respondents who were in a relationship, who completed the diary and were between 18 and 59 years of age. This range was adopted to focus on people of working age. In addition, families from this population were divided into childless and those that had children.

Table 2 describes a subpopulation of those living with spouses, where an additional condition was applied, according to which both adults were working in the market. Table 3 contains descriptive statistics for isolated population, where a single adult (usually a woman) takes care of children or lives alone.

In all the cases presented, the basic unit is a person. Standard deviations are given in brackets. They inform about the average deviation from the expected value expressed as the average level of a given characteristic or variable. For example, the household time of women equals 180.68 (Poland, families without children), meaning that the observed values may differ on average from the expected value by 111.04 minutes. Most of the values contained in the table should be understood as informing about a significant dispersion of the analysed observations.

Not all the values contained in the tables have been calculated for all the selected samples. For example, the average expenditure/income *per capita* was calculated only for people who chose to provide such information when they were surveyed.

On average, regardless of whether there are children in the household or not, women always work longer in the non-market sphere than men. The opposite situation emerges if market activity time is considered, as in this respect men work longer in both countries. What differs significantly between the compared populations is the scale of the disproportions. Considering the amount of time spent on work, and treating the daily sum of minutes allocated to market and home production (referred to later on in the article as “all work”) as 100%, it can be seen that in India the situation of women is much worse when compared to Poland. In

Table 1. Descriptive statistics of all families with two parents, separately with and without children (average and standard deviations in brackets)

Characteristics	Poland		India	
	no children	with children	no children	with children
Household time – women	180.68 (111.04)	262.53 (142.42)	331.92 (139.88)	425.23 (168.58)
Household time – men	98.09 (90.73)	126.66 (109.73)	24.65 (55.87)	33.27 (65.04)
Market time – women	516.33 (159.04)	482.36 (167.91)	219.33 (199.33)	185.72 (189.34)
Market time – men	592.78 (165.00)	586.79 (170.41)	500.98 (165.71)	526.31 (152.88)
No of children 0–2 y.o.	–	0.19 (0.40)	–	0.37 (0.55)
No of children 3–6 y.o.	–	0.38 (0.57)	–	0.78 (0.79)
No of children 7–12 y.o.	–	0.70 (0.77)	–	0.68 (0.83)
No of children 13–18 y.o.	–	0.64 (0.08)	–	0.48 (0.72)
Family size	2	3.86 (0.94)	2	4.72 (1.38)
Expenditure/Income *per capita*	1101.64 (1336.19)	987.99 (785.56)	687.52 (474.96)	519.80 (319.00)
% EDU1 – women	14.59	8.16	81.18	76.02
% EDU1 – men	15.03	13.26	69.15	58.72
% EDU2 – women	59.79	68.33	13.59	17.86
% EDU2 – men	61.27	72.52	21.92	28.05
% EDU3 – women	25.62	23.51	5.22	6.11
% EDU3 – men	23.70	14.21	8.93	13.23
Age – women	43.67 (11.90)	36.05 (6.73)	38.48 (12.59)	32.95 (7.99)
Age – men	44.30 (11.66)	36.93 (6.94)	40.77 (11.73)	37.47 (8.14)
N	627	1884	2310	16115
N – women	281	723	1302	8554
N – men	346	1161	1008	7561

Note: EDU – education level: "primary" (EDU1), "secondary" (EDU2) and "high" (EDU3). Detailed description of education levels in Poland and India are included in Tables A3 and A4 respectively in Appendix; N – size of the samples.

Source: own calculations using TUS data from Poland and India.

the former country, almost all household chores are performed by women. The percentage of their daily allocation of time for home production is as much as 93% (regardless of whether there is a child in the family or not). In Poland, the proportion is between 65% to 35% to the disadvantage of women (when there are no children) and 67% to 33% (when there are children).

When comparing the time spent on "all work", it can be seen that women in both countries carry out more of it than men. When there is a child in the family, the disproportion is even greater. In the case of Poland, this is a change from 6 to over 31 minutes a day; in India, the difference in total working time varies from almost 26 to over 51 minutes per day.

It is also worth noting that from the point of view of total working time, Polish respondents work longer than their counterparts in India. In the case of childless women, it is almost 146 minutes a day, while for mothers the difference is almost 134 minutes. The comparison of men's working time shows even greater discrepancies. Childless men in Poland work on average 165 minutes longer, and for fathers the difference is slightly smaller, amounting to 154 minutes per day. It should be emphasised that in order to be able to draw conclusions about these differences on the effects of production, it would be necessary to have additional information about efficiency (productivity of market and homework) which, taking into account the data used, cannot be measured here.

In addition, the societies compared differ in the number and age of children. In India, the size of families is greater (an average of 4.72 people vs 3.86 people in Poland). It can also be noted that in India there are clearly more young children, aged 0–6 years, than in Poland. Additionally, there are notable differences in structures as far as education levels are concerned. However, it is important to acknowledge that the method of categorising education levels involves a degree of subjectivity and is based on rough approximations. Consequently, any conclusions drawn regarding education should be approached with caution. Nonetheless, based on this analysis, it can be observed that in Poland, individuals with education at the EDU2 level form the majority, accompanied by a relatively high proportion of people with the highest level of education. In contrast, in India, the majority of the population sampled falls under the EDU1 level, with this category being predominantly represented by women.

The average values of expenditure/income *per capita* were calculated in national currencies; therefore, they should not be compared between the two countries. However, it can be noted that in families without children, in an expected way, higher amounts are spent on consumption as compared to the average expenditures of families with children. Of course, this does not prejudge the actual distribution of monetary income (and resources in general) within families. None of the databases contains information on the distribution of resources among members of a household.

Table 2. Descriptive statistics of adult spouses, both working in the market, separately with and without children (average and standard deviations in brackets)

Characteristics	Poland		India	
	no children	with children	no children	with children
Household work – women	181.50 (116.85)	270.02 (144.36)	242.30 (109.89)	286.85 (141.38)
Household work – men	103.30 (92.29)	136.67 (113.127)	33.66 (65.43)	33.27 (58.49)
Market work – women	511.38 (155.88)	474.91 (169.28)	406.03 (153.56)	407.41 (164.08)
Market work – men	596.14 (171.48)	578.92 (166.36)	502.58 (151.64)	532.17 (135.04)
No of children 0–2 y.o.	–	0.15 (0.37)	–	0.32 (0.53)
No of children 3–6 y.o.	–	0.34 (0.54)	–	0.76 (0.78)
No of children 7–12 y.o.	–	0.71 (0.77)	–	0.70 (0.81)
No of children 13–18 y.o.	–	0.67 (0. 80)	–	0.49 (0.69)
Family size	2	3.84 (0.93)	2	4.63 (1.31)
Expenditure/Income *per capita*	1125.01 (1079.94)	1026.00 (778.29)	592.49 (389.76)	430.62 (311.82)
% EDU1 – women	12.92	7.89	89.51	86.83
% EDU1 – men	10.75	10.71	81.23	73.69
% EDU2 – women	56.46	68.11	7.21	7.53
% EDU2 – men	60.75	71.77	14.44	17.79
% EDU3 – women	30.62	23.99	3.28	5.63
% EDU3 – men	28.50	17.52	4.33	8.52
Age – women	41.83 (12.42)	35.83 (6.55)	37.11 (11.80)	33.38 (7.81)
Age – men	42.78 (11.90)	37.73 (6.71)	40.83 (11.44)	37.99 (7.85)
N	423	1139	582	2534
N – women	209	420	305	1314
N – men	214	719	277	1220

Note: see Table 1.

Source: own calculations using TUS data from Poland and India.

On average, in the sample describing India, women are clearly younger compared to the population analysed in Poland. This applies to both childless women and mothers. In the case of men, the differences in age are clearly smaller (Polish fathers are even slightly younger).

It turns out that selecting from the available statistical material only such spouses where both people work does not significantly change the discrepancy in the amount of time spent on household work between men and women. In Poland, it is around 2/3 to 1/3 when comparing women with men (Table 2). In India, working women still perform the vast majority of household chores, doing near 90% of the total household work when counted in minutes per day.

However, an interesting phenomenon can be seen when considering the total working time (all work). In Poland, when both partners work in the market, the difference between men and women in this respect clearly decreases. In childless couples, it can even be observed that a small advantage for men (6 minutes a day) appeared in this respect. In contrast, in India, the disparities significantly increase, compared to those observed in Table 1, to the disadvantage of women. It turns out that if women work for money in India, their total working time per day is longer than their partners by 112 minutes in families without children, and as much as 129 minutes in families with children. Thus, entering the labour market means that women in India will work on average even more than their husbands, as compared to the situation when they stay at home. This can significantly discourage them from entering the labour market.

Summarising this description, it can be noted that in the case of the sample of couples working in the market, the advantage of the total working time of Polish women in relation to Indian residents significantly melts (by about 100 minutes for childless women and 84 minutes for mothers).[5] However, the average time expenditure of men hardly changes, regardless of whether they have children or not.

Households where both parents work and have children do not differ significantly in their average size from the sample described in Table 1. Accordingly, the average number of children in Polish families is smaller than analogous family units in India.

A significant convergence in "all work" time between the two countries is observed only among individuals living without a partner, which is particularly notable for single parents. Following the established comparison framework, when the average household work time of single men and single women is combined, women contribute approximately 60% of this total, while men account for about

[5] The difference in Table 1 for childless women is 697 – 551 = 146, and in Table 2, in case of childless women, the difference decreases to 693 – 648 = 45 minutes on average.

Table 3. Descriptive statistics of singles, separately with and without children (average and standard deviations in brackets)

Characteristics	Poland		India	
	no children	with children	no children	with children
Household work – women	249.75 (154.98)	338.04 (182.38)	194.63 (102.38)	300.17 (149.54)
Household work – men	201.51 (158.20)	178.01 (166.97)	128.42 (102.76)	175.45 (144.78)
Market work – women	195.06 (259.95)	172.36 (244.54)	371.31 (187.87)	324.53 (190.45)
Market work – men	244.94 (280.92)	263.36 (302.22)	476.15 (176.54)	458.03 (155.37)
No of children 0–2 y.o.	–	0.06 (0.26)	–	0.159 (0.40)
No of children 3–6 y.o.	–	0.12 (0.34)	–	0.56 (0.70)
No of children 7–12 y.o.	–	0.46 (0.65)	–	0.85 (0.79)
No of children 13–18 y.o.	–	1.37 (0.81)	–	0.62 (0.75
Family size	1	3.63 (1.09)	1	3.19 (1.03)
Expenditure/Income *per capita*	819.39 (874.93)	686.99 (807.55)	882.78 (765.61)	491.70 (371.24)
% EDU1 – women	11.93	16.93	80.79	81.82
% EDU1 – men	20.21	19.82	49.89	77.53
% EDU2 – women	59.43	70.60	6.62	12.78
% EDU2 – men	60.99	69.60	24.83	12.36
% EDU3 – women	28.64	12.47	12.58	5.40
% EDU3 – men	18.79	10.57	25.28	10.11
Age – women	42.82 (13.33)	39.59 (7.99)	45.47 (10.48)	36.86 (7.16)
Age – men	44.09 (11.13)	43.53 (6.89)	37.029 (11.63)	39.43 (8.14)
N	701	676	749	441
N – women	419	449	302	352
N – men	282	227	447	89

Note: see Table 1.

Source: own calculations using TUS data from Poland and India.

40%. However, the proportions are almost reversed when considering the allocation of market work time, with men contributing about 60% and women about 40%.

What is more, singles in India spend more time engaged in market work on a daily basis compared to singles in Poland, regardless of whether or not there are children in the household. In addition, it is also worth noting that in terms of total working time, single Indian men from the selected sample work longer than women. This observation, in comparison with the results in Tables 1 and 2, suggests a significant role for the institution of marriage in terms of the impact on labour activity disproportions between men and women in this country. Differences in this regard between genders are clearly smaller in the group of people who have no partner than in the sample who are married. From the point of view of average working time, it may be concluded that men are the primary beneficiaries of marriage in India.

The next part of the article presents the results of the estimations of parameters for the regression models. The variables describing the socio-demographic characteristics of selected populations are used here to describe market work time and household work time.

4. Results of estimations

The following tables (A5 and A6 in the Appendix) contain the results of the estimation for the dependent variable in the form of the daily market work time measured in minutes (*M*). The subsequent tables (A7 and A8) present the results of calculations in which non-market work time (*H*) becomes the dependent variable. In the case of models estimated for TUS data from India, model parameters were obtained taking into account the control variables. Given India's complex social structure, which is characterised by many religions and a specific caste system, binary (0–1) variables were used in the estimation to indicate whether respondents belonged to a Scheduled Tribe or Scheduled Caste (2 variables) and their professed religion (8 variables). To ensure the clarity of the results, the parameters are presented only for the explanatory variables included in the models.

Models 1–4 describe the working time (market or non-market) of people who live with a spouse. Models 5 and 6 describe the production of single people, and the parameters of models 7 and 8 were estimated taking into account only information about women. In the case of models 2, 4 and 8, an additional assumption was made that adult family members were labour market active and had a paid job. The standard deviations of estimations of the linear regression model parameters obtained with OLS are given in brackets.

The variable Sex is coded 0 for males and 1 for females. It can be seen that in the case of models 1–4 a change of sex from "man" to "woman" contributes to a decrease in market time in both countries. As in statistical descriptions, it can be seen that in India the influence of gender on limiting market activity is stronger than in Poland. The average drop is about 90 minutes a day in Poland, reaching as much as 342 minutes in the case of India (model 3).

In the cases as presented, the age of respondents plays a relatively small role. Along with an increasing number of years, market work time is rather limited. The exceptions are the estimates of the parameters in models 3 and 4 for India, but their values show that this feature has virtually no significance.

However, differences between the compared countries arise when taking into account the impact the presence of children has on the supply of market labour. In Poland, this impact is negative, albeit relatively small. In India, however, having children contributes to increased involvement in market work.

In India, regardless of whether there are children or not in a two-parent family, a higher level of education contributes to limiting the involvement in market work. However, in the case of childless couples, the impact of this variable is clearly stronger. Under Polish conditions, it does not play a significant role, as in models 1 and 2 the estimated parameters are not even statistically significant.

The Exp variable was treated as a proxy for the prosperity level of households. However, the impact of incomes (or expenses) *per capita* on the family can be neglected. Even if the estimated parameters are statistically significant, their impact on the time spent in the marketplace seems negligible.

The Emp value was introduced as a control variable. It plays a role in models where the person does not have to work (there is no limiting assumption). Then, the parameter estimates for such variables as Sex are obtained when controlled for the condition of being employed.

In the group of people living without a partner, men are clearly more active in the labour market. Again, in each of the analysed models (5 and 6) in India, gender is more important in the context of market activity; however, differences between countries are not as large as in the case of families in which there are two adults. Additionally, people from the selected sample limit their involvement in market work with age; however, the impact of this feature is relatively small (in models 6 and 8 for India, the parameter is not statistically significant).

The influence of children on limiting market work time is relatively small. Single parents simply need to work to earn money for themselves and a child. As in previous estimates, in the case of singles, the Exp variable is not important for describing the variability of the dependent variable. This is most likely due to its low quality in the sense that it informs about the average, not actual, distribution of income or expenditure between members of a household. Additionally, due to its nature, people could introduce false data when providing such information.

The estimations of parameters in models 7 and 8 show that the institution of marriage has a limiting effect on women's involvement in market work. The largest negative impact, 112 minutes a day, appears in the case of women in India (model 7).

The negligible significance for the number of children (Kid) in shaping female market work time (models 7 and 8) is quite surprising. The parameter's values relate to the average time reduction regarding each subsequent child in the family. This can be commented on by considering two elements. Firstly, if they have already decided to enter the labour market, women try not to limit this activity even if the number of children in the household increases. Secondly, when there are several children in the family, the older ones start to carry about the younger ones, partially replacing the parents which, with the greater value of this variable, can have a restrictive effect on the time spent on the youngest children.

The previously observed similarity between the two countries in terms of women's longer household work compared to men is confirmed by the Sex variable parameters in Table A7 in the Appendix. There is clearly a greater impact of gender in India. This is especially true for couples with children (models 3 and 4). In extreme situations, a change of gender from "man" to "woman" brings about an increase in the daily household workload of more than 6 hours.

Increasing age regarding the examined persons has little practical influence on the dependent variable values. However, the number of children translates into an increased involvement in household work, though to a greater extent in Poland than in India. For example, the parameter in model 4 reveals that for each additional child in a household the average home production time increases by almost 20 minutes a day. The level of education though is not important (statistically insignificant parameters), or it contributes to a growing involvement in household work (model 3 for both countries).

In the case of singles (Table A8 in the Appendix, models 5 and 6), gender influences the amount of time spent in the non-market sphere, but to a much lesser extent than in married households. However, the impact of the level of education is ambiguous.

In models 7 and 8 (Table A8 in the Appendix), which only include information about women, civil status (married or not) clearly had an impact on involvement in household work. Married women tend to spend more time on such duties; for instance, Indian women up to 109 minutes a day. In their case the presence of children also has a greater impact on involvement in home production and care.

In model 8, concerning Polish women for whom an additional condition (assumption) of working in the market was placed, the only determinant of time at home was education. It seems that Polish women active in the labour market do not change their involvement in household work after their change of civil status, or with the appearance of children.

Conclusions

A report published by the UN in 1980 revealed that "women represent half the global population and one-third of the labour force; they receive only one-tenth of the world income and own less than one percent of world property. They are also responsible for two-thirds of all working hours" (United Nations, 1980). Unfortunately, even today, economic justice is an elusive dream for women all over the world. According to an ILO report (International Labour Organisation, 2017), only 49.4% women worldwide are officially in the labour force, while for men the rate is 76.1%. Therefore, women's participation in the global labor market is 26.7 percentage points lower than that of men. Time use statistics provide a comprehensive account of time spent on various activities, thus enabling the reasons behind the low participation of women in the economic sphere to be probed more deeply.

The issue of time use has become the subject of numerous economic and sociological analyses in recent decades (Jarosz, 2013, pp. 2–3). They have been mainly concerned with such issues as the decision to enter the labour market, the range of labour in the supply of agents and the time spent on production in the non-market sphere (Hamermesh, 1996, p. 1). This article conforms to this type of analysis; thus, when examining production activity, both market and non-market activities were taken into account. The conclusions, which were formulated on the basis of the results obtained, should obviously be treated with caution. This particularly applies to the comparisons between Poland and India. Such reservations result from different methodologies of data collection during TUS editions in the above mentioned countries. In India, time use data was collected for three types of days: normal, weekly variant and abnormal day; similarly, the Polish dataset also had data for three types of days: weekday, weekend and holiday. However, the tools used for data collection in both countries were different. In Poland, the education levels were high, so the diary method was employed; while in India, at the time of the pilot survey, the literacy levels were low, so the most suitable method for data collection was the interview method. Although the tool employed for data collection will have a limited impact on the quality of the data collected, the Polish dataset already had the activities categorised into four main groups; market work, home production, leisure and personal care, with no such categorisation being present in the Indian data. However, the method of analysis, and more precisely the coding of individual features and the selection of the respondents' samples, was aimed at mitigating the problem. In order to overcome this shortcoming, the activities in the Indian dataset were coded by the authors in the four broad categories in a similar way to the Polish data.

The results presented here are confirmed by observations recorded in other studies, according to which men and women are characterised by a different struc-

ture of all work (Bertola et al., 2002; Bianchi et al., 2000). Regardless of whether there are children in the household or not, women from both countries work longer on average in the non-market sphere compared to men. The situation is the opposite where the allocation of time on remunerative work in the market is concerned. What differs significantly between the compared populations of individual countries is the scale of the disproportions in the scope of work performed by women in comparison with men, which is higher in India than in Poland. This shows that women in India have less autonomy over their time as they are tied to unpaid household chores, which in turn hinders their market engagement. This point can be very significant in explaining the precarious drop in female labour force participation in India as reported by various studies.

It was also shown in the article that women perform more "all work" (i.e. market and non-market work) per day compared to men; which is considered, in particular, a feature of developing countries (Aliaga & Winqvist, 2003; Apps, 2003; Haddad et al., 1995). The comparisons presented in our article show that the problem of such disproportion was greater in India at the turn of the 20th and 21st century than in Poland; and when children appeared in the family this disproportion was even larger.

It was also noticed that in selected samples, in terms of total working time (all work), Poles worked longer per day than the citizens of India; and at the same time the differences between men from both countries were greater than between women. Only singles worked longer in India than single people in Poland, and it did not matter if they had children or not.

It can be concluded that the hypothesis formulated at the beginning of this article, namely that being professionally active contributes to reducing inequalities in the scope of outlays on productive activity, seems to be true. When the "all work" time was measured for couples where both spouses work in the market, the difference between women and men in Poland is clearly decreased. However, in India working women also seem to work a "second shift[6]" at home as they still perform the majority of household duties. Thus, in this scenario, for women to enter the labour market in India means that on average they will work even longer than their husbands compared to the situation in which they stay out of the labour market. In an obvious way this may discourage women from activity in the labour market. Therefore, social policy (or social education) should be conducted in a way to evoke the consciousness that women active in the labour market should have less household work, and men should take up some household duties. Only then will marriage not have a negative impact (or be smaller) on the market ac-

[6] In her book entitled *The second shift*, Arlie Hochschild (1989) explains that the household responsibilities that a wife and mother takes care of, aside from working in her paid job, add up to at least 40 hours each week.

tivity of women in India. The India government is running a flagship programme of "Beti bachao, Beti Padhao" along with many other programmes for women's empowerment. However, the results of this paper clearly indicate that unless the conditions inside Indian households change, no programme is going to result in women's empowerment in India.

Significant convergence in all working time (both home and market) can be seen in the two countries only in the case of people living without a partner. This is particularly evident when it comes to single parents. In addition, it is also worth noting that in terms of "all work", single men in India work longer than women. Once again, this suggests a significant role for the institution of marriage in creating work time disparities between men and women in the nation of India. It is an even stronger factor than having children.

Based on the calculations made, differences can be pointed out in the role the institution of marriage plays in the compared societies. In Poland, people with partners in the samples presented in Tables 1 and 2 are characterised by an equally high activity in the labour market. However, in India, there are significant differences between the populations in the case of women's market activity. On the other hand, households of singles and single parents raising children in Poland are characterised by a lower amount of market work time than in analogous Indian households. Thus, it can be seen that having a family in Poland activates women in the labour market (the working time of women with a family is higher than single women). From the perspective of labor market activity, marriage has a positive impact in Poland, whereas in India, it does not translate into the same effect for active women. In fact, it even limits labor market participation among the general population (Table A6, models 7 and 8). Estimations of the parameters in the models show that the institution of marriage reduces women's involvement in market work. The largest negative impact, as much as 112 minutes a day, was seen in the case of women in India.

In the case of India, the exception is single women, who are characterised by a similar level of market activity as men. The recommendation for Indian social policy, which can be formulated on the basis of the results presented here, is the need to put more emphasis on the role of women's market activity. There should be an emphasis on increasing women's contribution to the economic development of the country.

In the case of Poland, the traditional family model works better when it comes to the market activity of women. Singles are clearly less active in this respect. In addition, in India, the presence of children does not have such a negative impact on the professional activity of mothers as in Poland. That is why Polish policy aimed at increasing fertility should be supplemented with programmes increasing activity on the labour market (e.g. support through greater access to institutions such as nurseries and kindergartens).

In the case of market labour, gender inequalities are more visible in India, being the most important determinant of market time in both countries. Estimations of the parameters of the regression equations showed that in India the influence of gender on limiting market work time is stronger than in Poland. In the latter case, the average drop is about 90 minutes a day, but in the case of India it is as much as 342 minutes. These findings clearly indicate the prevalence of gender bias in the Indian market. Thus, there is a need to plan policies which can help women in India overcome these biases. Additionally, in the group of people living without a partner, men are clearly more active in the labour market.

The two compared societies show a similarity in terms of the greater average number of women's household work minutes compared to men. However, the impact of gender on this type of disproportion is again greater in India than in Poland. In the most extreme situation, the change of gender from man to woman increases the daily workload of household work by more than 6 hours. In the case of single people, gender also influences the time spent in the non-market sphere, but to a much lesser extent than in the case of spouses.

The estimates presented here also showed the impact of civil status (marriage) on household work involvement. Married women perform such duties for longer time, and for Indian women it is up to 109 minutes a day. In the case of the latter, the presence of children has a greater impact on their involvement in home production and care compared to Polish women.

The analysis presented here is obviously not exhaustive. A complimentary problem that should be looked at in the future is the daily rhythm in the work of individuals. Hamermesh (1996, p. 2) points out that such knowledge can be useful not only to describe activities in the labour market, but also information about activities shaping the well-being of individuals. The degree of coordination in the spouses' time expenditure on paid work translates, among other things, into the possibility of maintaining social relations and everyday family contacts. If the rhythm of the spouses' work during the day is not aligned the possibility of spending time together decreases, for both them and their children. This influences their quality of life, the durability of their relationships, relationships with children, etc. These issues should be the next steps in time allocation descriptions for members of Polish and Indian households.

Appendix

Table A1. Activities included in the four main time categories in Poland

Market work (*M*)	Household work (*H*)	Leisure (*L*)	Personal-care (*P*)
– market work – study – work breaks – travel for work	– meal preparation – household work – shopping – childcare – volunteering – travel	– religion – social life – culture & entertainment – passive resting – physical activities – hobbies – playing – reading – TV – listening – other relaxation – travel	– sleeping – eating – self-care – travel

Source: authors division into main categories.

Table A2. Activities included in four main time categories in India

Market work (*M*)	Household work (*H*)	Leisure (*L*)	Personal-care (*P*)
– primary production activities – secondary activities – trade, business and services – learning	– household maintenance, management and shopping for own household – care for children, the sick, elderly and disabled in own household – community services and help to other households	– social and cultural activities, mass media, etc.	– personal care and self-maintenance

Source: authors division into main categories.

Table A3. Education levels – Poland

EDU1	EDU2	EDU3
– incomplete primary education – primary – 2 years of vocational education	– 3–4 years of vocational education – secondary	– higher education

Source: authors division into main categories.

Table A4. Education levels – India

EDU1	EDU2	EDU3
– not literate – literate without formal schooling: EGS/ NFEC/ AEC – literate without formal schooling: tlc – literate without formal schooling: others – literate: below primary – primary	– middle – secondary	– higher secondary – graduate and above in agriculture – graduate and above in technology – graduate and above in medicine – graduate and above in other subjects

Source: authors division into main categories.

Table A5. Results of the estimation for the market work time, in case of pairs of adults (in minutes per day)

Independent variables	Model 1		Model 2		Model 3		Model 4	
	Poland	India	Poland	India	Poland	India	Poland	India
Sex	–89.6 (15.42)***	–289.9424 (7.6417)***	–93.2 (18.7)***	–104.5995 (12.86)***	–92.0 (9.59)***	–342.26 (2.88)***	–87.7 (10.93)***	–119.41 (6.36)***
Age	–3.3 (0.67)***	–0.9515 (0.3116)**	–3.6 (0.78)***	–1.714 (0.561)**	–1.35 (0.64)*	0.899 (0.169)***	–1.16 (0.78)	1.1028 (0.3887)**
Kid	–	–	–	–	–12.6 (4.64)**	3.02 (1.18)*	–13.95 (5.52)**	6.276 (2.65)*
EDU	11.1 (12.98)	–29.3311 (7.3923)***	2.54 (16.03)	–33.384 (15.19)*	–15.7 (9.22)	–17.707 (2.416)***	–9.3 (10.8)	–10.376 (6.41)
Exp	0.01 (0.006)**	–0.0219 (.009)*	0.019 (0.009)	0.04 (0.018)*	0.05 (0.006)***	–0.046 (0.005)***	0.06 (0.007)***	–0.012 (0.012)
Emp	124.4 (160.9)	238.9755 (25.792)***	–	–	103.8 (69.17)	257.52 (12.44)***	–	–
Constant	573.3 (163.2)***	386.44 (55.318)***	718.7 (50.32)***	656.13 (70.86)***	522.8 (75.28)***	265.18 (21.31)***	587.23 (39.26)***	398.17 (31.92)***
N	445	2310	299	582	1 451	15 568	1 045	2456
R^2	0.142	0.4136	0.153	0.123	0.147	0.5231	0.176	0.1629
F	14.49	115.63	13.24	8.01	42.02	1137.23	44.28	36.56

Note: α = * 0.05; ** 0.01; *** 0.001; Sex – 0 male, 1 female; Age – values in years; Kid – number of kids 0–18 y.o.; EDU – education level; Exp – expenditure *per capita* (India), income *per capita* (Poland); Emp – control variable for employment status, 0 not employed, 1 employed; *N* – sample size; *F* – F stat.

Source: authors' calculations based on Polish and Indian TUS data.

Table A6. Results of the estimation for market work time, singles (models 5 & 6) and women (models 7 & 8) (in minutes per day)

Independent variables	Model 5		Model 6		Model 7		Model 8	
	Poland	India	Poland	India	Poland	India	Poland	India
Sex	–33.1 (17.4)	–44.803 (13.24)**	–54.5 (22.13)*	–102.38 (19.89)***	–	–	–	–
Married	–	–	–	–	–38.5 (10.43)***	–112.5 (6.38)***	–43.5 (21.04)*	–8.98 (7.92)
Age	–5.7 (0.71)***	–4.1 (0.577)***	–2.95 (1.22)*	1.27 (1.09)	–2.1 (0.36)***	2.01 (0.22)***	–1.78 (0.79)*	0.17 (0.38)
Kid	–	–	–4.4 (8.83)	–7.81 (7.84)	–2.7 (3.18)	–4.67 (1.43)***	–13.2 (6.15)*	1.89 (2.52)
EDU	–32.1 (15.0)*	22.17 (9.24)*	–2.22 (18.7)	–31.96 (15.92)*	–21.97 (7.14)**	–31.32 (3.65)***	–44.5 (14.23)**	–23.99 (6.96)***
Exp	–0.005 (0.015)	–0.006 (0.009)	0.002 (0.016)	–0.01 (0.02)	0.13 (0.006)***	–0.07 (0.006)***	0.01 (0.01)	0.03 (0.01)**
Emp	266.4 (22.51)***	201.51 (17.13)***	270.4 (24.02)***	202.82 (25.76)***	–	–	–	–
Constant	399.9 (48.6)***	445.3 (57.42)***	203.2 (70.7)***	301.58 (90.5)***	238.5 (23.37)***	336.1 (23.16)***	464.1 (50.06)***	388.58 (32.66)***
N	574	749	561	446	3 073	9 784	1 330	2 313
R^2	0.37	0.28	0.276	0.28	0.147	0.14	0.017	0.015
F	66.78	24.39	35.13	13.95	105.85	113.38	4.63	2.73

Note: see Table A5; Married – marital status, 1 if married, 0 if not.

Source: authors' calculations based on Polish and Indian TUS data.

Table A7. Results of the estimation for household work time, pairs of adults (in minutes per day)

Independent variables	Model 1		Model 2		Model 3		Model 4	
	Poland	India	Poland	India	Poland	India	Poland	India
Sex	91.6 (10.0)***	306.1 (4.7)***	87.7 (12.7)***	209.3 (7.8)***	136.7 (7.14)***	381.1 (2.18)***	132.5 (8.51)***	241.4 (4.54)***
Age	1.9 (0.43)***	–0.05 (0.19)	2.09 (0.53)***	0.5 (.34)	–0.56 (0.48)	–2.82 (0.13)***	–0.84 (0.61)	–2.6 (0.28)***
Kid	–	–	–	–	13.9 (3.45)***	7.12 (0.9)***	19.8 (4.3)***	2.21 (1.89)
EDU	–9.8 (8.42)	–2.62 (4.6)	–9.4 (10.92)	–0.57 (9.18)	20.2 (6.86)**	9.17 (1.83)***	16.7 (8.42)*	3.81 (4.58)
Exp	–0.006 (0.004)	0.01 (0.006)**	–0.006 (0.006)	–0.014 (0.01)	–0.017 (0.004)***	0.03 (.004)***	–0.03 (0.005)***	0.014 (0.008)
Emp	62.6 (104.4)	2.9 (16.02)	–	–	–30.9 (51.5)	–17.47 (9.42)	–	–
Constant	–18.0 (105.8)	8.4 (34.35)	45.6 (34.29)	21.7 (42.8)	130.2 (56.06)*	138.5 (16.14)***	125.3 (30.58)***	201.52 (22.79)***
N	445	2 310	299	582	1 451	15 568	1 045	2 456
R^2	0.205	0.66	0.186	0.57	0.256	0.71	0.27	0.595
F	22.65	315.25	16.78	76.81	82.73	2512.27	75.46	275.93

Note: see Table A5.

Source: authors' calculations based on Polish and Indian TUS data.

Table A8. Results of the estimation for household work time, singles (models 5 & 6) and women (models 7 & 8) (in minutes per day)

Independent variables	Model 5		Model 6		Model 7		Model 8	
	Poland	India	Poland	India	Poland	India	Poland	India
Sex	39.7 (12.07)**	44.83 (8.18)***	151.4 (16.65)***	107.1 (17.21)***	–	–	–	–
Married	–	–	–	–	20.56 (10.19)*	109.36 (5.55)***	14.90 (13.2)	32.83 (6.54)***
Age	4.1 (0.49)***	1.42 (0.36)***	1.8 (0.92)*	–1.96 (0.95)*	1.24 (0.36)**	–2.97 (0.18)***	–0.34 (0.43)	–1.79 (0.31)***
Kid	–	–	14.1 (6.64)*	9.49 (6.78)	–4.8 (2.86)	23.34 (1.2)***	–2.42 (3.13)	11.71 (2.08)***
EDU	26.5 (10.37)*	–11.09 (5.7)	19.0 (14.06)	35.999 (13.78)**	27.79 (6.76)***	9.58 (3.07)**	22.45 (7.37)**	10.79 (5.75)
Exp	–0.011 (0.01)	–0.013 (0.006)**	–0.007 (0.01)	–0.023 (0.021)	–0.03 (0.003)***	0.04 (0.005)***	–0.004 (0.003)	–0.017 (.009)
Emp	–60.2 (15.56)***	0.49 (10.58)	–114.2 (18.07)***	–91.48 (22.29)***	–	–	–	–
Constant	18.81 (33.59)	136.67 (35.49)***	113.3 (53.19)*	264.33 (78.31)***	111.2 (21.65)***	328.76 (21.3)***	136.15 (26.19)***	326.96 (26.96)***
N	574	749	561	446	2 261	9 784	1 602	2 313
R^2	0.192	0.16	0.248	0.2	0.04	0.15	0.008	0.083
F	26.97	11.95	30.54	8.83	18.88	117.45	2.47	15.92

Note: see Table A5.

Source: authors' calculations based on Polish and Indian TUS data.

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Underdetermination problem in methodology of economics

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Abstract

This paper explores the Duhem-Quine (DQ) problem and its impact on economic methodology, focusing on how the reliance on auxiliary assumptions complicates the testing and validation of theories. The DQ problem shows that no hypothesis is tested in isolation, as it depends on additional assumptions and background knowledge, making it challenging to pinpoint where errors lie. This issue is particularly relevant in economics, where complex models and assumptions about human behaviour play a significant role, and in finance, where the robustness of models is critical for decision-making under uncertainty. The paper highlights two key gaps: (a) the limited discussion of the DQ problem in economic methodology, and (b) the lack of alternative approaches to ensure rational methods in light of DQ. To address these issues, it proposes a multi-criterial framework for evaluating theories, emphasising consistency, diverse data, localised testing, comparing models and varying assumptions systematically. Using examples such as housing market models and the Ultimatum Game, the paper illustrates how addressing the DQ problem involves avoiding arbitrary changes to assumptions while adopting clear, rational strategies. By providing a stronger methodological foundation, this approach enhances the reliability of economic and financial theories, improving their influence on policy-making and practical applications.

Keywords

- Duhem-Quine problem
- economic methodology
- methodological rationality

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Introduction

The notion of rationality in the context of economic theory is usually presented as an exceptional and fundamental principle, especially in mainstream (monetarist/neoclassical) economic theory. The principle of economic rationality, however, is far from a homogenous concept, especially since the emergence of behavioural economics (Kahneman et al., 1986) and the concept of bounded rationality (Simon, 2008). To put it generally and somewhat synthetically, to speak of economic rationality means speaking of *choice* with respect to means allowing for maximalisation of utility for the economic agent; a *rational choice* is that which yields the highest utility for the agent with respect to the agents preferences about scarce resources (see: Jones, 2021; Li, 2020; Sen, 1977; Smith, 2007). From this perspective "Rational people systematically and purposefully do the best they can to achieve their objectives, given the available opportunities" (Mankiw, 2008, p. 6). Economic rationality conceived as the art of making choices[3] was, as is well known, formally modelled by Arrow (1963, 1974).

Less known thematisation of the notion of rationality regarding economics has to do with methodological and philosophical considerations about ways in which economic theories fulfil criteria of scientific rationality. This perspective conceives rationality as a property of economics considered as a scientific enterprise, while the former perspective views rationality as a property of economic agents. This type of rationality will be referred to as "methodological rationality" in this article. Firm belief in the rationality of the whole enterprise seems to be a necessary prerequisite in making epistemic and, further, policy-making analysis, modelling or predictions (Newton-Smith, 1981). As such, rational behaviour at the methodological level would require providing reasons as to why such-and-such, e.g. predictions are not *ad hoc*. To claim otherwise would mean to sanction the idea that, fundamentally, everything goes regarding economic theorising (Kuorikoski & Marchionni, 2024). Even though it is widely recognised that "pure" rationality at the methodological level, understood as the capability to reconstruct in terms of logic ways in which hypotheses are formulated and connected with empirical evidence, is impossible (Feyerabend, 1993; Kuhn, 1962), to surrender to arbitrariness as the methodological guiding principle seems to be a cost that is too high – especially with the general rising tide of pseudoscience.[4]

[3] It is worth noting that this concept is also applied in other social sciences (e.g. political science, international relations). However, some authors emphasise its significant limitations, both in economics and in other social sciences (Mearsheimer & Rosato, 2023).

[4] By "pseudoscience" we mean some set of beliefs falsely being presented or considered as based on the scientific method.

This paper addresses one of the main challenges to the methodological rationality of economics (as well as other scientific disciplines): the so-called underdetermination of theory by data, or "the underdetermination problem", or "the Duhem-Quine Problem" (DQ). As such, the work presented here is of conceptual nature. The research gap identified in the presented context consists of two parts: (a) the problem is not well known in the literature on economic methodology, so it is important to highlight this issue; (b) no alternative concept of methodological rationality, aside usual organisational standards within scientific institutions, has been proposed in the light of the DQ problem. The first gap is filled in this paper by presenting the DQ in economics; the second gap is filled in section 4 by proposing a multi-criterial concept of (general and synthetic) methodological rationality for economic theorising.

1. Research methodology

In this paper the critical review method is utilised (Grant & Booth, 2009; de Klerk & Pretorius, 2019). The critical review method involves systematically analysing, synthesising and evaluating existing literature to provide a comprehensive understanding of a specific research topic. This methodology is particularly valuable for identifying gaps, trends and debates within a field, offering a solid foundation for further research. By critically engaging with sources, the method goes beyond summarisation to assess the validity, reliability and relevance of existing work. Critical engagement with sources amounts to a synthetic presentation of the DQ problem in existing literature on methodology of economics and formulating an addition to it by formulating potentially fruitful methodological hypotheses. Data set consist in methodological and philosophical articles dedicated to the DQ problem – both at the general level and in economics. The keywords "Duhem AND Quine", "Duhem AND Quine AND problem", "Duhem", "Quine", "underdetermination" were used for researching the literature in Scopus and Google Scholar databases. The literature was chosen based on the clarity and thoroughness of characterisations of concepts and topics relevant for the paper, i.e. general DQ problem, DQ problem in economics, as well as examples of DQ problem in economics. Literature from no specific time period was considered, mainly because the DQ problem is neglected in methodological literature in economics. The Scopus database yields 7 items, when the research is limited to economics and finance literature. This is the reason why additional sources were used: books and articles evidenced in the philpapers.org, a website dedicated to aggregating information on philosophical papers. Ultimately, 38 items were selected in the process and subsequently subjected to critical analysis and synthesis.

2. Literature review

Let us limit this section to literature relevant to the DQ problem in economics. The seminal paper regarding this topic was presented by Cross (1982). Cross explores the implications of the Duhem-Quine (DQ) thesis for economic methodology by examining its influence on the Keynesian revolution. He argues that the DQ thesis – asserting that no hypothesis can be tested in isolation – poses challenges for economists seeking empirical validation for macroeconomic constructs. This early exploration underscores the need for pragmatic strategies in economic methodology to navigate the interconnectedness of economic models. V. Smith (1994) focuses on the rise of experimental economics and how laboratory experiments have introduced new ways to test economic theories. He discusses the inherent reliance on auxiliary hypotheses, such as the *ceteris paribus* conditions and participant behaviour assumptions, which align with the DQ thesis. Smith emphasises that while laboratory settings can control variables, they do not eliminate the complexity of auxiliary assumptions. He advocates for transparency in experimental designs in order to improve the robustness of economic hypotheses. Sawyer and Sankey (1997) delve into the philosophical underpinnings of the DQ thesis, focusing on its relationship with scientific realism. They propose that scientific theories should be evaluated based on their explanatory power and ability to generate empirical predictions. Their work contributes a broader philosophical perspective on how the DQ thesis applies across disciplines, including economics.

Starmer (1999) critically examines the reliability of experimental economics, questioning whether the methods employed by experimental economists are sufficiently rigorous to justify their findings. Echoing the concerns raised by the DQ thesis, Starmer highlights the role of auxiliary assumptions in interpreting experimental outcomes. He raises ethical and methodological questions about the validity of controlled experiments in capturing real-world economic phenomena, advocating for more scrutiny of experimental methods. Boylan and O'Gorman (2003) revisit the DQ thesis in the context of economic methodology, emphasising a pragmatic approach to navigating its challenges. Jones (2012) analysed the DQ thesis with a focus on economic methodology. He critiques two foundational assumptions in Quine's depiction of science: the interconnectedness of scientific statements and the flexibility of auxiliary hypotheses. By challenging these assumptions, Jones argues for localised testing and constraints on modifying auxiliary hypotheses to preserve theoretical integrity. His analysis contributes to a nuanced understanding of the DQ problem in economics, offering practical approaches to address it. Mäki (2013) examines the role of contested models in economics, framing them as a reflection of the discipline's methodological challenges. He ties these challenges to the DQ thesis, arguing that economic models often compete for explanatory dominance,

relying on different sets of assumptions and auxiliary hypotheses. Mäki suggests that rather than resolving these contests outright, economists should embrace their diversity as a source of progress. He emphasises the importance of evaluating models based on coherence, empirical adequacy and practical applicability.

In every case, the emphasis was understandably placed on ways to mitigate the DQ problem. However, the main issue raised by DQ – the challenge to scientific rationality – remains unaddressed. In the literature reviewed it is clearly argued that from the methodological standpoint the DQ requires a response at the level of reflections on economic theory; however, the notion of rationality, viewed as a property of economic scientific discourse, is never tackled. The theoretical stake is high, given the importance of the notion of scientific rationality. As mentioned above, this prompts two research gaps filled by this paper: (a) the problem is not well known in literature on economic methodology, so it is important to highlight this issue; (b) no alternative concept of methodological rationality, aside usual organisational standards within scientific institutions, has been proposed in the light of the DQ problem.

3. General Duhem-Quine problem

The underdetermination thesis refers, first and foremost, to a relation between scientific theory (or the whole body of scientific knowledge) and empirical evidence (see: Psillos, 1999, p. 156). Originally, the thesis was formulated by Duhem (1954) in his analyses of physical science:

> The prediction of the phenomenon, whose nonproduction is to cut off debate, does not derive from the proposition challenged if taken by itself, but from the proposition at issue joined to that whole group of theories; if the predicted phenomenon is not produced, the only thing the experiment teaches us is that among the propositions used to predict the phenomenon and to establish whether it would be produced, there is at least one error; but where this error lies is just what it does not tell us. (p. 185)

That is, in scientific endeavours when a hypothesis is purportedly tested, it is never tested in isolation; it is always supported by different hypotheses or theories. If a hypothesis is rebutted we may claim that the fault lies in the supporting hypotheses – usually called the auxiliary hypotheses and background knowledge. In Duhem's philosophy of science, this underdetermination is an empirical matter to be decided by evaluating theories case by case. For over half a century, the problem was generalised by Quine (1951) to other types of knowledge:

> The totality of our so-called knowledge or beliefs, from the most casual matters of geography and history to the profoundest laws of atomic physics or even of pure math-

> ematics and logic, is a man-made fabric which impinges on experience only along the edges. Or, to change the figure, total science is like a field of force whose boundary conditions are experience. A conflict with experience at the periphery occasions readjustments in the interior of the field. But the total field is so underdetermined by its boundary conditions, experience, that there is much latitude of choice as to what statements to reevaluate in the light of any single contrary experience. No particular experiences are linked with any particular statements in the interior of the field, except indirectly through considerations of equilibrium affecting the field as a whole. (pp. 42–43).

Since then the thesis is known as the "Duhem-Quine thesis" (DQ) (Grünbaum, 1960). Roughly, DQ's main insight may be captured in the following way: "When we assert that scientific theory choice is underdetermined by evidence, we mean that evidence by itself cannot direct a scientist to accept or reject a theory" (Turnbull, 2018, p. 2). The acknowledgment of the DQ thesis had some large consequences in philosophy and methodology of science.

DQ undermines strict and pure accounts of scientific rationality. Most famously, DQ undercuts the logic of scientific justifications presented in Popper's falsificationism (Popper, 1959). According to Popper, a theory is scientific only if it is, in principle, possible to establish its falsity, i.e. it is not immune to possibly discrediting data. This forms the backbone of Popper's claims about the logic of scientific rationality – the correct logic in science is the logic of *modus tollendo tollens*. A rational scientist should always accept an argument which has the following form:[5]

$$H_0 \rightarrow O \wedge \neg O \rightarrow \neg H_0$$

where H_0 is the hypothesis tested and O is the observation. However, owing to DQ, this formula is inadequate: H_0 is never tested in isolation (what is actually tested is the conjunction of H_0 and auxiliary hypotheses and elements of background knowledge) and if recalcitrant experience is unfavourable for H_0, other parts of the theory or system can be blamed. The point is that, according to Quine, this can be done arbitrarily; if H_0 is supposedly refuted by evidence, we may try to save it by modifying the auxiliary hypotheses.

4. Duhem-Quine problem in economics

In methodology of economics, DQ was recognised in the following ways. Some authors emphasize DQ's meaning, some downplay it, others remain agnostic to its relevance. Mäki (2013) generally agrees that the DQ is pressing in economics and

[5] The formula in propositional logic is: $[(p \rightarrow q)\neg q] \rightarrow \neg p$.

that it amounts to a situation in which a decision between economic models cannot always be settled by empirical means. Hausman (2007) elaborates on this point:

> First, the complexity of human behaviour requires the use of numerous initial conditions and strong simplifying assumptions. Some of these restrictions may actually be false (such as the infinite divisibility of commodities), some of these assumptions may be logically unfalsifiable (such as the assumptions of eventually diminishing returns), while still others may be logically falsifiable but practically unfalsifiable (such as the completeness assumption in consumer choice theory). (p. 191)

An appraisal of DQ-problem in experimental economics can be found in (Guala, 2005), following V. Smith (1994):

> All tests of a theory require various auxiliary hypotheses that are necessary in order to interpret the observations as a test of the theory. These auxiliary hypotheses go under various names: initial conditions, ceteris paribus clauses, background information, and so on. Consequently, all tests of a theory are actually joint tests – that is, a test of the theory conditional on the auxiliary hypotheses. (p. 127)

To give two examples of DQ in economics, let us refer to McMaster and Watkins (2006) as well as Jones (2012).

Example 1 (McMaster & Watkins, 2006)
A substantial body of research employs econometric methods to analyse urban housing market data. Typically, these models define house prices based on physical property features, neighbourhood quality and proximity to the central business district (CBD). The framework assumes that metropolitan areas function as unified urban housing markets, where households select their homes by balancing location accessibility and housing quality within their budget constraints. In this setup, the coefficient associated with the distance from the CBD reflects the slope of the bid-rent gradient, all else being equal. Even if the distance variable shows an insignificant or positive relationship, the access-space trade-off remains empirically supported within this analytical framework.

Example 2 (Jones, 2012)
Another case is the testing of the ultimatum game, where the primary hypothesis under examination is that of self-interest. While the ultimatum game appears to provide a clear and straightforward test of this hypothesis, its validity depends on a broad set of auxiliary assumptions, complicating its interpretation as a definitive measure of self-interest. These auxiliary assumptions include factors such as whether the payoffs are sufficient to motivate participants, whether subgame perfect equilibrium is the appropriate equilibrium concept, whether irrelevant changes in payoffs influence behaviour, and whether variables like players' characteristics (e.g., gender, nationality, culture), or their experience, impact performance.

Over time, these auxiliary hypotheses have been questioned, either to reinterpret the findings of the ultimatum game or to evaluate the robustness of its results.

Just in these examples the threat of arbitrality in economic theory is visible: presuppositions present in the abovementioned cases – considered as crucial devices of explaining or making predictions or adequately representing the situation – are proven as having loose connection to the phenomena considered. Other examples of the underdetermination problem can be found in Cross (1982), Sawyer and Sankey (1997), Starmer (1999), Hands (2001), McGovern (2006) and Bardsley et al. (2010).

One way to deal with the DQ problem is to question the Quinean view on science, as proposed by Jones (2012). His critique of the DQ thesis can be outlined as follows. He argues that two key assumptions in Quine's depiction of science need to be challenged. The first is the concept of science as an interconnected web of statements, and the second is the flexibility in altering auxiliary hypotheses. These assumptions are central to the DQ problem. If science is not as interconnected as Quine suggests, localised testing becomes a plausible approach. Similarly, if auxiliary hypotheses are not easily modifiable, it becomes harder to adjust them solely to preserve a theory. While it is true that experiments depend on auxiliary hypotheses to test the main hypothesis, it is equally valid that a significant portion of experimental science involves verifying these auxiliary hypotheses.

Another way of mitigating the DQ problem is to provide a set of a general list of possible courses of action, which is to be consulted whenever doubts about auxiliary hypotheses arise. While the notion of purely logical methodological rationality usually took a mono-criterial form (referring to a specific logical law), post-DQ methodological rationality in the context of economy may take a multi-criterial form and be understood as a meta-frame of reference. For example:

1. **Model Consistency**: When a model reliably predicts real-world outcomes across different scenarios, it supports the credibility of its underlying hypotheses, even if isolating auxiliary assumptions proves challenging.
2. **Data Pluralism**: Evaluating economic theories using diverse datasets or contexts. Consistent results across varying conditions strengthen the argument that findings are not solely influenced by flawed auxiliary assumptions.
3. **Localisation**: Conducting focused testing of economic theories within smaller subsystems. This approach assumes that certain auxiliary assumptions remain constant, enabling more precise hypothesis evaluation.
4. **Comparison**: Instead of testing a single hypothesis, economists can evaluate multiple models or hypotheses to identify which one best aligns with the data. Bayesian methods are particularly useful for updating hypothesis probabilities based on new evidence while incorporating prior beliefs and auxiliary assumptions.

5. **Variations**: By systematically adjusting auxiliary assumptions, economists can gauge the extent to which the main hypothesis depends on them. If a hypothesis remains valid across a range of plausible conditions, confidence in its robustness increases.

This list is clearly tailored for a specific discipline; one could view this as something unfortunate, since no absolute reference frame of rationality is provided. However, this is a lesson that needs to be learned from DQ: an absolute/pure notion of rationality is impossible. At the same time, this is no final reason to abandon the notion of methodological rationality.

The third way of dealing with the DQ problem is to utilise the fact that we can distinguish different versions of DQ. The first version can be called "Duhemian underdetermination": contrastive underdetermination, i.e. underdetermination which arises due to empirical equivalence of competing theories or models (Stanford, 2023). The second version is the weak DQ: "single descriptive propositions are never tested in isolation; rather, empirical testing presupposes complexes or systems of sentences" (Boylan & O'Gorman, 2003, p. 12). The third version is the moderate DQ which adds the possibility of modifying *some* parts of the mentioned conjunction in order to save the tested proposition from recalcitrant evidence: "No *descriptive* statement can be individually falsified by evidence, whatever the evidence may be, since adjustments in the rest of the system can always be devised to prevent its *falsification*" (Hesse, 1970, p. 195). The fourth version is the strong DQ, which is expressed in the claim that "Any statement can be held true come what may, if we make drastic enough adjustments elsewhere in the system" (Quine, 1976, p. 60). This means that, presumably, we can defend a hypothesis if we make changes in any part of the entire system of knowledge.

Now, the Duhemian underdetermination does not pose a threat to economic theories since it is usually not the case that the choice between models or theories is about perfectly equal competitors: there are reasons to pick one theory over the other, even if it is because of values like simplicity or mathematical elegance, which are important in practical applications. The weak DQ, arguably most important in the context of the examples mentioned in this paper, was addressed in Boylan and O'Gorman (2003). They claim that

> practising scientists tend to divide their theories into high-level and low-level parts and they frequently hold that the lower-level is better corroborated or confirmed than the higher-level. Consequently, if a scientific theory is falsified by empirical evidence, the scientists, quite correctly, tend to locate the responsibility in the less confirmed parts of the theory. Without prejudice to the complexities of confirmation theory, weak Duhem-Quine theorists have no difficulty either with this pragmatic strategy. (p. 14)

According to these authors, the weak DQ is harmless, while the moderate version of DQ poses potentially a large issue for economics. However, we argue with

this claim. Auxiliary hypotheses cannot be arbitrarily altered to uphold the main hypothesis, as they often represent well-established theories with strong predictive accuracy. Changing these hypotheses without justification risks replacing a thoroughly validated hypothesis with one that has little or no empirical support. While a better hypothesis might theoretically exist, there is no guarantee of finding one, and it is often unlikely. This idea is clearly illustrated in economic experiments, where some auxiliary hypotheses are not even considered for revision. For example, the shape of a researcher's glasses is not seen as having any meaningful impact on a proposer's behaviour in the Ultimatum Game (see: Jones, 2012). Additionally, one could retort to some multi-criterial account of methodological rationality and claim that the possibility of changing some part of the system is actually good news, since to change that part may mean to improve the system; but only if this decision is guided, in a non-dogmatic way, by rationally grounded considerations.

Conclusions

The Duhem-Quine (DQ) problem presents a significant challenge to the methodological rationality of economics and other scientific disciplines. It underscores the inherent difficulty in isolating and testing individual hypotheses, as they are always embedded within a network of auxiliary assumptions and background knowledge. In economics, this interdependence complicates the validation of theories and models, as seen in the examples provided. Addressing the DQ problem requires rejecting arbitrary adjustments to auxiliary hypotheses, given their foundational role in supporting robust predictions and their alignment with broader theoretical frameworks. Furthermore, nuanced approaches, such as multi-criterial methodological rationality, offer a path forward. By evaluating models through criteria such as consistency, data pluralism, localisation and systematic variation, economists can improve the robustness of their hypotheses while maintaining methodological rigor. The distinctions between different versions of the DQ problem – ranging from weak to strong forms – highlight varying degrees of challenges to scientific inquiry. While weaker forms of the DQ problem may be pragmatically managed by prioritising corroborated components of theories, moderate and stronger forms demand careful, rationally grounded approaches to theory adjustment. Ultimately, the ability to refine systems of knowledge rationally, rather than arbitrarily, allows for progress in economic methodology. The solutions proposed in this paper aim to balance theoretical flexibility with the need for methodological consistency, ensuring that scientific advancements remain grounded in rational principles.

Building on the insights presented in this study, several avenues for future research can be pursued to deepen the understanding of the DQ problem in economics and enhance methodological approaches to address it effectively:

1. **Empirical Exploration of Auxiliary Hypotheses in Economics**

   Future research could empirically investigate how auxiliary hypotheses function in specific economic models. For example:
   a) What factors influence the choice and modification of auxiliary hypotheses in economic theorising?
   b) How often are auxiliary hypotheses revised, and under what conditions are such revisions considered justified?
   c) Case studies could focus on high-stakes areas like macroeconomic policy models or experimental economic games.

2. **Development of Practical Multi-Criterial Frameworks**

   While this study proposes a conceptual multi-criterial approach to methodological rationality, further work is needed to operationalise this framework. Researchers could:
   a) Develop tools or guidelines to apply criteria like model consistency, data pluralism and localisation systematically in economic research.
   b) Evaluate the practical impact of such frameworks on decision-making in theory selection or model validation.

3. **Integration with Machine Learning and Computational Methods**

   The growing use of machine learning and computational models in economics offers an opportunity to revisit the DQ problem:
   a) How do machine learning models, which often rely on complex auxiliary assumptions, navigate issues of underdetermination?
   b) Can computational tools be used to systematically evaluate the robustness of auxiliary hypotheses and their role in theory testing?

4. **Policy Implications of the DQ Problem**

   Future work could explore the practical implications of the DQ problem for policy-making, particularly in economics:
   a) How does underdetermination influence the reliability of economic predictions used to guide policy decisions?
   b) Can multi-criterial methodological frameworks improve the robustness and transparency of economic policy recommendations?

5. **Educational Strategies for Methodological Rationality**

   Finally, research could focus on incorporating an understanding of the DQ problem and methodological rationality into the education of economists:

a) What pedagogical approaches can help future economists better recognise and address underdetermination in their work?
b) Can case studies of the DQ problem in practice enhance the teaching of economic methodology?

By pursuing these lines of inquiry, future research can continue to refine the theoretical and practical approaches to the DQ problem, enhancing the rigor and reliability of economic science.

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Quantitative analysis of money cycle and economic stability in economocracy

Constantinos Challoumis[1]

Abstract

The paper discusses economocracy and representative economocracy as innovative approaches proposed by author. These new economic systems, analogous to the political system of democracy, aim at managing global debt and promoting economic sustainability. Economocracy is presented as a reformed economic system, distinct from capitalism, that incorporates the mechanisms of a free-market economy to address disruptions such as wars (reconstruction of countries), recessions and economic crises. The results imply that economocracy has the potential to provide solutions to global economic issues by effectively circulating capital while promoting democratic governance and stable economies. The research involves a quantitative analysis of economic models, specifically focusing on the Economic Productive Reset (EPR) and Economic Periodic Injections (EPI) as tools to alleviate global indebtedness and maintain economic stability.

Keywords

- banking system
- capital distribution
- economocracy
- cycle of money
- regulatory policy

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Introduction

The key ideas behind economocracy introduced by Constantinos Challoumis promote a system where it is possible to reconcile economic reforms with democratic ideals. An economy and a democracy should be able to coexist peacefully

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without one intruding into the other's sphere of influence; hence the call for an economocracy. The aim is to ensure that there is harmony between democracy and economy so that the latter does not infringe on individual rights to interact politically or socially. By emphasising localised economic stability and minimising dependence on temporary fiscal measures, democracies advocate economocratic models which would represent more sustainable and equitable economies. The framework suggests that incorporating economocracy into already established democratic models can tackle the global debt crisis very effectively through offering long-lasting solutions instead of short-term remedies. Transitioning towards an economocratic setting will mark a movement towards an even more egalitarian kind of economy incorporating both democratic governance and economic stability. Economocracy, as stated, calls for economic changes with democratic tenets so as to have a reduction in world debts and instability in societies. Thus, an Economic Productive Reset (EPR) is urgently needed, enabling states or nations to redistribute resources and reduce global debts in proportion to their Gross Domestic Products (GDP). It is through this scheme that, instead of increasing inflation or altering currency prices, economic steadiness can enable debt payment by replacing high debt with high inflation (which does not make sense). Additionally, providing regular injections of capital into the education and health sectors may be made possible by means of Economic Periodic Injections (EPI). These targeted reinforcements address particular economic concerns of different nations, especially the war- and calamity-stricken countries (Challoumis, 2024f, 2024g). Their primary objective has been to assist in further consolidating national economic stability, as well as social development, aligning directly with lifetime GDP consumption while requiring continuous development. Secondly, through EPIs assisted by EPRs, we make sure that all debts are repayable without compromising the societal obligations.

The money cycle, also known as the money flow or production-consumption-return path, involves a continuous flow of money from income sources to productive activities and then to consumption. Its main objective is to determine efficiency in terms of growth, stability and productivity. It also serves as a measure of economic performance concerning the GDP and savings patterns. When money circulates steadily in the local economy, it positively impacts GDP and promotes growth. Conversely, interruptions like "escape savings" reduce opportunities for development, leading to stagnation. This research focuses on savings capacities and economic activities that contribute to economic stability, especially relevant amid rising unemployment and inflation challenges globally (Challoumis, 2022b, 2024a, 2024d, 2024g, 2024i). One unique thing about economocracy is that it reduces public debt. By focusing on the efficient management of saving and investing preferably in local economies, economocracy is capable of generating enough economic activities to finance public services and thus limit the reliance on ex-

ternal borrowing. This stands in contrast with the conventional capitalist model which often depends on borrowed-financed growth resulting in high levels of public indebtedness over time. Moreover, although its goal is to reduce inequality, there is no need for heavy government interference characteristic of many socialist countries, which often stifles innovation and economic freedom. Major sovereign states have very high debts that are threatening world economy (Gilpin & Gilpin, 2001; Richardson, 1964; Stiglitz, 2002; World Bank, 2003). The worsening social and economic conditions, with increasing fiscal burdens, risk prolonged global recessions and economic disarray. Low savings rates limit nations' ability to invest, contributing to prolonged austerity and disorganised international finance. Liquidity declines during economic crises, compounded by high debt repayment rates and cash flow constraints, leading to stagnation and reduced productivity (Boughton, 1994; Canh & Thanh, 2020; Engels, 1844).

1. Literature review

The modern-day world economy is mainly capitalist and faces tremendous challenges, such as rising global debts, ensuring economic stability and supporting democracy (Challoumis, 2024b). It has been noted that the traditional methods of employing temporary fiscal measures or adopting reactive economic policies are not enough to deal with the interconnectedness between economic deprivation and inequality. In fact, they have been said to deepen global debt crises, cause social unrests and undermine democracy by focusing more on short term solutions rather than those that lead to long lasting results (Challoumis, 2018a, 2019, 2021, 2022a, 2023a, 2023c, 2023d, 2023e, 2023f, 2023g, 2024c, 2024e, 2024h). Economocracy is an ideal solution to the problem since it advocates a modified economic environment where the economy is stable but democratically governed. Its goal is to bring forth a more balanced and fairer approach towards economic models. Nevertheless, transitioning into an economocratic framework demands an all-inclusive understanding regarding its effectiveness in addressing key issues like:

1. Global Debt Management: It is no secret that traditional capitalist systems have failed to effectively manage global debts, often using temporary methods which do not provide a long-term solution. The economocracy proposes EPR as a means of stabilising nations' economies via resource redistribution and debt repayment on par with each nation's GDP. What remains unresolved is how to measure EPR's effectiveness in alleviating global debt without triggering inflation or altering currency rates.

2. Achieving and maintaining economic stability is important to sustainable growth and social equity. The EPI mechanism is introduced by economocracy to provide regular capital payments for essential social structures such as education and healthcare. The question is how well EPIs can promote economic stability and serve the special needs of countries faced with crises.
3. Integration with Democratic Values: The goal of economocracy is to integrate economic reforms with democratic principles, ensuring that social and political rights are safeguarded through policy. The study should examine how such integration would be accomplished, and if it really manages to strike a balance between economic stability and democracy.
4. Implementation and Impact: Switching to an economocratic system as such calls for radical structural transformations. The problem under investigation pertains to EPR and EPI implementation, its bearings on the prevailing political and economic components, , and how they can contribute to creating a balanced economic model.

In this study, the main aim is to look at how economocracy may serve as a great alternative to usual economic systems through an in-depth examination of EPR and EPI. This will include evaluating their effectiveness in tackling issues of global indebtedness, stability of economies and integration into democratic values (Bergh, 2009; Bourdin & Nadou, 2018; Gilens & Page, 2014). The goal is to assess if it is possible for economocracy to alleviate present day economic challenges and also establish the practical ways through which it can be used so that sustainable and fair economic development can occur. It examines how savings enforcement, along with their escape mechanisms, interconnect within the monetary circle, providing a framework that can help to understand how different forms of saving can either make or break an economy (Challoumis, 2022b).

This is particularly true in modern economic challenges, where a thin line between domestic investment and capital flight makes the difference between how well- or badly-off an economy is. This research explores economocracy, a theoretical framework offering alternatives to traditional capitalist and socialist systems. Economocracy emphasises efficient money circulation for sustaining growth without relying on interventionist policies. The study focuses on optimising economic management through mathematical modelling, highlighting the impact of the money cycle on outcomes. Economocracy promotes economic stability by balancing enforcement and escape savings, ensuring local savings support reinvestment, and reducing speculative inflation risks. Unlike traditional capitalism, it maintains stability without aggressive monetary adjustments, keeping funds within local economies for continuous growth. It also encourages large companies to invest in local production, ensuring full use of resources and gradual, stable growth (Castro & Scartascini, 2019; Menguy, 2020; Tummers, 2019). This system contrasts with

those systems where outflow of escape savings takes place, which causes domestic investments to become weak, and slows down the rate of national economies. In achieving this, economocracy avoids capitalism-related expansions and contractions by letting all the currencies be directed to stay within itself.

2. Research methodology

Economocracy, is an economic system that has been developed by Constantinos Challoumis. The current concept is a new way of managing and governing economies. It aims at dealing with current problems in economy and society, such as public debt or social inequity, through new theories and practices in economics (Challoumis, 2019, 2020a, 2020b). This paper will analyse economocracy, comparing its principles to those of capitalism and socialism, while exploring its potential for implementation and the challenges it faces. The mathematics behind money cycle theory:

$$c_y = c_m - c_\alpha \tag{1}$$

$$c_y = \frac{dx_m}{dm} - \frac{dx_m}{da} \tag{2}$$

$$i_{cy} = Y \cdot b_d \tag{3}$$

$$g_{cy\text{country}} = \frac{c_{y\text{country}}}{c_{y\text{average}} + c_{y\text{country}}} \quad \text{or} \quad \frac{i_{cy\text{country}}}{i_{cy\text{average}} + i_{cy\text{country's}}} \tag{4}$$

$$g_{cy\text{average}} = \frac{c_{y\text{average}}}{c_{y\text{average}} + c_{y\text{average}}} \quad \text{or} \quad \frac{i_{cy\text{average}}}{i_{cy\text{average}} + i_{cy\text{average}}} = 0.5 \tag{5}$$

$$c_{y\text{total}} = \sum_{i=1}^{n}\sum_{t=1}^{m} c_{yi,t} = \\ = \sum_{i=1}^{n}\sum_{t=1}^{m}\left[\frac{\partial(\text{GDP})}{\partial(S+I+\text{X})}d(S+I+\text{X}) - \frac{\partial(\text{GDP})}{\partial(S'+I'+\text{M})}d(S'+I'+M)\right]_{i,t} \tag{6}$$

The c_m is the velocity of financial liquidity, c_α is the velocity of escaped savings and c_y is the cycle of money. The i_{cy} is the index of the cycle of money, Y is the national income or GDP, and b_d is the bank deposits of the country. In addition, $g_{cy\text{country}}$ symbolizes the general index of c_y of the country, $i_{cy\text{country's}}$ or $c_{y\text{country's}}$ is the index of c_y of the country, and $i_{cy\text{average}}$ or $c_{y\text{average}}$ is the global index of i_{cy}. Concluding, $g_{cy\text{average}}$

is the general global index of c_y, and is obtained as a global constant. S is the savings, I is the investments and X is the exports. Then, S', is about the savings which are oriented to banks out of the country's economy, I', is about the investments which oriented to banks out of the country's economy, and M are the imports.

The relationship centers around the money cycle, demonstrating that surpluses and deficits at the international level will always balance, with $g_{cyaverage} = 0.5$. Therefore, because the money issued by banks is less than they expect to receive, due to interest it is impossible to return the full amount, creating public debts. Thus, only by introducing unproductive money can the structural problem of capitalism be corrected by replacing it with economocracy (Challoumis, 2022c, 2023b).

The mathematical background of economocracy:

L_0 – the initial amount of the loan created by the bank.

r – the interest rate of the loan.

t – the time period of the loan.

T – the total amount required to be reimbursed at the end of the time period t.

Calculation of the total amount to be reimbursed: The total amount to be repaid at the end of the time period is the original loan amount plus interest.

Analysis of the relationship between borrowing and repayment: To understand why debts are constantly increasing and cannot be fully repaid, we need to compare the initial amount of the loan with the total amount required to be repaid $T = L_0 \cdot (1 + r)^t$. The non-productive money of economocracy's equaliser is the equation $N = L_0 [(1 + r)^t - 1]$.

The representation of the equation that performs these treaties is the following:

$$E_{jk} = e \cdot (\widetilde{\mathrm{GDP}_j} + c_k) + i \cdot (\widetilde{\mathrm{GDP}_j} + s_j) \tag{7}$$

where $j = 1, \ldots, n$ and $k = 1, \ldots, n$.

The variable E_{jk} represents the amount of money or economic value allocated to country j in relation to country k. This is an equation that dictates how much a particular country j should receive in terms of financial aid or economic assistance when compared with another country k. The coefficient of e is a variable representing a factor that must be agreed upon by multiple countries in order to balance global economies. The coefficient of e likely determines the size of EPR needed for the global balance. This coefficient could be tied to international consensus or conditions. EPR is an economic policy response aimed at mitigating financial crises or ensuring global economic stability. The coefficient i denotes the value of EPI, which is used as a benchmark or agreed-upon value for measuring economic policies. This is a constant or agreed value used in policy decisions. The relationship between e and i suggests that i is a preferred metric when estimating EPIs, while e can be avoided in those cases unless the situation calls for a hybrid approach. The GDP represents the estimated value of GDP for country j. This term

highlights the importance of considering a country's estimated economic output in the allocation of funds or resources. The c_k represents the individual factors of some economies, such as credit rating or financial stability, which must be taken into account. These factors are economy-specific characteristics (like creditworthiness) that modify the calculation of the resources allocated to each country. The s_j represents the individual characteristics and requirements of country j, particularly related to sectors like health care. This could be a socio-economic factor representing each country's unique needs, such as healthcare, education or infrastructure, which must be factored into the economic balance equation. The n_1 represents the total number of countries involved in the sum. The n_2 represents additional assistance given to countries facing special economic circumstances. The condition $n_1 \geq n_2$ ensures that additional assistance is provided only to a subset of the total countries. For debts and EPR in cases of debt management, the magnitude of e should be used without the presence of i. This implies that during debt crises, the economic balancing process should focus on the coefficient e, rather than relying on a fixed policy indicator i. For EPIs and Estimations when estimating EPI, the constant i should be preferred, and the use of e (which is more variable) should be avoided. In cases where a hybrid mixture of both e and i is required, this could indicate a need for flexible policy responses, mixing both the agreed-upon values of i and the variable e based on the current economic conditions. In the case that the condition $e >> i$ holds, it indicates that the variable economic factor e has a much larger magnitude than the constant policy indicator i. This situation might arise during periods of economic instability or global crises, where a stronger intervention (represented by e) is necessary.

The aggregate value of stability in economocracy is determined by the following relationship:

$$E = \sum_{j=1}^{n_1} \sum_{k=1}^{n_2} E_{jk} \tag{8}$$

where $j = 1, \ldots, n_1$ and $k = 1, \ldots, n_2$.

This equation defines the quantity of money, E which is needed for international balance and serves at the same time the democratic and economocratic concerns. The function representing the economocracy impact, $\tilde{E}$ is given by the equation:

$$\tilde{E} = \widetilde{\mathrm{EPR}} + \widetilde{\mathrm{EPI}} + \sum_{j=1}^{n_1} \tilde{f}_j \tag{9}$$

Besides, in the process of defining the variables, the factor of $\tilde{f}_j$ construes the economic structures of each economy accordingly. Estimated $\widetilde{\mathrm{EPR}}$ and $\widetilde{\mathrm{EPI}}$ defined by the equations:

$$\widetilde{\mathrm{EPR}} = e \cdot (\widetilde{\mathrm{GDP}_j} + c_k) \tag{10}$$

$$\widetilde{\mathrm{EPI}} = i \cdot (\widetilde{\mathrm{GDP}_j} + s_j) \tag{11}$$

This section details the methodology used to analyse the effects of enforcement and escape savings on economic performance under economocracy. The analysis includes six key plots visualising the savings distribution, GDP impact and money cycle dynamics. The study assumes a hypothetical economy with a GDP of 1,000 units and total savings of 300 units (70% enforcement, 30% escape). Efficiency is modelled using two indices (both approximately 0.94) to represent savings efficiency and overall economic efficiency. The first bar chart shows savings distribution, while the second illustrates their impact on GDP. The pie chart highlights the ratio of enforcement to escape savings, emphasising their importance for growth. The 2D line chart shows GDP changes under different scenarios, and the 3D line chart provides a holistic view of the effects of savings on GDP. These plots demonstrate the impact of savings distribution on economic performance, supporting the money cycle theory.

The Q.E. method has been applied to establish initial estimates, followed by a computational procedure using generated-code data (Challoumis, 2018b, 2019, 2024b), to validate the theoretical background, ensuring a comprehensive analysis, as real data for the application of economocracy do not exist, unlike in capitalism.

3. Results

The analysis is based on hypothetical data to demonstrate how money operates according to the theory of Cycle of Money as well as an additional aspect of the economic system, where using real data would be possible to reduce debts in a hypothetical framework. Money cycle analysis provides insight into the functioning and stability of an economy. Hence, the author tries to reach an optimal balance between enforcement and escape savings in this work when evaluating their influence on general health. Indeed, it contributes to the general understanding of how these savings impact GDP and the economic structure as a whole. Typified by capital retained locally within the banking system, enforcement savings are critical to boost the economy. These savings contribute to investment in more domestic businesses and infrastructures, leading to increased economic activity and optimised productivity. On the other hand, escape savings, which involve siphoning capital out of the local economy, undermine economic stability through the reduction in circulation and effective use of the funds within the country. As it turned

out, these results imply a more resistant and self-sustained economy characterised by a higher velocity of money, working with the fullest possible use of resources, in the presence of stronger enforcement savings. This contrasts with escape savings, which lead to reduced activity and hence pose the risk of structural imbalances. It also underlines how the efficiency of the money cycle, reflected in indices close to the theoretical ideal value, contributes to overall economic stability and growth. In addition, the results underline the necessity of focused policy intervention in keeping the money cycle effective. The author sheds some light on how these different ways of savings work, comparing the effects of enforcement with those of escape savings on economic performance and stability. These are important insights in the context of informing policies aimed at economic resilience with the objective of fostering sustainable growth.

The graph (Figure 1) illustrates the division between enforcement and escape savings, highlighting their economic impact. According to the Cycle of Money theory, enforcement savings stay in the local economy, supporting businesses and investments, which strengthens economic stability through sustained spending and employment. A higher percentage of enforcement savings indicates a stronger local economy. In contrast, escape savings are diverted away, reducing capital availability and hindering growth. Figure 1 emphasises the importance of maximising enforcement savings for a healthy economy and highlights the negative

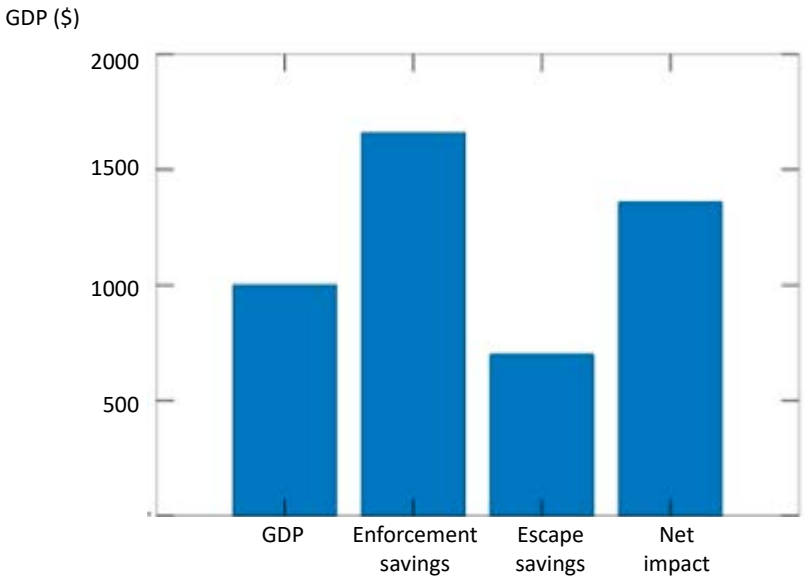

Figure 1. Enforcement vs escape savings

Source: author's own work, see Appendix A.

impact of high escape savings. It visually reinforces the emphasis put in the Cycle of Money theory on managing the balance between these savings to ensure economic stability and growth.

The graph (Figure 2) depicts the effect of enforcement and escape savings on GDP. It explains how escape savings improve GDP due to their interactions, which helps reinvest money within the economy. On the other hand, it explains how enforcement savings decrease GDP through siphoning money from the local economy. The net impact of GDP is a combination of the above-mentioned, as theoretically, enforcement savings enhance the economy while escape savings weaken it.

The pie chart (Figure 3) shows the balance between enforcement and escape savings, which, according to the Cycle of Money theory, determines economic health and efficiency. Enforcement savings remain in the local banking system, supporting domestic reinvestment, stimulating business activity and creating jobs. A higher proportion of enforcement savings indicates more capital available

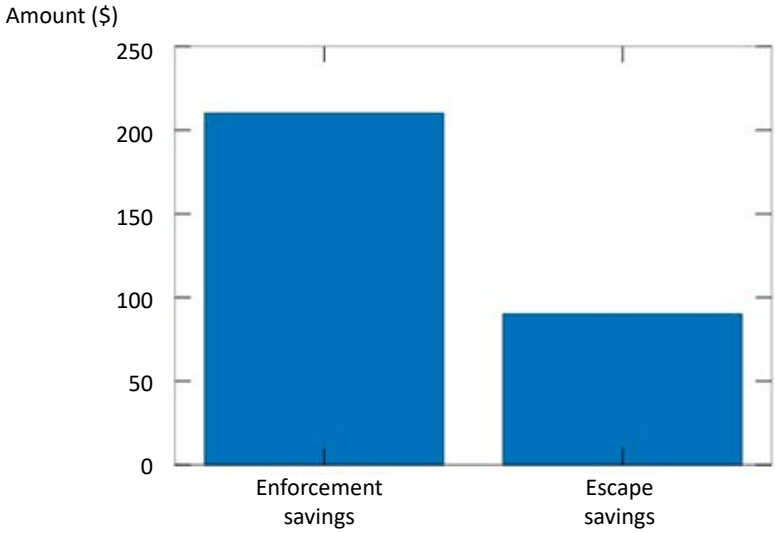

Figure 2. GDP impact

Source: author's own work, see Appendix A.

for local economic growth. In contrast, escape savings leave the local economy, reducing domestic investment and hindering growth, jobs and financial stability. The pie chart helps policymakers and economists assess the effectiveness of current economic policies. A high percentage of enforcement savings aligns with a strong, self-sustaining economic cycle, reflecting continuous capital circulation and reinvestment. Conversely, a larger share of escape savings highlights issues like capital flight or insufficient local investment incentives.

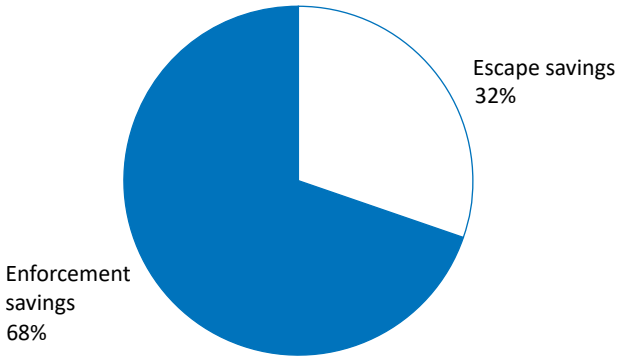

Figure 3. Savings ratios

Source: author's own work, see Appendix A.

Figure 4 presents the development of GDP influenced by enforcement and escape savings, illustrating the Cycle of Money theory. Initially, GDP reflects standard conditions. Reinvesting enforcement savings locally leads to a significant GDP increase by stimulating business activity and improving resource allocation. Conversely, escape savings reduce GDP by diverting funds from domestic investment, resulting in diminished growth. The net impact line balances these effects, emphasising that enforcement savings boost local activity while escape savings

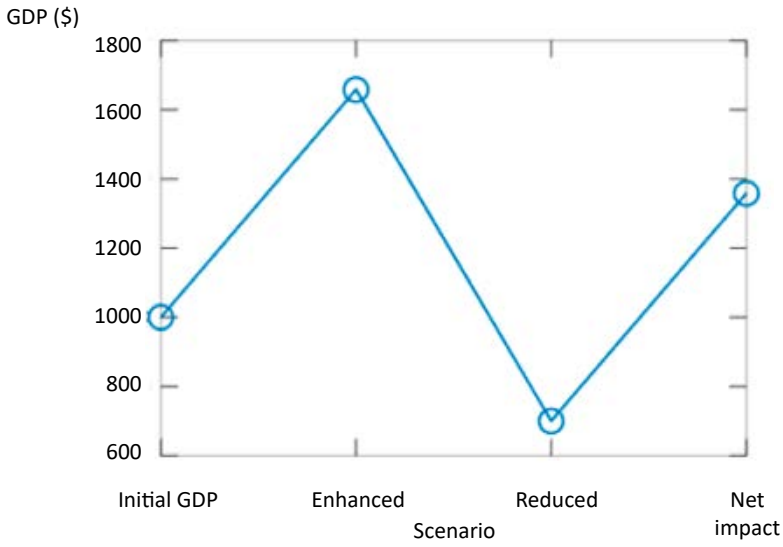

Figure 4. GDP impact (2D line plot)

Source: author's own work, see Appendix A.

hinder growth. This visualisation supports the importance of optimising saving strategies for economic stability and growth.

X-Axis – "Scenario" – categorises various scenarios analysed: Initial GDP, Enhanced by Enforcement Savings, Reduced by Escape Savings and Net Impact. Y-Axis – "Savings($)" – represents the dollar value of savings, whether enforcement or escape. Z-Axis – "GDP($)" – shows GDP in dollars, capturing the variation across scenarios based on savings type. The 3D plot illustrates the impact of enforcement and escape savings on GDP across different scenarios, supporting the theory that enforcement savings boost GDP, while escape savings reduce it. Figure 5 clearly demonstrates the interdependence between savings behaviour and economic outcomes, aligning with the theoretical focus on the money cycle. These visualisations make theoretical concepts more tangible by showing how enforcement savings enhance GDP, escape savings hinder growth and the money cycle's efficiency maintains economic health. Together, the theory and the figures provide a comprehensive view of the relationship between savings types, the money cycle and economic stability.

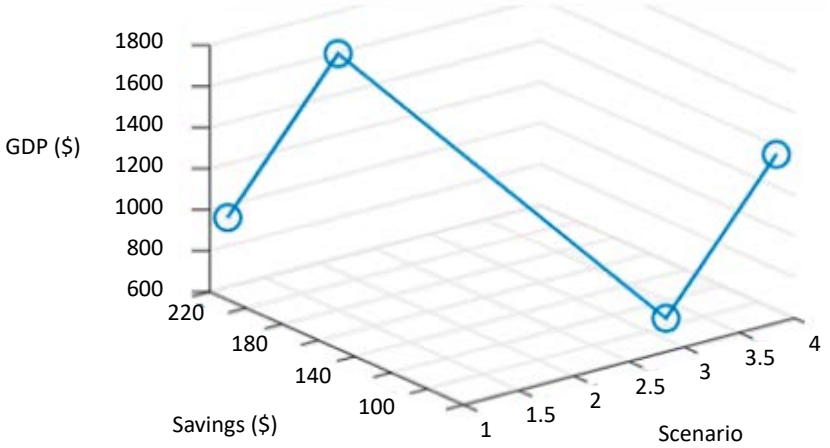

Figure 5. Savings and GDP impact (3D line plot)

Source: author's own work, see Appendix A.

Figure 6 shows a bar chart comparing the effects of economocracy on debt reduction across major economies. It displays the "Original Debt" and the "New Debt" under the economocracy model for each country. The results show significant debt reductions: the United States' debt falls from $20 trillion to $15 trillion (a 25% decrease), China's debt is halved from $10 trillion to $5 trillion, and Germany's debt decreases from $3 trillion to $2 trillion. The United Kingdom and France also see notable reductions, from $2.5 trillion to $1.8 trillion and $2.4 tril-

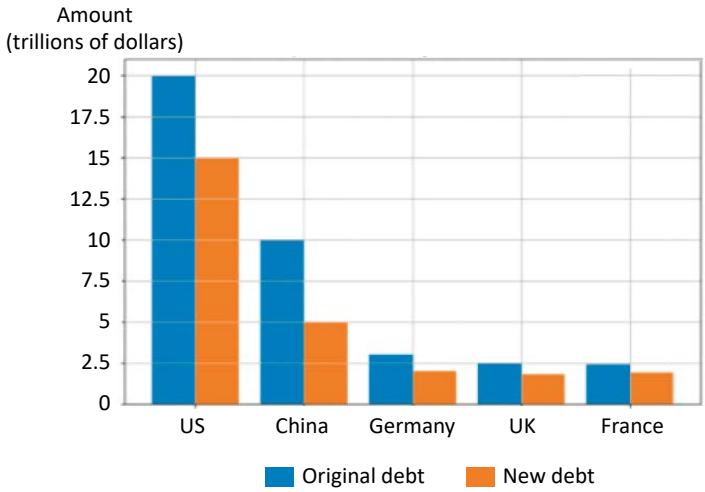

Figure 6. Impact of economocracy on debt reduction

Source: author's own work, see Appendix B.

lion to $1.9 trillion, respectively. These results highlight economocracy's potential to substantially reduce national debt, offering a solution to the global debt crisis. Debt reduction under economocracy could increase economic stability by freeing up fiscal space for investments in social programs and infrastructure. The chart supports the broader argument that adopting economocracy could address systemic issues within the current global economic system, promoting a more sustainable economic environment with manageable debt levels aligned to productive capacities.

Figure 7 illustrates trends in global GDP and debt from 2020 to 2024, showing a growing disparity between economic output and indebtedness. Global GDP increased from $83 trillion in 2020 to $95 trillion in 2024, reflecting gradual economic growth. In contrast, global debt rose from $90 trillion to $105 trillion, consistently outpacing GDP, highlighting a growing reliance on borrowing. By 2024, debt exceeds GDP by $10 trillion, underscoring a critical imbalance in the global economy. This growing debt burden suggests that the current economic framework is unsustainable.

Comparisons to similar studies, including those by Challoumis, strengthen the study's foundation. The Cycle of Money theory is linked to findings from Poland and Germany. Relationships between enforcement and escape savings are explored, demonstrating how enforcement savings boost GDP growth while escape savings hinder stability. Economocracy offers a sustainable debt reduction approach by emphasising efficient local capital flow (Challoumis, 2022b, 2024a, 2024g). Key elements include EPR for resource redistribution to repay debt and EPI for capital

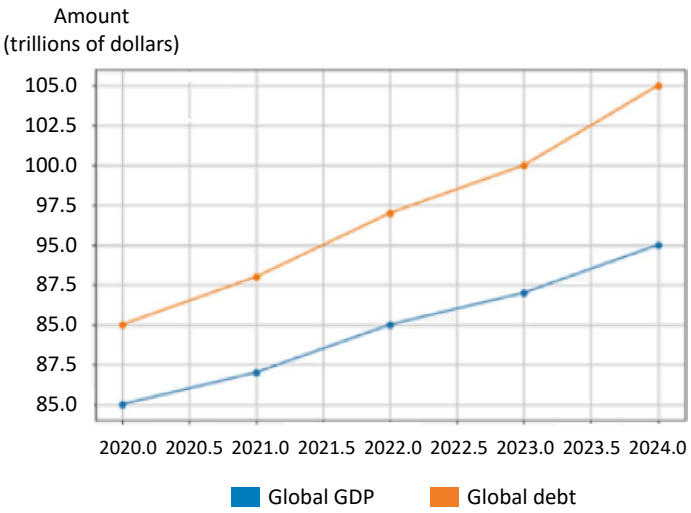

Figure 7. Track of global GDP and global debt

Source: author's own work, see Appendix C.

allocation to essential sectors. Unlike traditional capitalism, economocracy encourages local reinvestment, reducing reliance on external borrowing. For post-war recovery, economocracy focuses on rebuilding infrastructure and stimulating growth through targeted investments. EPR allocates resources to critical sectors, while EPI ensures ongoing capital flow. This fosters financial stability, reduces reliance on foreign aid and supports sustainable development (Challoumis, 2022b, 2024a, 2024g). For post-war recovery, economocracy focuses on rebuilding infrastructure and stimulating growth through targeted investments. EPR allocates resources to critical sectors, while EPI ensures ongoing capital flow.

4. Discussion

The findings regarding enforcement savings align with the principles which suggest that capital retention within local economies contributes to growth (Altman, 2008; Dollery & Worthington, 1996; Koethenbuerger, 2011; Lin et al., 2020; Rizzo & Throsby, 2006; Ruiz et al., 2017; Ud Din et al., 2016; Wilson & Gowdy, 2013). The reduction in public debt observed under economocracy's EPR mechanism is also consistent with Challoumis's analysis of the Cycle of Money in Poland, which highlights the importance of optimising the balance between enforcement and escape savings. Policymakers and financial institutions should develop mechanisms

to encourage enforcement savings, such as incentives for local investment like tax breaks for reinvestment. Financial technologies can further enhance the efficiency of the money cycle, building a resilient, self-sustaining economy. Policy recommendations include encouraging domestic investment, reducing capital flight, lowering corporate tax rates for businesses investing locally and tightening regulations to prevent tax dodging. Governments should provide incentives for local reinvestment to maximise enforcement savings and implement measures to limit escape savings. Practical examples of successful local savings retention strategies provide actionable guidance for stakeholders, supporting long-term economic stability.

Conclusions and implications

Analyses of the money cycle reveal the relationship between enforcement and escape savings and their impact on economic stability and growth. Enforcement savings, retained and reinvested locally, play a vital role in fostering a strong economy by boosting domestic investments and increasing overall economic activity. In contrast, escape savings reduce money circulation and undermine stability by limiting funds for local reinvestment. Policymakers should prioritise enforcement savings for economic stability and growth. Policies that encourage local reinvestment through favourable tax incentives and regulations can retain capital within domestic banks.

Economocracy provides a solution to global debt and the restructuring of war-affected countries through EPR and EPI. The EPR mechanism aims to reduce global debt by redistributing resources proportional to each nation's GDP, ensuring economic stability without causing inflation or currency devaluation. EPI focuses on providing regular capital injections into critical sectors such as education, healthcare and infrastructure, which are vital for the reconstruction and recovery of war-torn countries. By emphasising internal stability and sustainable resource allocation, economocracy promotes economic resilience and social development, offering an alternative path to manage global economic challenges effectively.

Further research on economocracy should focus on proving its viability and impact on global economic systems. First, empirical studies are needed to simulate and analyse the effects of the EPR and EPI mechanisms on different economies, including interactions with existing policies, potential for reducing global debt and impacts on inflation and currency stability. Second, research should explore the practical challenges of integrating economocracy with current political and economic systems, including necessary reforms to democratic institutions and potential conflicts with capitalist interests. Third, comparative studies between econo-

mies that have implemented elements of economocracy and those that have not could highlight its effectiveness in securing economic stability and social equity. This could involve case studies of transition economies and those in debt crises to assess real-world implications. On the theoretical front, further refinement of EPR and EPI concepts is needed to evaluate their long-term sustainability and adaptability, helping shape a robust framework for wider empirical testing and implementation.

Acknowledgements: I am grateful to the editor, the reviewers and, above all, the journal for their valuable feedback and continuous support during the review process. Their profound comments and suggestions have significantly improved this article.

Appendix A

The following code was developed in Octave specifically for the purposes of this paper:

```
% (C)(R) 2024 All Rights Reserved Constantinos Challoumis
% Set global figure and axes background to white
set(0, 'DefaultFigureColor', 'white');
set(0, 'DefaultAxesColor', 'white');

% Parameters
GDP = 1000; % Total GDP
total_savings = 300; % Total savings in the economy
enforcement_savings_ratio = 0.7; % Percentage of savings as
enforcement savings
escape_savings_ratio = 1 - enforcement_savings_ratio; % Percentage
of savings as escape savings

% Calculate enforcement and escape savings
enforcement_savings = total_savings * enforcement_savings_ratio;
escape_savings = total_savings * escape_savings_ratio;

% Money cycle indices (hypothetical values)
high_index_money_cycle = 0.94; % Efficiency of the money cycle for
enforcement savings
general_index_money_cycle = 0.94;

% Economic impact of enforcement vs escape savings
```

```
% Assuming enforcement savings contribute positively to GDP while
escape savings do not
GDP_enhanced_by_enforcement = GDP * (1 + high_index_money_cycle *
enforcement_savings_ratio);
GDP_reduced_by_escape = GDP * (1 - escape_savings_ratio);

% Net GDP after considering savings
net_GDP = GDP_enhanced_by_enforcement + GDP_reduced_by_escape -
GDP;

% Results
fprintf('Enforcement Savings: $%.2f\n', enforcement_savings);
fprintf('Escape Savings: $%.2f\n', escape_savings);
fprintf('GDP Enhanced by Enforcement Savings: $%.2f\n', GDP_
enhanced_by_enforcement);
fprintf('GDP Reduced by Escape Savings: $%.2f\n', GDP_reduced_by_
escape);
fprintf('Net GDP Impact: $%.2f\n', net_GDP);

% Plot 1: Enforcement vs Escape Savings (Bar Chart)
figure;
bar([enforcement_savings, escape_savings]);
title('Plot 1: Enforcement vs Escape Savings');
ylabel('Amount ($)');
set(gca, 'XTickLabel', {'Enforcement Savings', 'Escape Savings'});
set(gca, 'FontSize', 12);
disp('Displaying Plot 1: Enforcement vs Escape Savings');

% Pause and clear for the next plot
pause(2);
clf;

% Plot 2: GDP Impact (Bar Chart)
figure;
bar([GDP, GDP_enhanced_by_enforcement, GDP_reduced_by_escape, net_
GDP]);
title('Plot 2: GDP Impact');
ylabel('GDP ($)');
set(gca, 'XTick', 1:4, 'XTickLabel', {'GDP', 'Enforcement
Savings', 'Escape Savings', 'Net Impact'});
set(gca, 'FontSize', 12);
set(gca, 'XTickLabelRotation', 45);
set(gca, 'Position', [0.1, 0.2, 0.8, 0.7]);
xlim([0.5, 4.5]);
disp('Displaying Plot 2: GDP Impact');

% Pause and clear for the next plot
pause(2);
```

```
clf;

% Plot 3: Savings Ratios (Pie Chart)
figure;
pie([enforcement_savings_ratio, escape_savings_ratio],
{'Enforcement Savings', 'Escape Savings'});
title('Plot 3: Savings Ratios');
set(gca, 'FontSize', 12);
disp('Displaying Plot 3: Savings Ratios');

% Pause and clear for the next plot
pause(2);
clf;
% Plot 4: Money Cycle Indices (Bar Chart)
figure;
bar([high_index_money_cycle, general_index_money_cycle]);
title('Plot 4: Money Cycle Indices');
ylabel('Index Value');
set(gca, 'XTickLabel', {'High Index', 'General Index'});
set(gca, 'FontSize', 12);
disp('Displaying Plot 4: Money Cycle Indices');

% Pause and clear for the next plot
pause(2);
clf;

% Plot 5: 2D Line Plot for GDP Impact
figure;
x = [1, 2, 3, 4]; % x-axis points
y = [GDP, GDP_enhanced_by_enforcement, GDP_reduced_by_escape, net_
GDP]; % y-axis values
plot(x, y, '-o', 'LineWidth', 2); % 2D line plot
title('Plot 5: GDP Impact (2D Line Plot)');
xlabel('Scenario');
ylabel('GDP ($)');
set(gca, 'XTick', x, 'XTickLabel', {'Initial GDP', 'Enhanced',
'Reduced', 'Net Impact'});
set(gca, 'FontSize', 12);
disp('Displaying Plot 5: GDP Impact (2D Line Plot)');

% Pause and clear for the next plot
pause(2);
clf;

% Plot 6: 3D Line Plot for Savings and GDP Impact
figure;
z = [GDP, GDP_enhanced_by_enforcement, GDP_reduced_by_escape, net_
GDP];
```

```
plot3(x, [enforcement_savings, enforcement_savings, escape_
savings, escape_savings], z, '-o', 'LineWidth', 2);
title('Plot 6: Savings and GDP Impact (3D Line Plot)');
xlabel('Scenario');
ylabel('Savings ($)');
zlabel('GDP ($)');
grid on;
set(gca, 'FontSize', 12);
disp('Displaying Plot 6: Savings and GDP Impact (3D Line Plot)');
```

Appendix B

The following code was developed in Python:

```
# (C)(R) 2024 All Rights Reserved Constantinos Challoumis
import matplotlib.pyplot as plt
import pandas as pd

# Sample data
data = {
 'Country': ['US', 'China', 'Germany', 'UK', 'France'],
 'Original Debt': [20, 10, 3, 2.5, 2.4],
 'New Debt': [15, 5, 2, 1.8, 1.9]
}

df = pd.DataFrame(data)

# Plot
df.plot(x='Country', kind='bar', figsize=(10, 6), width=0.8)
plt.xlabel('Country')
plt.ylabel('Amount (Trillions of Dollars)')
plt.title('Impact of Economocracy on Debt Reduction')
plt.xticks(rotation=45)
plt.grid(True)
plt.show()
```

Appendix C

The following code developed in Python:

```
# (C)(R) 2024 All Rights Reserved Constantinos Challoumis
```

```
import matplotlib.pyplot as plt
import pandas as pd

# Sample data
data = {
 'Year': [2020, 2021, 2022, 2023, 2024],
 'Global GDP': [85, 87, 90, 92, 95],
 'Global Debt': [90, 93, 97, 100, 105]
}

df = pd.DataFrame(data)

# Plot
plt.figure(figsize=(10, 6))
plt.plot(df['Year'], df['Global GDP'], marker='o', label='Global
GDP')
plt.plot(df['Year'], df['Global Debt'], marker='o', label='Global
Debt')
plt.xlabel('Year')
plt.ylabel('Amount (Trillions of Dollars)')
plt.title('Track of Global GDP and Global Debt')
plt.legend()
plt.grid(True)
plt.show()
```

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