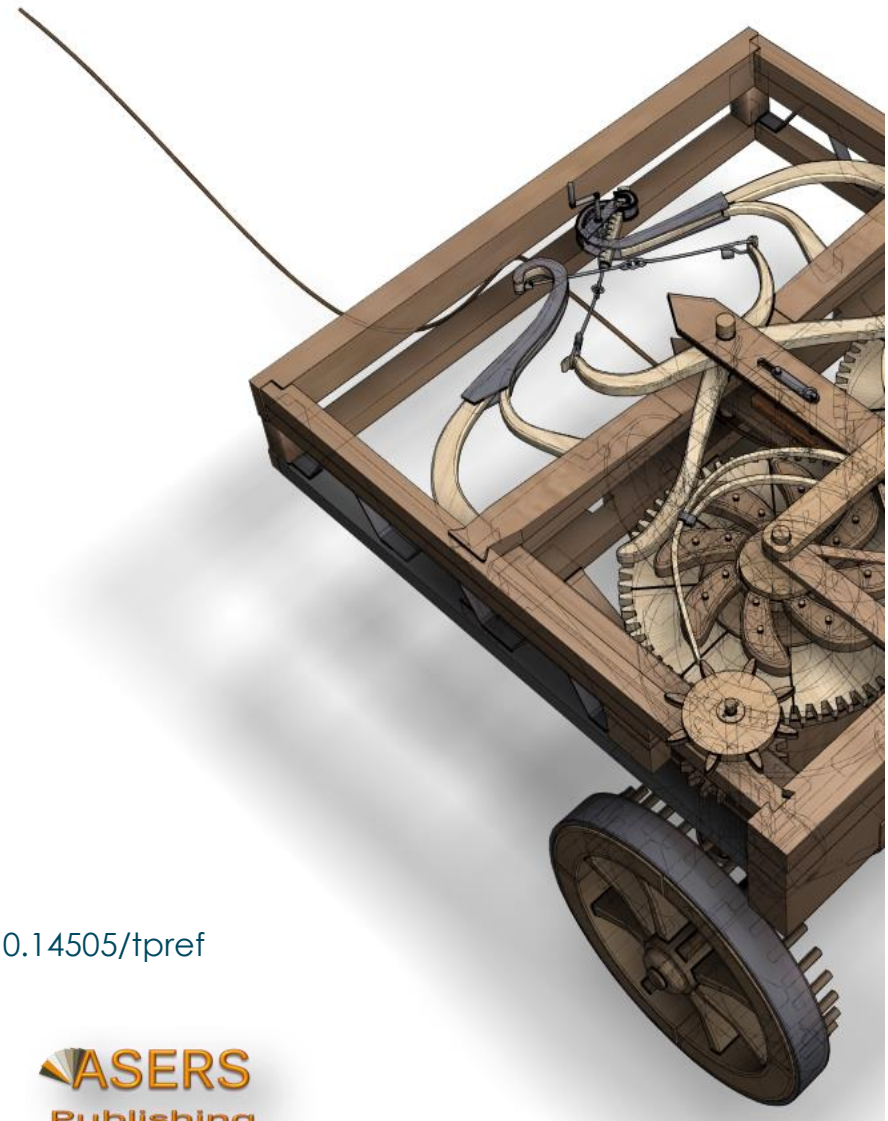
Theoretical and Practical Research in Economic Fields



Quarterly
Volume XV
Issue 4(32)
Winter 2024

ISSN: 2068 – 7710
Journal DOI: https://doi.org/10.14505/tpref

ASERS
Publishing

Volume XV
Issue 4(32)
Fall 2024

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ASERS Publishing
ISSN 2068 – 7710
Journal's Issue DOI:
https://doi.org/10.14505/tpref.v15.3(31).00

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ISSN 2068 – 7710
Journal's Issue DOI:
https://doi.org/10.14505/tpref.v15.3(31).00

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DOI: https://doi.org/10.14505/tpref.v15.4(32).01

Trends and Prospects of Financial System Development in the Context of Digitalization

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Article info: Received 23 August 2024; Received in revised form 17 September 2024; Accepted for publication 30 October 2024; Published 30 December 2024. Copyright© 2023 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: Due to the intensive development of technologies worldwide in the previous years, the issue of the digitalization of the financial and banking sectors is an interesting area for research, as these industries see almost immediate implementation of modern technologies. The purpose of this study is to find out the current trends in the development of the national digital market and identify its priority areas in the future. Using a combined application of multiple scientific methods, the existing financial technology toolkit was examined. As a result of the work, the positive dynamics of the share of electronic sales exceeding 20% of global volumes in 2022 was revealed, the structure of foreign direct investment in the budget of the Kyrgyz Republic was determined, where 20% is occupied by foreign investments in fintech, as well as the constant growth in the period from 2017 to 2023 of such indicators of digital economy development as the number of Internet users and social media users was noted. The Digital Code of the Kyrgyz Republic with its concept of universal codification was considered as a legislative basis for regulating digital processes. Such system-forming phenomena of the modern virtual financial system as cryptographically protected blockchain, cryptocurrencies and non-mutually exchangeable tokens were also studied. Based on the obtained data, the concept of regional leadership of the Kyrgyz Republic in creating an educational cluster was formulated, which may be of interest to the relevant ministries of the country.

Keywords: fintech; digitalization; electronic banking; blockchain; cryptocurrencies; cybersecurity.

JEL Classification: F63; K24; O33.

Introduction

Numerous sectors of society have been profoundly altered by the rapid advancement of digital technologies, with the financial system being one of the most significantly affected. In the past decade, the global financial landscape has been significantly impacted by innovations such as cryptocurrencies, electronic digital signatures, contactless payments, blockchain technology, and tokens. These digital transformations are not merely technological advancements; they are a fundamental shift in the manner in which financial transactions are conducted, providing enhanced security, efficiency, and transparency. To remain competitive in the global economic order, the Kyrgyz Republic (KR) is, like numerous other nations, actively investigating methods to incorporate these digital innovations into its financial system.

The digitalisation of the national economy is acknowledged as a critical factor in the advancement of post-industrial societies. This transformation is especially significant in the context of Kyrgyzstan, as it has the potential to reduce corruption, increase financial inclusion, and lower transaction costs. Nevertheless, the journey to complete digitalisation is replete with obstacles, such as the digital divide between urban and rural populations, the necessity of robust cybersecurity measures, and the necessity of regulatory frameworks that can keep up with technological advancements (Zelisko *et al.* 2024; Oklander *et al.* 2024). The objective of this investigation is to offer a thorough examination of the present trends in the digitalisation of the Kyrgyz financial system, identify the primary obstacles, and suggest strategies for surmounting these impediments to guarantee sustainable growth and development.

This research aims to contribute to the existing body of knowledge and offer practical recommendations for policymakers, financial institutions, and other stakeholders in Kyrgyzstan by comprehending the dynamics of digitalisation and its impact on the financial sector. The results of this study can assist in the direction of the nation's endeavours to capitalise on digital technologies to improve the well-being of its citizens, promote innovation, and increase its economic competitiveness.

1. Literature Review

N. Temirov *et al.* (2023) stressed that the digitalization of the national economy, which implies the replacement of outdated principles of financial transactions, is the key direction of development of post-industrial society. Transparency of transactions, inherent in innovative principles of calculation, is a defence against all kinds of corruption schemes and a guarantor of reducing transaction costs. In their work, the authors considered the synergistic effect arising in the process of digitalization of the financial structure of Kyrgyzstan, proved the necessity of prompt transfer of commercial enterprises to the state accounting system and named the introduction of unified identification principles and unified electronic payments among the priorities.

S.R. Semenov *et al.* (2024) also devoted their work to the readiness of the KR to the challenges of modernization of the financial sector. In particular, the “Action Plan of the Cabinet of Ministers of the Kyrgyz Republic to implement the National Development Programme of the Kyrgyz Republic until 2026” (2021) was studied in detail, and with the help of statistical analysis of time series individual categories of industries were considered and actual trends in the implementation of the Programme were determined. In the process of work, it was noted the presence of positive dynamics in the development of the investment sector, designed to attract additional development funds to the country’s economy. At the same time, the authors pointed the need for a more thorough elaboration of mechanisms to respond to crisis phenomena.

Among the negative factors, experts include the so-called digital divide – inequality in access to modern digital technologies (Makhazhanova *et al.* 2022). K.D. Ismailova *et al.* (2023) studied the positions of the KR in such international rankings as the Global Cybersecurity Index, the E-Government Development Index, and the level of e-commerce and were convinced that the country has significant potential in this direction. In particular, there is still a noticeable imbalance between the digital financial literacy of users from the largest cities of Kyrgyzstan – Bishkek, and Osh – and residents of the provinces. The importance of innovations in the financial sector is so important that the international community has even created a separate term – fintech – denoting modern technologies applied in the industry (Shveda *et al.* 2024). As noted by A. Risman *et al.* (2021), it is fintech that plays the most important role in the availability of financial services, thus bi-directional, synergistic effect – the development of national economies and the growth of well-being of individual households and citizens.

Digital banking, which has become the epitome of new financial technologies for most people, is an important media factor in the economy (Ismayil-Zada, 2023). A multivariate factor analysis of consumer reactions using the UK as a case study was conducted by C.I. Mbama and P.O. Ezepue (2018). They found that respondents ranked functionality, the ability to receive prompt advice, and the perceived value of the product among the most important factors of digital banking. In addition to banking apps for the public, digital money has

come to play an important role in today's financial sector (Kyrychok *et al.* 2023; Niyazbekova *et al.* 2023). These cryptocurrencies, usually created by private entities, have fundamentally overturned traditional views not only on how to calculate but also how to earn money. T. Adrian and T. Mancini-Griffoli (2021), comparing some cryptocurrencies with their more traditional counterparts, have shown that despite the significant risks of holding intangible money, digital funds are winning the competition due to their mobility and relative anonymity.

M. Javaid *et al.* (2022) investigated another digital attribute of the new financial system – blockchain technology. Algorithms based on blockchain principles provide faster and more reliable operations, but, at the same time, exclude any changes in the already formed data blocks. As a consequence, the authors describe the security of credit reporting as an important advantage of blockchain technology compared to traditional digital methods of storing data on servers. Integration of innovative technological solutions into the state banking system is also important (Nurgaliyeva *et al.* 2014). R. Auer and R. Boehme (2021), after calculating the financial and administrative requirements for such an invasive design, proved that the best prospects are for digital money operating as a hybrid currency of a central public bank, but with the possibility of direct requests from private companies. Ideally, such a digital currency should be attractive as a universal medium of exchange, but not functional as a means of accumulation (Kyrychok *et al.* 2020). The further development of fintech and banking will inevitably involve digital innovation. Perhaps, as predicted by D. Broby (2021), an increasing role in the finance market will be played by the desire to attract new customers, or perhaps, as assessed by M. Sharma *et al.* (2022), there will be a merger of payment platforms with social networks.

Despite the extensive research conducted on the digitalisation of the financial sector and its impact on national economies, there is a substantial gap in the literature regarding the specific challenges and opportunities encountered by developing countries such as Kyrgyzstan. There is a lack of a comprehensive analysis of the unique context of Kyrgyzstan, including its digital divide and the specific mechanisms required to address crisis phenomena, even though existing studies emphasise the importance of digital transformation and the necessity of robust regulatory frameworks. Furthermore, even though the digital divide and fintech's potential have been addressed, there are no practical recommendations that are specifically designed for the Kyrgyz context. The objective of this study is to address these deficiencies by conducting a comprehensive examination of the current trends in the digitalisation of the Kyrgyz financial system, identifying the primary obstacles, and suggesting strategies for surmounting them to guarantee sustainable growth and development

2. Materials and Methods

In the process of conducting this study, various trends in the development of digital innovations in the financial system as a whole and in the banking sector of the KR were considered. In order to understand the dynamics of the process of attracting foreign capital for the purpose of innovation development, as well as the structure of foreign direct investment (FDI), the method of statistical economic analysis was applied. Next, trends were identified and compared using the current data with the indicators of previous periods. Such key indicators of digitalization of the Kyrgyz economy as the number of Internet and social network users, the volume of cellular mobile connections was analysed in the dynamics of 2017-2023, and the number of ATMs and point of sale (POS) terminals were displayed in the form of line graphs.

A generalised and comprehensive picture of the future of digital transformation in Kyrgyzstan, including the modernisation of existing facilities, the transition of the majority of banking operations online, and the popularisation of online banking among all categories of the population, was developed through the method of theoretical synthesis, utilising scattered data from professional financial publications, expert opinions, and other open sources. Among the materials used in this study, in addition to those already mentioned, were data from the National Statistical Committee of the Kyrgyz Republic (2023) on the dynamics of attracting foreign capital to the Kyrgyz Republic and their application, "Centralized data bank of legal information of the Kyrgyz Republic" (2024), "Digital 2023: Global overview report" by S. Kemp (2023a), on the number of Internet users and original mobile numbers, as well as statistics "Country data on inclusive digital financial services: Kyrgyz Republic" (2023) from the World Bank.

In the course of the work, the authors also identified the challenges faced by public and private financial structures in the process of digital transformation of the industry – risks of data loss, hacker attacks by intruders, fraud, and loss of remote access due to technical failures. As part of determining the most likely prospects for the development of digital finance and ways to achieve the set goals, a contextual analysis of the current status of regulation of relations between market players was conducted, and the presence of excessive legal barriers to further development of digitalization. The potential for the development of the most widespread and promising cryptocurrencies, tools based on blockchain technology and unique cryptographic tokens non-fungible token

(NFT) in the KR was also assessed. In addition, using the extrapolation method, the conditions for the full-fledged inclusion of fintech in Kyrgyzstan in the global movement of digital capital were predicted on the basis of the obtained and processed data, existing trends and expert opinions. At the same time, the key principles of preserving the financial sovereignty of the state were formulated, as well as the conditions for increasing the attractiveness of the Kyrgyz Republic from the point of view of potential external investors.

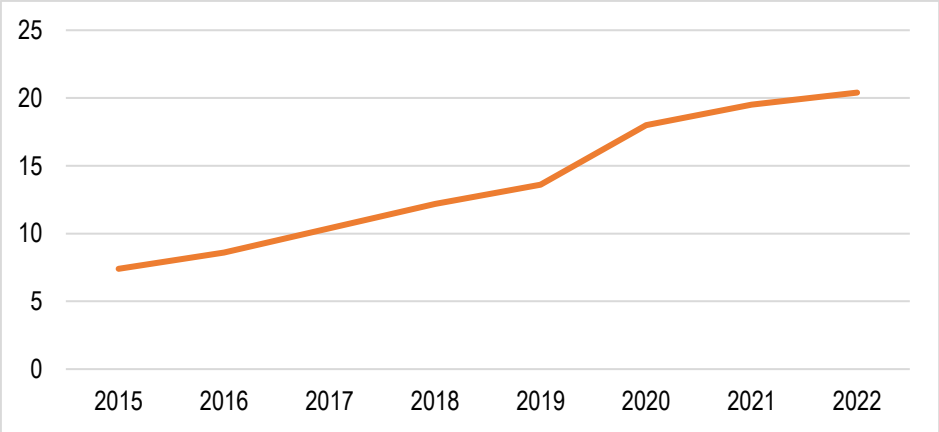
3. Research Results

The total digitalization of the world in previous years has become avalanche-like and irreversible. Of the world's 8 billion people in 2023, 5.2 billion are internet users and 5.44 billion own mobile phones. In addition, 60% of the world's population are social media users. This digital revolution has significantly impacted various sectors, including the financial system, which is a cornerstone of the global economy. Shopping online, transferring money between cardholders, paying for services – all this is becoming a convenient daily routine.

Datareportal's annual report "Digital 2023: Kyrgyzstan" by S. Kemp (2023b) demonstrates that the Kyrgyz Republic has been diligently adhering to these global digitalisation trends. The number of internet users in the country increased from 2.08 million to 5.2 million during this period, while the count of original mobile numbers increased from 7.5 million to 10.8 million. Additionally, the number of regular social media users climbed from 0.6 million to 2.75 million, resulting in an almost five-fold increase. It is important to note that a significant portion of this expansion was fuelled by individuals under the age of 25.

The transition to online financial transactions was significantly accelerated by the COVID-19 pandemic and the subsequent quarantine measures. The level of online purchases increased by 77% during the initial months of the quarantine, as per J. Koetsier (2021). This rapid expansion propelled e-commerce to levels that experts had anticipated would require 4-6 years to achieve. In 2020, numerous individuals discovered the convenience of online payments and continued to utilise them even after the quarantine restrictions were lifted, as they were unable to conduct financial transactions in traditional ways due to the pandemic. More detailed statistics are shown in Figure 1.

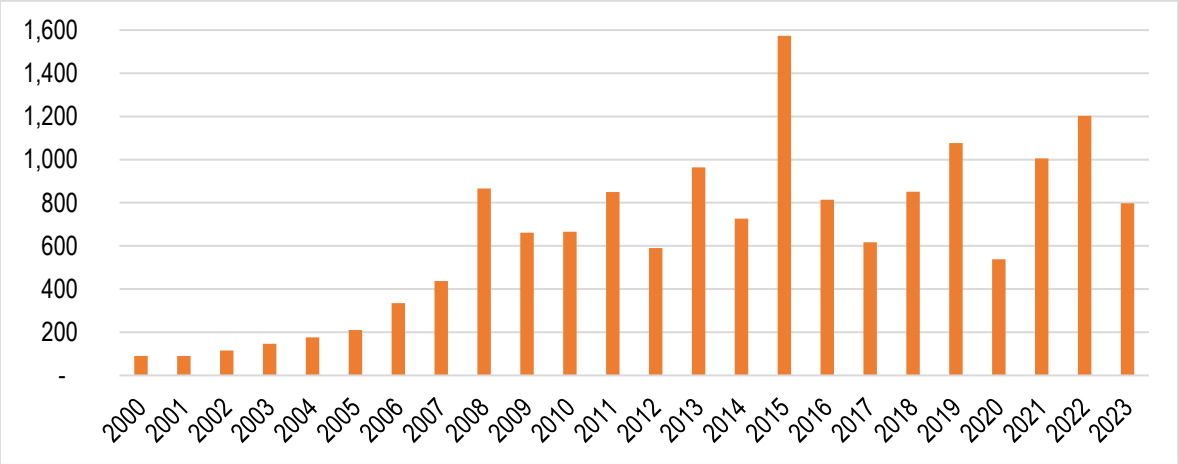
Figure 1. Share of e-commerce in global retail sales, %



Source: compiled by the authors based on "Impact of COVID pandemic on ecommerce" (2022).

The pandemic has resulted in a significant increase in the share of online sales, as illustrated in Figure 1. Despite the relaxation of restrictions, there has been no significant return to pre-pandemic levels. External investments are required as a result of the integration of contemporary technologies into the national financial systems of developing countries. Figure 2 illustrates the dynamics of the Kyrgyz Republic's attraction to foreign capital.

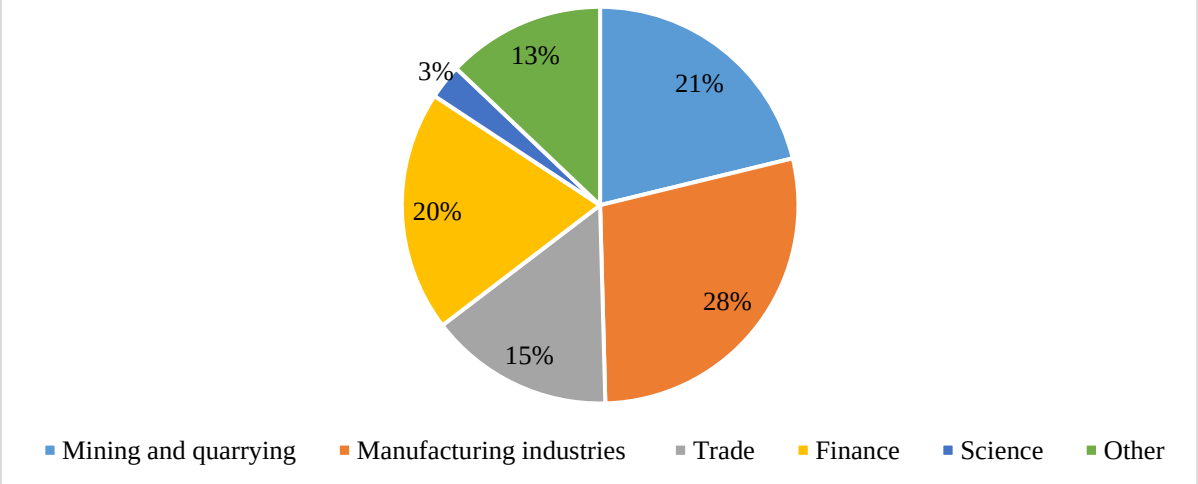
Figure 2. Volumes of foreign direct investment inflows to the budget of the Kyrgyz Republic, million USD



Source: compiled by the authors based on the National Statistical Committee of the Kyrgyz Republic (2023).

The volume of FDI fluctuates annually without a discernible trend, as demonstrated. The formation of concrete plans for the utilisation and reinvestment of foreign capital in innovative projects within the country is impeded by the unpredictability of foreign capital inflows. Furthermore, the average rate of foreign investment over the past decade and a half has remained relatively stagnant, except for a few blips in 2015 and 2020. This is unfavourable for a developing economy. It is imperative to not only analyse the volume of foreign investment but also its structure to conduct a thorough examination of the FDI situation in Kyrgyzstan. Figure 3 illustrates the sectors that are particularly attractive to foreign investors.

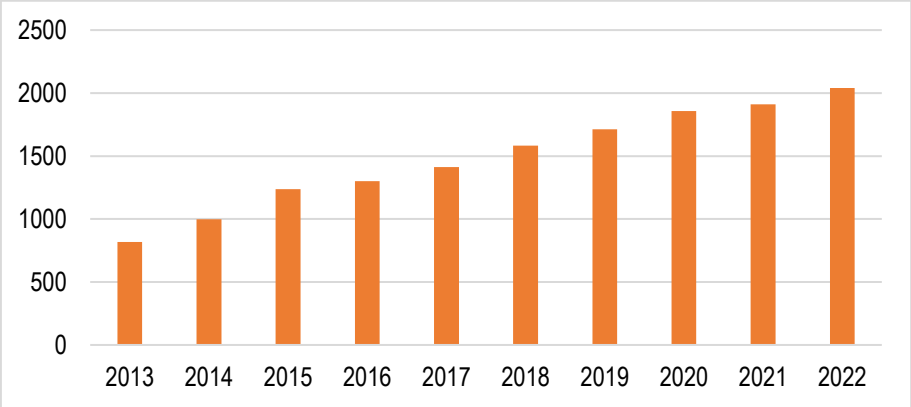
Figure 3. Structure of FDI inflows in 2023



Source: compiled by the authors based on the National Statistical Committee of the Kyrgyz Republic (2023).

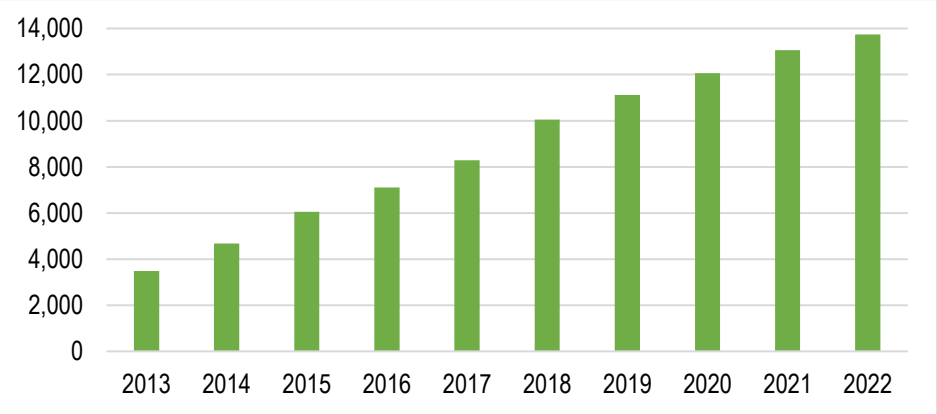
In addition to mining and manufacturing, the financial sector of Kyrgyzstan is among the top three priority areas for foreign investment. The volume of foreign investments in this sector totalled more than 150 million USD in 2023, which emphasizes the understanding of the importance of the prospects of the country's financial market by foreign investors. As for various indicators of financial market development at the level of ordinary consumers, the progress is more tangible. The dynamics of the number of ATMs, POS-terminals and the volume of plastic cards in the Kyrgyz Republic for the previous ten years are presented on Figures 4-6. For all ten years there is a constant, almost linear growth, which indicates the expansion of the country's banking system and the popularization of non-cash transactions.

Figure 4. Number of ATMs by year



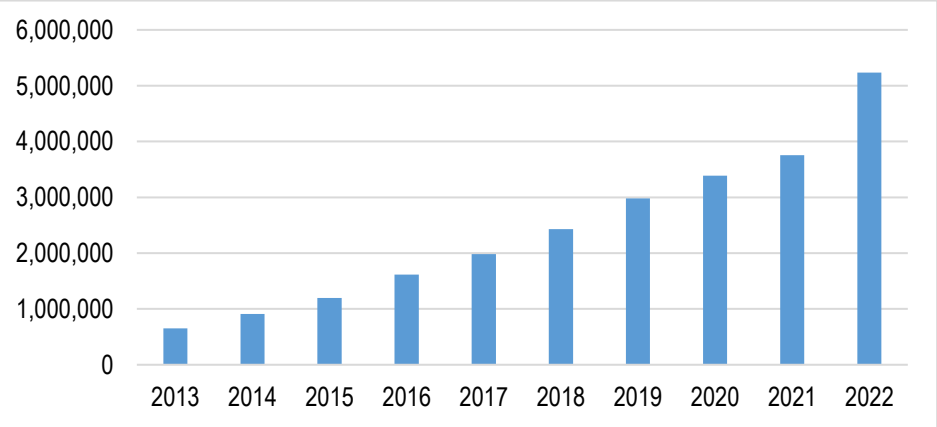
Source: compiled by the authors based on National Statistical Committee of the Kyrgyz Republic (2024).

Figure 5. Number of POS terminals by year



Source: compiled by the authors based on National Statistical Committee of the Kyrgyz Republic (2024).

Figure 6. Number of active bank cards by year



Source: compiled by the authors based on National Statistical Committee of the Kyrgyz Republic (2024).

The number of active bank cards held by the population is another indicator of the digitalisation of monetary settlements in the country, similar to the growth in ATMs and POS terminals. The financial sector's selected development vector is positively reflected in this trend. In addition, Kyrgyzstan's inclusive digital financial services are becoming increasingly popular and accessible each year, as indicated by a special World Bank study titled “Country data on inclusive digital financial services: Kyrgyz Republic” (2023). In 2011, only 4% of the adult population had their own bank account. This figure increased to 40% by 2017, and by 2021, nearly half of all adult citizens had their own financial accounts. In 2014, 15% of Kyrgyz citizens utilised this transaction type; this figure increased to 36% in 2017, and by 2021, 39% of Kyrgyz citizens were regularly conducting digital transactions. Additionally, digital payments have demonstrated substantial advancements. Furthermore, the ratio of households

that pay utility bills online - 5% in 2014 and 15% in 2021 - and the percentage of citizens who receive their salaries in non-cash form to a personal account (25% in 2014 vs. 40% in 2021) are additional factors that contribute to the digitalisation of the financial sector. Kyrgyzstan's financial sector is continuing to undergo a digital transformation, as evidenced by these trends.

Due to trends in the development of digital technologies and the increasing involvement of Kyrgyz citizens in virtual financial innovations, legislative regulation of these processes is required. The concept of the Digital Code of the Kyrgyz Republic (2023) is designed to formulate the basic rules for working with digital innovations in the Kyrgyz Republic and to prevent fraud or speculation on the part of unscrupulous users. The Digital Code of the Kyrgyz Republic, once finalized and approved by J. Kenesh, should become a generalized document that unambiguously declares the system of state governance in the fintech industry and provides a uniform interpretation of the rules of interaction in the digital sphere, as well as the specifics of its regulation. In the process of a comprehensive study of the KR legislation and existing positive global practices, a draft was formulated that includes the principles of digital environment management, systematization of existing terminology and regulations for the digital economy. The creation of such a codified framework is intended to solve a number of urgent tasks – to identify and eliminate existing contradictions; to eliminate unnecessary barriers caused by the obsolescence of some legislative norms; to ensure fair arbitration on the part of the state according to previously known and transparent rules; to ensure responsible behaviour and fair communications on the part of all subjects of the digital economy.

The universal codification proposed in the draft Digital Code of the Kyrgyz Republic (2023) provides an opportunity to use an ecosystem approach to resolving possible conflicts and contradictions – that is, not in relation to individual situations and cases, but in relation to all elements of technological ecosystems at once. Thus, the document is a kind of “digital constitution” declaring the basic principles and rules of interaction in the digital environment and serving as a reference point for the rest of the economy and jurisprudence. Consequently, similar to constitutional law, “virtual law” should include two essential components – the basic principles of interaction between subjects in the digital environment and the rules of formation of objects within the rules of digital governance. Based on existing practices, such “digital management”, in turn, should regulate digital resources (websites, applications), digital services, digital networks and digital logistics. The introduction of such a Code would help to reboot the entire legislative system in the field of digital technologies and eliminate the need for numerous adjustments and amendments to existing regulations. While the Digital Code of the Kyrgyz Republic (2023) has not yet been approved, the Law of the Kyrgyz Republic No. 12 “On virtual assets” (2022) plays an important role in the work with digital finance. At this stage, it is the Law of the Kyrgyz Republic No. 12 “On virtual assets” (2022) that is intended to regulate the circulation of virtual finance, the rules for its issuance, storage, sale, and purchase in the context of the digital economy of the Kyrgyz Republic. According to this Law, such important concepts as blockchain, cryptographic signature, virtual asset, crypto-wallet are legally enshrined in the Kyrgyz Republic.

In the context of modern fintech realities, the initiatives of the Kyrgyz authorities to ensure the security of digital capital deserve special attention. According to the legislation of the Kyrgyz Republic, the activities of virtual asset service providers are classified as licensed activities and are under constant control of the state regulator (Kaparbekov *et al.* 2024). This regulatory attention to the digital economy is primarily due to security concerns. The shift of many transactions to the digital dimension has opened up vast opportunities for speculation, data theft and other fraudulent activities. According to a number of studies and expert surveys of banking executives, the most vulnerable point of any security system is the human factor. Lack of digital literacy among staff or simple negligence of employees causes almost 80% of information security problems (Abdullayev *et al.* 2024). Among the most common mistakes are disclosing the configuration of internal systems to outsiders, following phishing links, passing passwords to unfamiliar people, opening files received from unknown addresses, and accessing service subsystems from personal unprotected gadgets.

Therefore, in order to improve the security of digital financial systems, employees of banks and other relevant institutions should undergo regular training courses, understand the existing risks and receive timely information about new threats. In addition, employees should be held accountable for breaches of their obligations to keep proprietary information confidential, and contracts stating such conditions should be in place for some time after the employee’s termination (Stender *et al.* 2024). To effectively confront the challenges faced by the financial sector in the modern world, all employees of the banking system should constantly monitor abnormal situations, pay attention to extraneous connections and non-standard actions of security systems. Also, in order to prevent the loss of or access to official data, it is necessary to regularly create insurance copies of documents, change passwords with a high level of protection, establish access to digital resources exclusively

through two-factor authentication, and categorically prevent the use of personal computing equipment for work purposes (Musayeva *et al.* 2022).

As the experience of developed countries suggests, the most effective system for protecting digital financial data is the creation of a modular data storage configuration (Kerimkhulle *et al.* 2023). In this case, the modules operate autonomously from each other and are protected from data spilled by firewalls. In this way, information entering module "A" is transferred to another module "B" for processing, and the results of this processing can no longer return to the original module out of order. Moreover, a third type of module, "C", which has no access to external digital communication channels at all, is used for long-term data storage. In order to qualitatively forecast the further development of digital financial processes in Kyrgyzstan in the coming years, it is necessary to pay attention to the current trends of developed countries in this area. Since, due to economic inertia, there is a backlash in technology imports, some technological lag helps the Kyrgyz Republic to see global innovation trends in advance and prepare for them.

According to the regular Digital 2023: Global overview report by S. Kemp (2023a) on the global development of blockchain technology, in 2023 the demand for cryptocurrencies has increased significantly, while NFT tokens have started to lose their position. The existing dynamics give every reason to assume that already in the foreseeable future, blockchain technology will become the basis for the next phase of digital transformation (Smutchak *et al*. 2023). According to the portal's statistics, despite the fact that the share of adult internet users who own at least one form of cryptocurrency has decreased by 3% in 2023, the overall capitalization of digital finance continues to grow steadily, and this decline will be easily recovered in the coming months. Supporting this hypothesis is the fact that within certain national economies, 2023 has shown an increase in the number of crypto wallet owners. Such countries include Turkey, Brazil, Australia and several other countries with quite strong economic positions (Khalegi *et al*. 2024).

If looking at these statistics in relation to individual households, the fact that the average volume of transactions with cryptocurrency is directly correlated with the level of salaries of the population – for example, the average trader in Turkey in 2022 invested 120 USD, in the United States – 635 USD, and a typical Swiss retail crypto investor spent about 1000 USD (Spytska, 2023). This fact supports the observation that at this stage, most crypto market operators do not consider digital currency as a full-fledged means of exchange and trade, but only as an investment asset. At the same time, the phenomenon of non-interchangeable NFT tokens in 2023 has almost completely exhausted itself and brought losses to its owners. According to the global online publication The Register "95% of NFTs are now totally worthless, say researchers" by B. Vigliarolo (2023), dedicated to technology, 95% of unique tokens as of the end of 2023 have zero value and the relevant services of the Kyrgyz Republic need to systematically convey such information to the population to avoid fraudulent actions.

Returning to the prospects for the development of the financial system of the Kyrgyz Republic in the context of digitalization, special attention should be paid to educating the younger generation on current economic trends – this should be done not on the basis of outdated training programmes, but using the experience of modern schools of digital economy. Since a key characteristic of innovative trends is the possibility of local concentration of markets practically from scratch, the unique trade advantages that Kyrgyzstan could use to secure its place in the new economic order should be developed separately. The authors pay special attention to the personnel issue – foreign volunteers with relevant qualifications will be sent to the regional innovation offices to form a strong educational base on site. Thanks to this initiative, rural youth in the Kyrgyz Republic will gain skills in digital financial innovation and ecological production based on advanced technologies. Achieving sustainable development goals in this case can be closely combined with the introduction of digital economy principles and digitalization of the financial system, which, as proven above, Kyrgyz society is steadily striving for. Moreover, with proper government support for the renewal of the higher education system, Kyrgyzstan could in the foreseeable future become a serious international training ground specializing in adapting the principles of the digital economy to the goals of sustainable development.

4. Discussions

The data obtained in the course of the research allow taking a comprehensive look at the trends and prospects for the development of the financial system in Kyrgyzstan in the context of digitalization. The specifics of the sphere under study are such that innovations and improvements of its individual components require constant updating and calibration with respect to global trends.

That is why it is crucial to study also the experience of the world scientific literature in the study of trends in the digital economy. For example, F. Kitsios *et al.* (2021) noted that digital transformation, illustrated in this paper by the example of Kyrgyzstan, is a continuous process that affects the world around us and literally redesigns

familiar concepts. By conducting a survey among 161 employees of Greek banks, the authors used multivariate regression analysis to compile statistics on the acceptance by financial sector employees of the new realities contributing to the transition to the new digital era. Characteristically, even among the direct actors of digital finance, there are still many people who are psychologically unprepared for the transformation (Makedon *et al.* 2020). The unprofessional behaviour of some employees of the financial sector was also noted in the course of this research. This aligns with the observations made in this study regarding the need for ongoing innovation and adaptation in the Kyrgyz financial sector.

L.T. Ha (2022), in his empirical study of the impact of digitalization on the financial sector, developed nine indicators to identify access to and efficiency of modern financial markets. The importance of digital transformation in the education and healthcare sectors was argued, stressing that it is in the public sector that digitalization is essential for the national financial market to enter the foreign economic arena (Trusova *et al.* 2021). The importance of the regulatory function of the state was also noted in this paper. The author has also demonstrated through modelling that digital commerce has a long-term positive impact on the activities of financial institutions. This study also underscores the significance of digital transformation in these sectors and the regulatory function of the state in ensuring the successful integration of digital technologies. É. Pintér *et al.* (2021) studied the impact of fintech on the behaviour of young people. As might be expected, it is this category that is the first to take the risk of using technical innovations and quickly learn digital finance skills at the household level – as this study has emphasized, and in Kyrgyzstan young people are the most active audience. Young people also demonstrate a higher willingness to take risks when it comes to digital investments (Makedon *et al.* 2022).

As it was proved in the process of this research, the most important trend in the development of digital finance is security. C. Calliess and A. Baumgarten (2020), who studied this issue on the example of the banking system of the European Union, analysed the advantages and disadvantages of existing integrated solutions. According to the authors, one of the problems lies on the legal plane and concerns the blurred boundaries of responsibility of individual departments. At the same time, there is a tendency to increase the participation of private companies in overall cybersecurity, which has a positive impact on the security of the financial system against modern threats (Quraish *et al.* 2024). It is important, however, that these private institutions work for the common good on a common basis, without preferential treatment from the state. S. Varga *et al.* (2021), studying risk management in the Swedish banking industry and comparing it with other national systems, found a fairly high level of staff training and readiness to deal with the latest fraudulent schemes. A survey of middle managers, conducted to identify the reasons for this progressive approach, revealed that an important feature of the Swedish cybersecurity structure is the constant exchange of information not only domestically, but also with foreign colleagues. This makes it possible to learn about certain cases of digital fraud in time and be prepared for their emergence in the national financial space – as it was proved above, the problem of virtual offences is relevant for the KR as well.

In the process of studying the digitalization of the Kyrgyz financial system and the challenges it faces; the expert community has noted the predominant influence of the human factor on various kinds of failures and problems. A.S. Villar and N. Khan (2021) devoted their work to the possibility of minimizing human influence on the banking system by maximizing its automation. The example of a European bank, to which the authors referred, demonstrated that writing software scripts for low margin transactions not only eliminates operator error, but also reduces the risk of malicious interventions. Characteristically, a similar study conducted by H.H. Hettiarachchige and N. Jahankhani (2021) in the same year in the UK, demonstrated the same advantage of replacing a bank employee with a software script in a number of cases. It was noted that the absence of human factor has a downside as well, as transactions do not undergo additional security in terms of critical thinking. The solution to this problem is the introduction of two-factor authentication, the need for the installation of which was also emphasized in this study.

E. Btoush *et al.* (2021) devoted their work to researching various fraudulent activities aimed at bank customers, created a list of recommendations for end users of banking services, and created a whole register of known criminal schemes aimed at swindling money from cardholders. Some of these fraudulent activities have been discussed in this paper. In continuation of the topic of digital banking, the growing popularity of which in the Kyrgyz Republic has been proved above, it is worth mentioning also the study of A. Geebren *et al.* (2021) who drew attention to the importance of customer trust in the financial sector. Having conducted a special survey among consumers of banking services and processed their results, the scientists proved that in most cases an average consumer will choose from several financial institutions the one that will be more trustworthy, even if the

material benefit from such cooperation will be less. This finding is quite important and should be considered when developing future communication strategy in the Kyrgyz Republic.

The blockchain protocol, which formed the basis of modern cryptocurrencies and tokens, has repeatedly been the subject of research by leading financiers, which correlates with the importance of the role assigned to this phenomenon in this paper. According to A.S. Rajasekaran *et al.* (2022), this technology has completely changed the usual concept of financial management and the advantages of blockchain such as decentralization, transparency, uniqueness and peer-to-peer communication help to effectively develop the digital economy worldwide. As another group of experts, A.I. Sanka *et al.* (2021), pointed out, the practical use of cryptographically secured blockchain principles creates principles of trust between anonymous users on the Internet and allows them to conduct transactions without resorting to an intermediary. Consequently, when planning the widespread implementation of this protocol in Kyrgyzstan, it is necessary to calculate the possible risks to the national economy posed by the presence of uncontrolled financial transactions.

Similar problems may also be caused by the introduction of new cryptocurrencies – in this study, a trend towards popularization of this new settlement instrument was noted. In this regard, M. Sockin and W. Xiong (2023) warned in their paper that the ability to resell digital money reduces the risk of bankruptcy on new platforms due to the inflated expectations of new users, but at a certain point this advantage is lost due to the activation of speculators. S. Arsi *et al.* (2021), on the other hand, categorized technological failures, fraudulent activities, legal threats, market fluctuations, liquidity problems and, more recently, pandemic risks as the main risks in cryptocurrency settlements between ordinary citizens. A. Trozze *et al.* (2022) noted that the occurrence of technical crises leads to distrust on the part of owners in the mining technology of a particular cryptocurrency, and speculation can cause unjustified rate hikes. In addressing the legal dimension of this issue, while extensively reviewing Kyrgyz legislative documents, it is imperative that all regulations pertaining to cryptocurrencies remain subject to continuous state oversight. Depending on the rapidly changing circumstances of the digital financial market, these laws, and decrees of the Cabinet of Ministers should be subject to revision.

The decline in 2023 of the market for the promising NFT token project, the majority of which became zero-valued, noted in this paper, has received a wide resonance in the scientific literature. P. Szydło *et al.* (2024), after studying the capitalization of several popular token collections, concluded that this new digital market, although driven by innovative trading mechanisms, still bears statistical similarities to traditional capital markets. E.I. De Silva *et al.* (2024) gave some hope for the recovery of NFT positions – they believed that the decline in the value of tokens in 2022-2023 was psychological and due to the "herd behaviour" of operators, the prices for this virtual commodity, having survived the effect of the financial bubble, returned to their objective values. The authors were able to prove this hypothesis thanks to the method of sliding time windows of 10, 20 and 30 days, based on a comparison of the volume of token transactions obtained from open sources with expert forecasts published in the media during this period. M.C. Compagnucci *et al.* (2023) found an important application of NFT-tokens – as a basis for sustainable innovation in pharmaceutical research and development. The specifics of creating medical products are such that almost any data exchange is seen by pharmacists as a threat to intellectual property. Thanks to blockchain technology and non-interchangeable tokens, drug creators can now store, transfer and reuse data from their discoveries without fear of losing rights to it (Spytska, 2024). This fact casts doubt on the thesis of the collapse of the NFT market voiced in this paper and makes us reconsider our position, paying attention to the further development of the tokenization phenomenon.

The findings of this study are supported by the existing literature on digital finance and its impact on national economies. The experiences and insights gained from global studies can significantly facilitate Kyrgyzstan's navigation of the intricate digital finance landscape, ultimately contributing to the nation's economic competitiveness and the well-being of its citizens. In the context of digitalisation, the discussion has offered a thorough examination of the trends and prospects for the advancement of the financial system in Kyrgyzstan. The critical role of digital transformation in reshaping the financial landscape is underscored by the analysis of global and local trends. The significance of regulatory frameworks, digital literacy, and security measures in the successful integration of digital technologies into the financial sector is underscored by the experience of developed countries and the insights from various studies. The necessity of continuously updating and calibrating financial innovations with global trends, the importance of digital transformation in education and healthcare, and the critical role of regulatory oversight are among the key findings of the discussion. The human factor continues to pose a substantial challenge, as research underscores the necessity of consistent training and accountability measures to reduce the risks associated with digital fraud and negligence.

The digital economy is being driven by the blockchain protocol and cryptocurrencies, which have been identified as pivotal technologies. The adoption of these technologies is associated with both opportunities and

risks. A cautious approach and continuous monitoring are required in light of the volatility and unpredictability of digital assets, as evidenced by the decline in the NFT market. In summary, the digitalisation of the financial system in Kyrgyzstan presents both opportunities and challenges. To capitalise on the advantages of digital technologies and mitigate their associated risks, it is imperative to implement effective regulation, digital literacy, and robust security measures. Kyrgyzstan's navigation of the intricate digital finance landscape is significantly facilitated by the experiences and insights gained from global studies.

Conclusions

The study determined that the global digital transformation is facilitating the inevitable digitalisation of the financial system in the Kyrgyz Republic. In recent years, the country has experienced a substantial increase in the number of internets, mobile device, and social media users, which has had a positive effect on the population's use of digital financial services. The expansion of the banking system and the popularisation of cashless payments are particularly evident in the increase in the number of users of online banking, ATMs, and POS terminals.

Nevertheless, the analysis also identified several obstacles that must be surmounted to ensure the sustainable development of the digital financial system. The irregularity of foreign direct investment inflows is one of the primary challenges, as it complicates the long-term planning of innovative projects. A substantial portion of the population is unable to access modern financial technologies due to a persistent digital divide between residents of large cities and rural areas. In the context of an active transition to digital financial transactions, cybersecurity and data protection issues continue to pose a substantial challenge.

The security of the financial system has been exposed to new risks as well as new opportunities as a result of digitalisation. In particular, hacker attacks, data breaches, and fraudulent activities have been identified as challenges that necessitate the implementation of more robust security systems and the provision of training to bank staff to reduce human error.

Consequently, the findings of the investigation indicate that Kyrgyzstan's digital financial system necessitates the implementation of comprehensive measures to achieve its full potential. The adoption of the draft Digital Code, which will systematise and regulate the work with digital innovations, is a critical step in the improvement of the legal and regulatory framework. Equally critical are educational initiatives that educate the populace about potential hazards and enhance their digital literacy. The country will be able to successfully capitalise on the advantages of digital technologies and guarantee sustainable economic development only if these conditions are satisfied.

Credit Authorship Contribution Statement

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Vugar Mehdiyev: Methodology, Formal analysis, Validation, Writing – review and editing, Visualization.
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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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Volume XV, Issue 4(32), Winter 2024

DOI: https://.doi.org/10.14505/tpref.v15.4(32).02

Improving Strategic Planning and Ensuring the Development of Enterprises Based on Relational Strategies

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Article info: Received 19 August 2024; Received in revised form 22 September 2024; Accepted 30 October 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: The article is aimed at improving the strategic planning processes at enterprises through the effective implementation and use of relational strategies. These strategies are aimed at increasing the competitiveness, sustainability, and adaptability of enterprises in the face of rapidly changing market realities. The study aims to provide a comprehensive understanding of relational strategies as a strategic planning tool that can contribute to the development of more effective strategic initiatives. The methodological basis of the study includes the use of evolutionary planning, which involves building a long-term model of enterprise development, a methodology for implementing strategic changes that allows assessing the organization's ability to adapt to innovations, and a systematic planning approach to detail key milestones for achieving strategic goals. The main result of the study was the identification of the peculiarities of forming a relational strategy of an enterprise. Relational strategies are based on the creation of bilateral relations between the enterprise and other market participants, which contributes to the formation of mutually beneficial cooperation. The main goal is to obtain relational rent and ensure sustainable development of the enterprise through collaboration. The key elements of a relational strategy are an understanding of the concept of "relational rent" and the importance of "relational assets". The study reveals the importance of relational strategies in modern strategic planning of enterprises, highlighting them as an important tool for achieving competitive advantage, sustainability and effective adaptation to dynamic market conditions

Keywords: strategic factors; policy; relational potential; assessment matrix; competitiveness.

JEL Classification: G30; O20; L10; M10; M21.

Introduction

Improving the economic prospects and competitive position of enterprises largely depends on the quality and effectiveness of their strategic planning. However, the complexity of the market environment, in particular, due to

its uncertainty, growing competition and the diversity of conditions in different regions, makes the development of well-designed strategies more challenging. In this context, the use of traditional strategies, such as cost reduction or product quality improvement, no longer guarantees the maintenance of competitive advantage and market success (Makedon *et al.* 2022). Therefore, in search of more effective strategic decisions, managers are increasingly focusing on optimizing the interaction between enterprises and the external environment.

The approach based on relational strategies not only helps to improve interaction with other market participants, but also helps to reduce market uncertainty and associated risks (Burstein *et al.* 2019). Strategies that rely on unilateral benefits are ineffective in competition due to high costs and lack of a guarantee of success. At the same time, cooperation in the mark*et al*lows partners to combine their potential and competencies, share costs and risks, and increase market control (Sintani *et al.* 2023; Dumi *et al.* 2014). The development of a relational direction in strategic planning, focused on gaining partnership advantages through cooperation to access new resources and competences, is becoming increasingly important (Trusova *et al.* 2020). This emphasizes the need to create a methodological and regulatory framework for strategic planning that takes into account relational interactions and to address existing problems in this area, which determines the relevance of the study.

In general, current trends in strategic planning indicate an active period of search and reassessment in this area. Traditional methods of strategic planning no longer guarantee the success previously achieved, which confirms the need to update and adapt them to modern market conditions. It is also important to explore new approaches that can lead to innovative, "unconventional" strategic paradigms. These new directions should reflect changes in all aspects of socio-economic life, including the transition to a new information economy (Johanson and Vahlne, 2009). The aim of the study is to improve the strategic planning processes at enterprises through the implementation and effective use of relational strategies to ensure their competitiveness, sustainability, and adaptability in dynamic market conditions.

1. Literature Review

Studies on assessing the readiness of an enterprise for strategic transformations and analysing the effectiveness of strategic initiatives play a key role in the modern understanding of strategic change (Datta, 2022; Root, 1988). In the context of strategic planning, according to D.J. Kelley & M.P. Rice (2001), A. Osterwalder & Y. Pigneur (2010), there are three main paradigms. The first, the rational paradigm, is based on the assumption that strategies can be planned and executed, which makes it attractive to managers due to its ease of application. The second, the evolutionary paradigm, emphasizes the need to update strategic plans, based on the fact that rational forecasts are often difficult to implement. The third, the process paradigm, focuses on learning and adaptation, enabling businesses to achieve strategic goals by selecting and adhering to effective behaviours.

In conformity with R. Albahsh & M.F. Al-Anaswah (2023), the enterprise acts as a "strategy processor", transforming both external and internal strategic initiatives into a comprehensive strategic plan. This, in turn, allows the enterprise to formulate actions for its development and present its strategy as a corporate policy within the business community. This approach ensures the integration of all components and subsystems of the enterprise, promotes their harmonization and consolidation, as well as differentiation of the internal environment, which can cause changes aimed at achieving greater harmony (Teece, 2022; Shahini 2024).

Well-known experts in the field of competitive strategies, such as D. Ford *et al.* (2011) and M.A. Schilling (2022), emphasize not so much the harmonization of interests after the implementation of strategic plans, but rather the need to improve the efficiency and competitiveness of enterprises. They identify two main criteria for evaluating a strategic approach: expanding the scope of activities and ensuring sustainable growth rates. It is also worth mentioning the views of H. Håkansson and I. Snehota (1995), which reflect the peculiarities of developing and implementing enterprise strategies in a competitive environment.

In the field of studying competitive strategies for enterprise development, new scientific theories were presented by such authors as M. Goodman and S.M. Dingli (2017), R. Masoud and S. Basahel (2023), who point to the existence of alternative ways of competition. They emphasize that too intense competition may not contribute to market efficiency, but rather lead to its degradation. The authors W. Chan Kim and R. Mauborgne (2005), J.M. Munoz (2023) argue that successful development of enterprises can be achieved without participation in competition, pointing to the importance of economic efficiency, prices, and sales volumes, which confirms the prospects of relational strategies in strategic planning.

According to A. Adamik (2021), value creation according to the chain logic is possible through the logic of the value network and its appropriation by maximizing mechanisms. Thus, the choice of different actors (not only key ones) among suppliers and customers will open up access to new markets and the benefits of cooperation.

The common thread between the findings in these studies is the finding that managers still rarely establish cooperative relationships characteristic of a value network and prefer the known inter-industry interdependence based on the value chain. It should therefore be noted that this factor may be a consequence of low relational awareness or inability to use the potential of the value network.

2. Materials and Methods

Building on existing literature, we use analysis, synthesis, and deduction methods to develop a theoretical framework for relational strategies. This includes: analysing factors influencing relational strategy formation; synthesizing a model for creating relational strategies; deducing a matrix for assessing relational potential. To conduct this study, the analysis method was used. On its basis, the article considers the peculiarities of formation of the relational strategy of an enterprise. This method was used in the process of studying the essence of this type of strategy and its elements. In addition, the analysis played an important role in identifying the impact of relational factors on the activities of the enterprise. Using this method, the study revealed the impact of relational strategies on the level of synergy in various business areas, as well as the distribution of commercial risks.

The synthesis method was used in the study to identify the relationship between strategic planning and enterprise development. Accordingly, on the basis of this method, it was possible to reveal the specifics of the model of the relational strategy of an enterprise and to establish its impact on the activities of a modern enterprise. It is worth noting that this method was used as the basis for studying the role of relational strategies in increasing the competitiveness of an organizational unit, as well as its implementation of the investment strategy. The synthesis method allowed revealing the relationship between the process of implementation of strategic planning at an enterprise and improvement of quantitative and qualitative indicators of its work, including profitability. Furthermore, the method of deduction was used to conduct the study. It allowed expressing the specifics of the process of creating relational strategies based on general knowledge about the concept of strategy as a process of adaptation. This method was used as the basis for studying the structure of the strategic modelling methodology, as well as its individual elements, in particular, the relational strategy model.

The method of comparison was used to identify and describe the current challenges faced by enterprises in the market environment. Accordingly, the financial results were compared with the internal capabilities of a company operating on the basis of a relational strategy. The comparison was necessary to establish the optimal level of the relational effect that should arise at enterprises as a result of the implementation of strategic planning. The generalization method was used as the basis for the process of assessing the relational potential of enterprises. This method was used to characterize the features of the developed methodology for assessing the relational potential of enterprises, namely, to highlight its advantages.

The modelling method was used in the study to present the process of forming the relational strategy of an enterprise. Accordingly, on its basis, a process model was developed, which allowed revealing the key stages of the relational strategy formation. The application of the modelling method allowed structuring and visualizing the sequence of actions in the development of a relational strategy at enterprises. Given the matrix method, the study assessed the relational potential of an enterprise in relation to potential partners. On this basis, the study proposed to use a matrix for assessing the relational potential. This matrix was formed on the basis of a comparison of key performance indicators of enterprises and allowed identifying the most promising areas for relational interaction.

It should also be noted that in the matrix for assessing the relational potential, the calculation method was used to present the calculated relations, in particular: Y=A/B, X=C/A. The use of this method made it possible to compare the performance of the enterprise with the performance of potential partners.

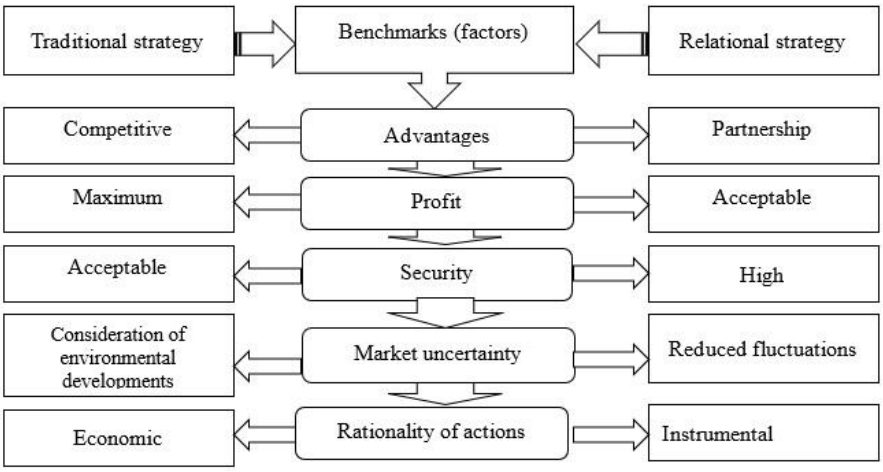
3. Results

3.1 Peculiarities of Forming a Relational Strategy of an Enterprise

The relational strategy of an enterprise is to create a network of bilateral relations between the enterprise and other market participants to form cooperation that brings mutual benefits. The main goal of this approach is to obtain relational rents, or profits arising from joint efforts within partnership alliances, and to ensure the safe development of the enterprise through collaboration with partners. A key aspect of this strategy is the concept of "relational rent", which serves as a measure of the economic benefits of partnerships. This term is closely related to the idea of "relational assets" (Grove *et al.* 2023), which is part of the stakeholder concept. Thus, the relational strategy opens up new strategic guidelines, in particular, a shift away from competition in favour of building cooperative relationships, which reduces market uncertainty not through traditional environmental analysis, but through deepening partnerships with business partners.

Minimizing discrepancies in the actions of business partners with defined strategic goals requires deep coordination of joint work, including production processes (Kalna-Dubinyuk *et al.* 2023). This is possible through the formation of appropriate organizational structures. Investments in such organizational elements lead to an increase in the costs associated with relational strategies, which may seem contradictory from the point of view of economic rationality. However, this helps to stabilize market conditions and reduces the risks of losing partners or their opportunistic behaviour (Makedon *et al.* 2023; Leonow *et al.* 2019). Thus, significant losses that may arise when it comes to finding new partners can be avoided, providing additional competitive advantages to enterprises that focus on cooperative relations (Fig. 1).

Figure 1. Comparison of the main relational and traditional strategic factors



Source: developed by the authors based on M.R. Mauro & F. Pernazza (2023), S. Suriyankietkaew & P. Petison (2020)

Table 1. The most important conditions for the formation and implementation of relational strategies

No.	Organizational form of relational strategy	Purpose of strategic planning	Terms	
			General requirements	Need for accounting
	1	2	4	5
1	**Alliances with competing partners**			
1.1	Integration of several enterprises at different stages of the production process (participation of several participants)	Minimizing dependence on external suppliers	Each of the partner companies produces standardized components or parts for a variety of products	No strict dependence on the development dynamics of other participants
1.2	Cooperation of several companies to produce a common product	Entering new markets with these products	Each partner contributes its own resources to the development and production of a joint product	Challenges in preserving intellectual property
1.3	Integration of diverse assets (two participants)	Substitution of one partner's market opportunities for another's technology or product	The products of one partner do not compete with the products of the other	Dependence on the development dynamics of other participants
2	**Alliances of non-competing partners**			
2.1	Integration of two companies from different but related industries	Minimizing dependence on external supply chains	The partnership is focused on producing high quality products and reducing inventory	The success of cooperation depends on the innovative development of one of the partners
2.2	Alliances between different industries	Entering new business areas	The aim is to increase the company's adaptability by divesting unproductive assets	Increases the risk of incorrect management decisions in an unknown area
2.3	International partnerships	Exchange of technologies and distribution channels	An alternative to traditional export routes is being created.	Challenges in maintaining the required quality standard

Source: developed by the authors

It is worth noting that any form of cooperation can be integrated with other types of interactions in various fields of activity (Climent and Haftor, 2021). This implies setting specific goals, conditions for the creation and implementation of organizational forms that support the relational strategy (Table 1).

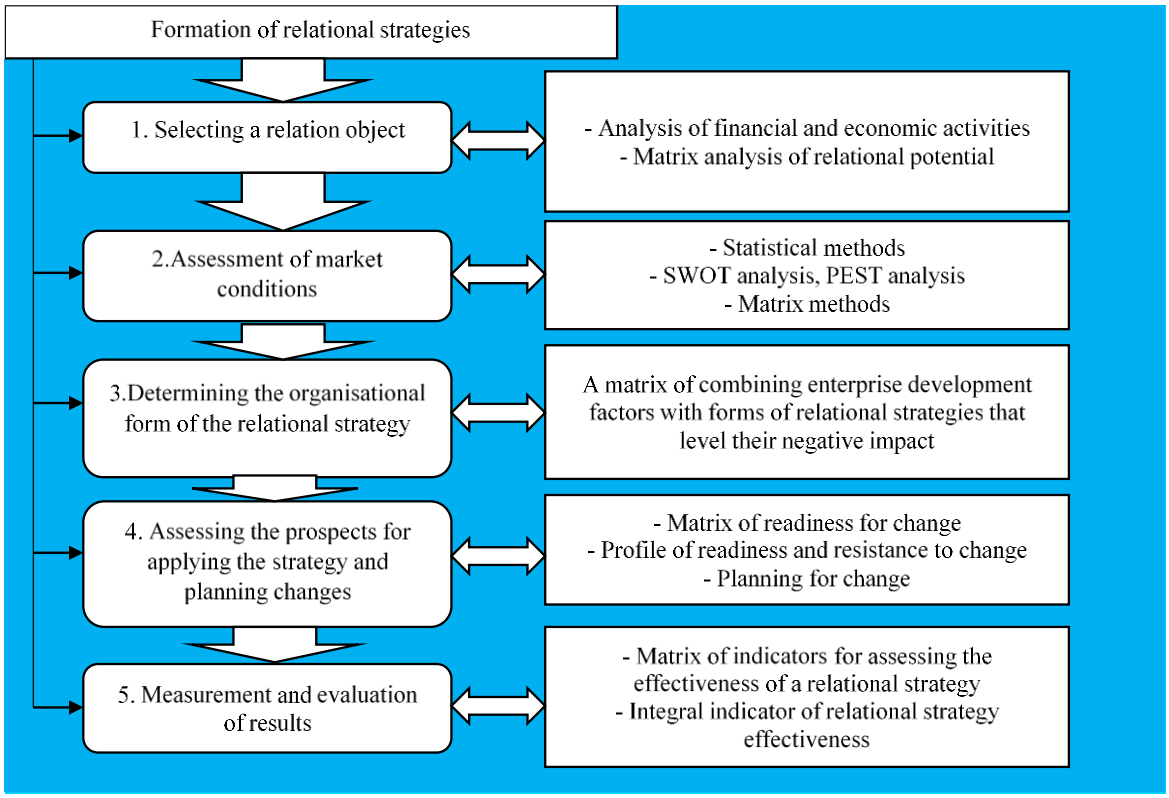
The diversity of approaches to relational strategy is driven by the need to address the complex strategic challenges faced by enterprises in an intense market competition (Kormakova *et al.* 2023). Relational strategies help to increase synergies in various business areas by distributing commercial risks and reducing the impact of competition.

3.2 Model of Relational Enterprise Strategy

In modern practice, experts emphasize the importance of using strategic planning for the sustainable development of enterprises, maintaining competitiveness, implementing an investment strategy to stabilize and increase market share, and improving quantitative and qualitative performance indicators to ensure profitability as the basis for development (Battisti *et al.* 2020).

Given the fundamentals of creating relational strategies, one should proceed from the concept of strategy as a process of adaptation. Analysing various strategic modelling techniques, it can be argued that the relational strategy model should be consistent with market conditions, be focused on financial results and take into account internal capabilities to achieve the optimal relational effect. Strategic adaptation through planning and implementing changes aimed at achieving key strategic goals is important (Claxton and Kent, 2020). Based on the theoretical foundations of strategic planning, considering the analysis of modern strategic approaches, the relational strategy model can be presented as a process model that can be decomposed into several key stages (Fig. 2).

Figure 2. Model for forming relational strategies of an enterprise



Source: developed by the authors

The first step is to identify the area where relational interactions will be developed, which requires an analysis of economic activity, an assessment of the company's own capabilities to implement a relational strategy, and their comparison with the potential of possible partner enterprises in key areas (Mandal, 2023; Bessant and Tidd, 2020). The area of relational interaction is understood as a selected area of the enterprise*'s* activity, such as production, finance, innovation, investment, or market presence, where efforts to develop partnerships will be concentrated (Lassala *et al.* 2021; Trusova *et al.* 2022). It is important to analyse in detail not only one's own weaknesses and strategic goals, but also the potential of one's partners.

Relational capability means that enterprises have the capabilities to support relational strategies in one or more areas, which is necessary for the formation of a relational object (Heimberger, 2020). To assess these capabilities, along with the analysis of financial and economic activities, it is recommended to use a relational potential assessment matrix. This tool allows considering both the internal capabilities of the enterprise for cooperation and the external market conditions for a potential partnership. The choice of a specific area for relational interaction is based on a comparative analysis of the performance potential of each specific area between potential partners and the enterprise (Ferrer-Estévez and Chalmeta, 2023). The object of the relational strategy is to determine where each enterprise has the strongest performance. The necessary information for analysing the relational potential and selecting the object of relational interaction is presented in Table 2.

Table 2. Initial data for assessing the relational potential of an enterprise

No.	Indicators	Indicator 1	Indicator 2	Indicator 3	Indicator 4
1	A_i (Indicators of Partner 1)	A_1	A_2	A_3	A_4
2	B_i (Indicators of Partner 2)	B_1	B_2	B_3	B_4
3	C_i (Own indicators of the enterprise)	C_1	C_2	C_3	C_4
4	$Y_i=A_i/B_i$	Y_1	Y_2	Y_3	Y_4
5	$X_i=C_i/A_i$	X_1	X_2	X_3	X_4

Source: developed by the authors

The indicators for the first and second partners (first and second rows) reflect the relational potential of potential partners. The third row shows the indicators of the enterprise that initiates the interaction. The fourth row (Y_i) is defined as the ratio of A_i to B_i and an indicator of the preference between the two partners. If $Y_i>1$, then the first partner's performance is better than the second, if $Y_i=1$, then both partners' performance is equal, if $Y_i<1$, then the second partner's performance is better. The fifth line (X_i) shows the ratio of C_i to A_i, which allows comparing one's own performance with that of the first partner. If $X_i>1$, one's own performance is better, if $X_i=1$, the performance is equal, if $X_i<1$, the performance of the first partner is better.

By placing the equations and inequalities in the Y_i index horizontally and in the X_i index vertically, we obtain a matrix of nine sections that provides an idea of the highest efficiency of the relational potential of each of the three analysed enterprises in a particular industry (Hamel *et al.* 2022). Such a comparison of the relational potential of the enterprise with the potential of its partners allows management to identify the most promising objects for relational strategies with each partner. Thus, the general view of the matrix can be presented as follows (Table 3).

Table 3. General view of the relational potential assessment matrix

Indicators	$Y_i>1$	$Y=1_i$	$Y_i<1$
$X_i>1$	1. Own indicators are higher than those of partners 1 and 2 at min for partner 2	2. Own indicators are higher than those of partners 1 and 2, with the latter being equal	3. Own indicators are higher than those of partners 1 and 2 at min for partner 1
$X_i=1$	5. Partner 1's performance and own performance are equivalent to and higher than partner 2's	6. Partner 1, 2's and own equivalent indicators	7. Partner 2's performance is higher than own and partner 1's, with the latter being equal
$X_i<1$	8. Partner 1's score is higher than its own and partner 2's	9. Partner 1, 2's performance is equal to or better than own performance	10. Partner 2's score is higher than its own and partner 1's

Source: developed by the authors

When the indicators are in quadrants 1, 2, and 3, the firm's own indicators are higher than those of potential partners, in quadrants 7 and 10 the second partner has better indicators, while in quadrant 8 the first partner has better indicators than the other participants in the analysis.

3.3 Methodology for Assessing the Relational Potential of Enterprises

The proposed methodology for assessing the relational potential of enterprises is distinguished by its versatility in choosing factors for analysis and identifying key indicators to determine the type and object of relational relations. It is important to take into account the difference in the values of indicators to determine the general trend and economic content of each indicator, where some of them should strive for a minimum to ensure optimal efficiency (Yu & Xu, 2022; Piddubna *et al.* 2024). For example, if the first partner's specific cost indicator is higher than the

enterprise's, it means that in-house production will be more cost-effective, and cooperation with these partners to reduce production costs is not advisable. This analysis allows focusing on the most efficient stage of the production cycle when developing a relational strategy (Pulsiri and Vatananan-Thesenvitz, 2021; Musayeva *et al.* 2024). Indicators reflecting financial, economic, investment, innovation, and strategic activity can be used to build the matrix (Amoako, 2019, Nogoibaeva *et al.* 2024).

Based on the analysis of the factors and conditions that influence the formation of relational strategies, specific combinations of indicators can be proposed to identify the object of relational interaction, depending on the goals and expectations of the partnership (Table 4).

Table 4. Combining relational potential indicators with the relational object

Indicator	Role in assessing relational potential	Possible relation object	Possible goals of strategic planning
1	2	3	4
Unit production costs in USD	Indicates the cost of production	Stages of the production process	Minimizing dependence on external suppliers and increasing product competitiveness
Utilization of production capacities in %	Indicates potential for expansion	Production of goods	Entering new business areas. Exchange of distribution channels for partner technologies or products
Share of research and development (R&D) expenses in total sales, %	Reflects the level of technological development		Financial resources and intellectual property. Mutual exchange of access to markets for the partner's technologies or products
Market share, %	Reflects the effectiveness of the company's strategic initiatives	Expansion into new markets. Entering new markets	Mutual use of the partner's markets and technologies or products

Source: developed by the authors

Table 5 presents a variant of filling in the matrix for the machine building sector based on the proposed indicators.

Table 5. Matrix for assessing relational potential for an enterprise

Indicators	$Y_1>1$	$Y_1=1$	$Y_1<1$
$X_1>1$	Own production is more expensive than that of partner 1 and 2, at min partner 2	Own production is more expensive, with equivalence of 1 and 2	Own production is more expensive than that of partner 1 and 2, at min for partner 1
$X_1=1$	Partner 2's production is cheaper than own and partner 1's	Equivalent values	Own production and partner 1's is cheaper than partner 2
$X_1<1$	Partner 1's production is more expensive than partner 2's own and partner 3's	The production of partner 1 and 2 is equivalent and more expensive than own production	Partner 2's production is more expensive than its own and partner 1's
	$Y_2>1$	**$Y_2=1$**	**$Y_2<1$**
$X_2>1$	Own investment is higher than that of partners 1 and 2 at min for partner 2	Own investments are higher than those of partners 1 and 2	Own investment is higher than that of partner 1 at min for partner 1
$X_2=1$	Partner 1's share of investments and own investments are equivalent and higher than partner 2's	Share of investments of partner 1, 2 and own equivalent	Partner 1's share of investments and own are equivalent and lower than partner 2's
$X_2<1$	Partner 1's share of investment is higher than its own and partner 2's	The share of investments of partner 1, 2 is equal to and higher than its own	The share of partner 2's investments is higher than partner 1's and own
	$Y_3>1$	**$Y_3=1$**	**$Y_3<1$**
$X_3>1$	Own capacities are loaded more than those of partners 1 and 2 at min in partner 2	Own capacities are higher than those of partners 1 and 2	Own capacities are loaded higher than those of partners 1 and 2 at min for partner 1
$X_3=1$	Capacity utilization of partner 1 and actually equivalent to or higher than partner 2	Capacity utilization of partner 1, 2 and equivalent capacities	The capacity utilization of partner 1 and partner 2 is equivalent, but lower than that of partner 3

Indicators	$Y_1>1$	$Y_1=1$	$Y_1<1$
$X_3<1$	Partner 1's production capacity utilization is higher than own and Partner 2's	Utilization of production capacities of partner 1, 2 is equivalent to and higher than own	The share of partner 2's investments is higher than partner 1's and own
	$Y_4>1$	**$Y_4=1$**	**$Y_4<1$**
$X_4>1$	The market share of the enterprise is larger than that of partners 1 and 2 at min for partner 2	The market share of the own company is higher than that of partners 1 and 2	The market share of the own enterprise is larger than that of partners 1 and 2 at min 1
$X_4=1$	Partner 1's market share and own market share are equivalent and higher than partner 2's	Market share of partner 1, 2 and own are equivalent	Partner 1's market share and own market share are equivalent and lower than partner 2's
$X_4<1$	Partner 1's market share is higher than its own and partner 2's	Market share of partners 1, 2 is equal to or higher than own	Partner 2's market share is higher than partner 1's and own

Note: Y_1 – specific costs of production of a certain type of product (unit); Y_2 – specific R&D costs by sales, %; Y_3 – capacity utilization, %; Y_4 – market share, %.
Source: developed by the authors

Each quadrant in this matrix demonstrates different aspects of advantage depending on the analysis. Comparative analysis between its own capabilities and those of potential partners allows management to identify opportunities for cooperation, the optimal areas of such interaction, and to reveal the roles and importance of each participant in the partnership. The choice of partners for evaluation can be quite large, allowing for a pairwise comparison across a wide range of criteria (Rousul and Hidayati, 2022).

In the process of selecting the area for relational relationships and assessing the capacity of the participants, it is necessary to determine the specific type of relational strategy. For this purpose, it is recommended to refer to Table 6, which serves to determine the type of relational strategy based on the assessment of capabilities and indicators.

Table 6. Recommendations for choosing the type of relational strategy for enterprises

Indicator	Possible relation object	Recommended types of relational strategy	
		Competing businesses	Non-competing businesses
1	2	3	4
Unit costs in thousand USD	Stages of the production process	Integration at one or more stages of the production process	An association of companies from different but related industries
Utilization of production capacity in percentage terms	Volume of products manufactured	Realization of total production through integration at various stages of the production process	Cooperation between companies from different industries
R&D expenses as a percentage of total sales	Financial resources and intellectual property	Integrating diverse assets	Transnational alliances
Market share, %.	Distribution channels	Integration of diverse assets. Partnerships between industries. Cooperation between companies from similar sectors of the economy	International alliances

Source: developed by the authors

Once a specific type of relational strategy has been selected, it is important to analyse the feasibility of its implementation for the participating enterprises. Differences in structure, management systems, organizational structure, corporate culture, and other key characteristics may affect the readiness of enterprises to adopt innovations. The final step in developing a relational strategy is to define and measure performance through key performance indicators to ensure that the planned goals can be realized. Implementation of any strategy is only worthwhile if the intended results are achievable.

4. Discussion

The shortcomings of the study may be related to the following aspects:

1) there is insufficient research on the long-term effects of implementing relational strategies, including the sustainability of partnerships and the long-term effectiveness of relational rents;

2) there is a potential underestimation of external risks, such as changes in the market environment, regulatory changes or international conflicts that may affect the success of relational strategies and underestimation of the costs of creating and maintaining relational structures or risks associated with opportunistic behaviour of partners;

3) insufficient consideration of challenges related to the protection of intellectual property and the exchange of confidential information between partners;

4) there may be a lack of analysis of the interaction of relational strategies with other strategic initiatives of the enterprise, which may lead to a conflict of interest or resources.

In the scientific doctrine, there are different approaches to the expediency of using relational strategies for planning the development of an enterprise. N. AlQershi (2021) studied the impact of strategic thinking, strategic planning, strategic innovation on the productivity of small and medium-sized enterprises in Yemen. Common to the results of this study is that these indicators have a significant positive impact on human capital. Accordingly, human capital mediates the relationship between strategic thinking, strategic planning, strategic innovation, and the productivity of small and medium-sized enterprises. It has been found that the indirect impact of strategic thinking, planning and innovation on the productivity of enterprises through human capital is dominant compared to their direct impact. Thus, the common thread between the conclusions of both studies is the position that in order to increase productivity, SMEs need to develop their strategic planning and innovation capabilities. Investments in human capital development, in particular, through in-house training, play an equally important role. Both studies emphasized the priority of human capital in implementing strategic initiatives and increasing the productivity of enterprises in the current environment.

H. Lopez-Vega & N. Lakemond (2022) set out to better understand how companies from emerging markets (EMNEs) develop their innovation potential. Using the example of Natura, a Brazilian cosmetics company, they analysed the importance of market and non-market environments. Accordingly, the conclusion that the environment in which a company operates plays a key role in its innovation strategy is common with the results of this study. Accordingly, it has been found that companies are more likely to use non-market strategies to adapt to the institutional environment and are open to innovative strategies. This approach facilitates the development of new technologies and the search for sources of innovation. The general conclusion is that cooperation is the key to success, as EMNEs can develop their innovation potential through joint (market and non-market) strategies that combine the institutional environment of emerging markets and the global market context (Chernetska and Chernetskyi, 2023). Thus, the evolutionary nature of the development of innovation potential is expressed gradually through local and global open innovation processes. Following M.S. Mathibe *et al.* (2022), EMNEs use different strategies to develop their innovation potential than companies from developed markets. As a result, open innovation helps EMNEs become leaders in global technology. A common thread among the findings of this study is the evidence that EMNEs can create opportunities for local organizations and communities, which contributes to sustainable economic development. The study also highlighted that it is important for EMNEs to engage local stakeholders (customers, universities, suppliers) to meet the needs of both emerging markets and the global marketplace.

Special attention should be paid to the study by M. Barbosa *et al.* (2020). The researchers studied the specifics of sustainable strategic management (GES) models for small companies. It was also aimed at developing their own sustainability management model for small companies. This approach is similar to the one used in this study. In particular, they developed a model called Sustainable Strategic Management (GES). What is common between the studies is that the models developed are based on well-known strategic management concepts, such as the triple bottom line and the balanced scorecard. It is worth noting that both studies focused on the specifics of integrating these principles in different small businesses, which is the main task of the GES model. It was found that this allows for a holistic, effective, and controlled integration of sustainable principles into their operations. Thus, the common thread between the findings of both studies is that companies can gain a competitive advantage in the market by using such strategies. Moreover, as noted in the study by the researchers, the GES model was tested on a small Brazilian company and showed theoretical validity. Therefore, the results obtained should be integrated with the findings of this article to confirm the long-term effectiveness of the GES model. In both studies, plans and strategies were developed to help small companies with tools to strategically implement, apply, and monitor sustainability principles in all areas of their operations. It is important to note that the conclusions were drawn considering the resource constraints and operational complexities of small businesses.

Our study on improving strategic planning through relational strategies has yielded several significant findings. Our analysis revealed that successful relational strategies are built on a foundation of mutual benefit and

trust. Technology and manufacturing sectors showed the highest positive impact from relational strategies, while the effect was less pronounced in the financial services sector. This suggests that the benefits of relational strategies may be contingent on industry-specific factors. A key finding from our research is that relational strategies are most effective when fully integrated into the broader strategic planning process. Companies that treated relational strategies as a separate initiative saw limited benefits. In contrast, those that incorporated relational considerations into all aspects of their strategic planning reported more sustainable competitive advantages. These findings provide novel insights into the role and implementation of relational strategies in strategic planning.

However, further research in the area of improving strategic planning and enterprise development based on relational strategies promises to open up new horizons for understanding and implementing innovative approaches to strategic management. In the future, it is important to study the cross-cultural aspects of relational strategies, which will allow understanding the peculiarities of their application in international business. This includes studying cultural and legal differences that affect the formation and success of relational strategies in different countries. Another area for research is the integration of relational strategies with strategic risk management, and it is important to develop approaches that will allow relational strategies to be integrated into the enterprise's strategic risk management system in order to minimize potential threats. It is also necessary to develop comprehensive methods for measuring the effectiveness of relational strategies. This involves the creation of indicators and analysis methods that would help assess the impact of these strategies on the key performance indicators of the enterprise. This will not only contribute to scientific development in this area, but will also provide practical tools for enterprises seeking to achieve sustainable development and higher competitiveness in a complex and changing business environment.

Conclusions

As a result of the study, in particular, the analysis of factors and conditions that influence the development of relational strategies, the key aspects of their creation and implementation were identified, taking into account different types of relational relations. In addition, different types of relational relationships are identified and described according to the goals of strategic planning, and the possibility of their implementation is substantiated, considering the benefits and potential difficulties. The organizational forms for implementation of relational strategies at enterprises are defined, considering the obstacles that may hinder their development, which contributes to optimization of managerial decisions in the process of strategic planning.

The study also developed a model for creating relational strategies based on the assessment of the relational potential of stakeholders, which considers important factors for the development of enterprises in modern conditions through relational ties. The formed model includes methods of assessment of the relational object, SWOT-analysis, adapted to the peculiarities of the relational strategy, methods of assessment of prospects of application of the strategy and a system of criteria for evaluation of its effectiveness. Thus, the methodical approach to evaluating the effectiveness of strategic planning in the context of relational activities developed in the study includes an analysis of the potential of the relational alliance and the establishment of indicators for monitoring relational processes. It has been determined that this methodology is based on the general principles of evaluating the effectiveness of strategic planning, supplemented by the principle of mutual compatibility of enterprise processes with market conditions, specific to relational relations.

It should also be noted that one of the key points in developing relational strategies is to define the goals and directions of relational relationships. Accordingly, relational strategies can be aimed at establishing partnerships with suppliers, customers, competitors, or other stakeholders. The study found that the choice of the type of relational relationship depends on the specifics of the enterprise, its strategic goals and market environment. The article also analyses the benefits and risks associated with each type of relational relationship. It is established that after defining the goals of relational strategies, it is necessary to develop a specific plan for their implementation. This includes defining the organizational structure, responsible persons, communication, and information exchange processes between partners, mechanisms for conflict resolution and risk allocation. The study found that the effective implementation of relational strategies requires clear coordination between all participants and mutual trust and openness.

Monitoring and evaluation of the results of the implementation of relational strategies was also important in the study. In particular, key performance indicators were identified to track progress and identify any problems or deviations in a timely manner. In turn, regular analysis of the indicators and adjustment of the strategy, if necessary, is the key to its successful implementation in the long term. It has been established that special attention should be paid to developing and strengthening trust between partners, which is the fundamental basis

for sustainable and mutually beneficial relational relations. Creating an open dialogue, honesty in communication, and adherence to commitments will greatly contribute to the formation of an atmosphere of mutual understanding and cooperation between the participants of a relational alliance. In the following research, it is advisable to reveal ways to involve artificial intelligence in the process of improving the strategic planning of companies in the current environment.

Credit Authorship Contribution Statement

Viacheslav Makedon: Project administration, Conceptualization, Data curation, Validation, Writing – review and editing.
Oksana Budko: Methodology, Software, Writing – original draft,
Kostiantyn Salyga: Project administration, Writing – original draft, Visualization.
Valentin Myachin: Formal analysis, Writing – original draft, Visualization.
Nadiia Fisunenko: Investigation, Formal analysis, Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have used/not used generative AI and AI-assisted technologies during the preparation of this work.

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Volume XV, Issue 4(32), Winter 2024

DOI: https://.doi.org/10.14505/tpref.v15.4(32).03

Tax Avoidance by Public Firms: Unveiling the Overlooked Economic Consequences

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Article info: Received 12 September 2024; Received in revised form 10 October 2024; Accepted for publication 8 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: The existing literature on tax avoidance of listed firms is rich in research results. Moreover, many tax avoidance studies are closely related to research themes. Still, there are large differences in conclusions and a lack of systematic exploration of their findings and the theoretical mechanisms behind them. In particular, the U.S. and China are rich in research on tax avoidance, and many issues of tax avoidance are viewed differently. Therefore, it is necessary to carry out a systematic review to clarify further the theoretical ideas on the influencing factors and economic consequences of tax avoidance.

This study conducts a statistical analysis of 172 empirical studies examining the factors influencing corporate tax avoidance and its economic consequences, including 97 studies on influencing factors and 75 on economic outcomes. Given the close interrelation between these factors and economic consequences, this paper systematically reviews the economic consequences of tax avoidance, building on the research of influencing factors. This approach aims to provide readers with a more comprehensive understanding of the determinants and economic implications of tax avoidance under agency theory.

Similar topics are categorized and organized, and related studies' theories and conclusions are summarized to facilitate a systematic understanding of the progress of tax avoidance research.

The literature related to this study was obtained by searching for a summary of the recent empirical literature on the factors influencing firm tax avoidance and economic consequences on ScienceDirect, EBSCO, SSRN, Zhiwang, and Baidu Academic. The study is divided into the possible risks arising from tax avoidance, which are discussed mainly from the perspective of tax agency theory, tax risk, accounting information risk, reputation risk, and financial risk.

Tax avoidance is an important and complex issue related to the quality development of firms and the coordination of the interests of various parties, such as the government, shareholders, and managers. This study finds that conclusions based on different systems, perspectives, study designs, and samples may not lead to the same conclusions. This study is dedicated to systematizing the literature on tax avoidance, understanding the various research perspectives, and comparing them. This study contributes to a systematic understanding of the content and perspectives of tax avoidance research. In addition, it provides direction for further work on high-quality firm tax avoidance in the future.

Keywords: tax avoidance; influencing factors; economic consequences.

JEL classification: H26; H00.

Introduction

Tax avoidance is the act of a firm taking various possible measures aimed at reducing its tax burden (Hanlon and Heitzman, 2010). The existing facts and evidence indicate that firms' tax avoidance is common and that firms may

engage in tax avoidance under their circumstances. For example, the United States is the largest developed country in the world. Tax differences in U.S. public firms have increased yearly (Manzon and Plesko, 2001; Lennox *et al.* 2012) and more than tenfold over the decade (Boynton *et al.* 2005). The increase in tax differences may result from the increasing aggressiveness of firm tax avoidance (Mills, 1998; Wilson, 2009; Blaylock *et al.* 2011). The Internal Revenue Service (IRS) and the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) estimate the percentage of firm tax evasion to be over 10% through extensive checks. China is the largest developing country in the world, and tax evasion is more severe in Chinese-listed firms compared to other countries (Cai and Liu, 2009; Lin *et al.* 2017). According to the Ministry of Public Security and the State Administration of Taxation, as many as 22,800 cases of tax-related crimes were investigated by the Ministry of Public Security in 2018 alone, involving an amount of 560 billion yuan. This study finds that the studies related to tax avoidance fit their respective institutional contexts regarding influencing factors, but the conclusions are the same. However, the conclusions differ significantly in terms of economic consequences.

Research on the factors influencing tax avoidance is rich and most developed in the context of the respective systems. For example, when exploring how managers' characteristics affect firm tax avoidance, the Western literature is more often based on general managers' characteristics, such as gender (*e.g.*, Francis *et al.* 2014), or local Western contexts, such as political beliefs (*e.g.*, Francis *et al.* 2016). On the other hand, the literature related to tax avoidance in China is more often explored based on China-specific contextual models, such as the reform of the tax system (*e.g.*, Wang *et al.* 2009), the reform of mixed ownership of state-owned enterprises (*e.g.*, Wang *et al.* 2021), and the reform of reverse mixed ownership (*e.g.*, Zhai *et al.* 2021). Unlike the studies on the impact factors of tax avoidance, there are more differences in the economic consequences of tax avoidance. In particular, is tax avoidance more controversial regarding whether it raises risks? However, the prominent features of the lack of a systematic framework for tax avoidance research, the complexity of tax avoidance measurement, and the dichotomy between theoretical and empirical evidence have greatly reduced the value of tax avoidance theory and practice. This study provides an integrated overview of the existing tax avoidance literature. It helps understand what previous authors have focused on in tax avoidance research and their main views and disagreements. It is helpful for systematically constructing a theoretical framework for tax avoidance.

This study makes three main possible contributions. First, this study systematically organizes the theory and evidence of the economic consequences of tax avoidance and improves the study of the economic consequences of tax avoidance. The existing theories on the economic consequences of tax avoidance can be summarized in two: classical economic theory and tax agency theory. The former suggests that tax avoidance allows firms to gain tax savings and thus reduce firm costs. The latter demonstrates that tax avoidance becomes a means for insiders to extract rent from outsiders, resulting in a loss of firm wealth. Existing empirical studies partially support both theories but lack a holistic approach. This study attempts to explore the two theories and evidence provided systematically.

Second, this study enriches the research related to tax avoidance and provides a valuable reference for the future development of tax avoidance. Tax avoidance is influenced by the firm's motivation and external stakeholders, so how to coordinate the interests of all parties to coordinate the cost of tax avoidance and tax saving benefits and achieve high-quality tax avoidance is an essential issue for firms to consider. This study provides theoretical and practical support for future high-quality tax avoidance through a systematic theoretical review.

Third, building upon Ge *et al.* (2024) research on the determinants of tax avoidance, this paper explores the economic consequences of tax avoidance within the framework of agency theory. This study not only enhances the reader's comprehension of the multifaceted factors influencing tax avoidance but also fosters a deeper understanding and familiarity with the overarching perspective of tax avoidance under agency theory.

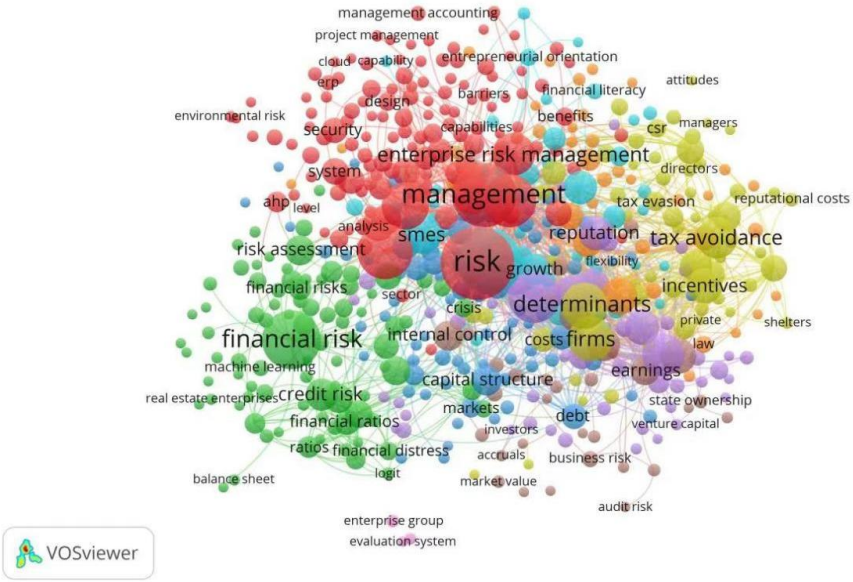
1. Research Methodology

1.1. Literature Collection Methodology

Following the practice of Awan and Sroufe (2022), this study searches for studies related to firm tax avoidance from 1992 to 2024 by keywords, abstracts, and subject terms in leading academic websites such as ScienceDirect, EBSCO, SSRN, Zhiwang, and Baidu Academic. Furthermore, 172 empirical studies were obtained on the factors influencing firm tax avoidance and economic consequences. Among them are 97 papers on the influencing factors of tax avoidance（Ge *et al.* 2024）and 75 papers on the economic consequences of tax avoidance, shown in Figure 1.

After analyzing the final literature on the factors influencing firm tax avoidance, it was concluded that the research themes on the factors influencing firm tax avoidance focused on managers' characteristics, fundamental firm characteristics, and corporate governance. It can be found that early studies on influencing factors focused on essential characteristics, such as firm size, business strategy, and industry classification. However, the tax avoidance literature has recently incorporated corporate governance features to reduce agency conflicts. While the research themes are rich, there are limitations to the specific details. First, most studies on tax avoidance and potential conflicts between managers and shareholders based on principal-agent theory are premised on the first type of agency costs. They do not address the second type of agency costs. Second, the current field of research is less concerned with comparing different forms of taxation, mainly based on the institutional contexts of different countries. Third, most of the current literature's widely used tax avoidance measures originate from U.S. academia and cannot be used in other countries except for the effective tax rate and accounting-tax difference categories.

Figure 1. Tax avoidance economic consequences.



The analysis revealed several potential economic consequences of firm tax avoidance. These consequences may be direct, such as increasing cash flow, reducing the tax burden on the firm, and creating a range of risks, such as tax risk, reputational risk, and financial risk, or indirect, such as changing the firm's capital structure. With the integration of tax and social responsibility, it can be found that the economic consequences of tax avoidance have received increasing attention in recent years. Still, there are some unresolved issues. First, the relationship between the interests associated with tax avoidance and managers and shareholders can be complex. Understanding the internal dynamics of tax avoidance decisions may require more in-depth case studies or surveys in willing firms. Second, using the cash saved through tax shelters is subject to further exploration as to whether tax-sheltered firms use the additional cash to engage in more productive activities. Third, managers may not always make the best choices in allocating firm resources, and the possible impact of tax avoidance on managers' decisions has not been fully explored.

1.2. Theoretical and Research Framework

1.2.1. Theoretical Framework

Classical tax avoidance theory considers tax avoidance as a tax avoidance between the firm and the state, where tax avoidance causes tax base erosion for the state but helps tax-avoiding firms to reduce their tax burden (Hanlon and Heitzman, 2010). With the Enron financial fraud incident in the United States in the past three decades, Enron executives hid accounting fraud information with the help of tax avoidance. They tunneled small and medium shareholders with the help of tax avoidance. Russia rectified oil tax evasion to increase the firm's wealth. The theoretical community gradually reflected on two issues. First, who influences tax avoidance? Second, is tax avoidance beneficial to the shareholders of a firm? Tax avoidance agency theory points out information asymmetry between internal managers and external shareholders in tax avoidance. Managers use

the name of tax avoidance to extort shareholders and make the firm suffer losses. This theory has become the most popular research topic in tax avoidance.

Tax avoidance agency theory implies that the initiative of tax avoidance is in the hands of the information-advantaged managers, who strategically adopt tax avoidance measures according to the firm's situation and stakeholder requirements (Desai *et al.* 2006; Desai *et al.* 2007). Therefore, tax avoidance does not necessarily benefit the firm, but it benefits managers. Although the existing literature gives reasons for influencing tax avoidance, almost all of the existing literature examining the factors influencing tax avoidance lacks an analytical framework for what influences the extent of firm tax avoidance.

1.2.2. Research Framework

Based on the tax avoidance agency theory research framework, this study proposes a three-factor model that affects tax avoidance. That is, the decision maker avoids taxes (managerial characteristics), the intrinsic conditions and magnitude of the ability to avoid taxes (fundamental firm characteristics), and the pressure faced by the decision maker and other stakeholders of the firm (corporate governance). These frameworks help clarify the stakeholders and role-play in tax avoidance decisions.

In addition, in terms of the economic consequences of tax avoidance, this study has reviewed four aspects of tax avoidance risk: tax risk, accounting information risk, reputation risk, and financial risk, focusing on the debate of whether tax avoidance triggers agency risk in recent decades. These areas of tax avoidance risk are of most interest to theoretical research.

The above framework is the research framework for this study to examine the factors influencing tax avoidance and economic consequences.

2. A Review of the Economic Consequences of Tax Avoidance

Tax avoidance saves firm cash support and increases firm value while providing stakeholders with more information to facilitate decision-making (Hanlon *et al.* 2005; Lennox *et al.* 2012). However, tax agency theory suggests that tax avoidance may incur reduced transparency of accounting information, increased agency risk, and other risks. Thus, tax avoidance's economic consequences may be risky and beneficial.

On the one hand, firms with a high degree of tax avoidance can deteriorate the quality of firm accounting information and information opacity through complex tax planning and tax accounting (Dhaliwal *et al.* 2017; Chen *et al.* 2016; Bennedsen and Zeume, 2018). On the other hand, external investors and government regulators have difficulty obtaining effective information to monitor the behavior of firm insiders, which worsens the agency problem between firm insiders and outsiders (Jenson and Meckling, 1976) and increases firm risk.

On the other hand, tax avoidance brings incremental information, and rational outside investors and government regulators identify the various risks behind firms with high levels of tax avoidance and thus be more cautious. Therefore, managers pay more attention to managing firm risk to avoid suspicion from investors and external regulators (Erickson *et al.* 2004; Lennox *et al.* 2012). In conclusion, the existing literature is controversial and inconclusive regarding whether tax avoidance brings more benefits or risks.

Inefficient market theory, share price changes are considered a composite reflection of investors' information about the firm. An increase in the share price means that investors hold that information about the firm, which helps increase the firm's value. On the contrary, the information reduces the value of the firm. There are different views on whether tax avoidance affects the value of a firm. One view is that managers view tax avoidance as a by-product of maximizing firm value. The level of tax avoidance for the market results from the firm's maximization decision, and they benefit from that optimal tax decision. Therefore, the level of tax avoidance does not affect the firm's value.

Another view is that tax avoidance does not affect the firm's value if the information between investors and the firm is perfectly symmetric. Managers can consistently achieve optimal incentives (Hanlon and Heitzman, 2010). However, the reality is that there are extensive information asymmetries between firms and shareholders and incentive efficiency losses for managers and shareholders (Slemrod, 2004; Chen and Chu, 2005), leading to tax avoidance that may affect firm value.

However, the existing literature does not agree on the relationship between tax avoidance and firm value. For example, Katz *et al.* (2013), based on an agency theory framework, find that tax avoidance leads to a decrease in the firm's future profitability. In contrast, Blaylock (2012) finds a positive association between tax avoidance and future firm performance. There is also some evidence that corporate governance is an essential factor in the economic consequences of tax avoidance (Desai and Dharmapala, 2009). Desai *et al.* (2007) studied the widespread tax evasion and weak tax enforcement in the Russian oil industry during Yeltsin's presidency.

They find that enhanced tax enforcement efforts drive up firms' share prices and related industries with significant tax evasion and avoidance. When a firm is located in a country with a higher corruption index, increasing tax rates can lead to tax evasion. Hanlon and Slemrod (2009) find that a good or bad corporate governance environment affects investors' judgments about firm tax behavior based on U.S. listed firms. When the market learns of a firm's involvement in tax sheltering, the share price declines, while news of a firm with a better governance environment whose taxes are sure to lead to an increase in the share price.

Similarly, Zhang *et al.* (2015), based on a sample of Chinese listed firms, find that overall tax avoidance does not increase the cash holding value of a firm. Still, tax avoidance helps increase cash-holding value among firms with better corporate governance. Also, based on market research on investor reaction to firm tax avoidance news, Desai and Dharmapala (2009) find that overall tax avoidance does not reduce the overall firm value. Still, for firms with higher corporate governance, tax avoidance helps increase firm value.

Based on the above evidence, there is no consensus on the impact of tax avoidance on firm value, and conclusions are influenced by various factors, including the firm's corporate governance. The impact of taxation on the value of a firm is reflected in various aspects, and studies have explored different aspects of the impact of taxation with widely divergent conclusions. This study explores the perspectives relevant to international and China's economic consequences based on the existing literature to provide an objective theoretical basis for various empirical studies in the future. The literature on the economic consequences of tax avoidance involves 75 pieces of empirical literature, as detailed in Table 2.

Table 2. Summary of literature on the economic consequences of tax avoidance (75 papers)

Authors	Country	Findings
Panel A: Tax risk (11studies)		
Dyreng *et al.* (2019)	United States	Aggressive tax avoidance may increase tax uncertainty.
Ciconte *et al.* (2016)	United States	Uncertain tax benefits predict future tax cash outflows.
Saavedra (2018)	United States	Firms with higher tax exposure have higher financing costs.
Law and Mills (2015)	United States	Law and Mills (2015) find that firms with financing constraints have higher tax exposure and greater IRS audit adjustments.
Frischmann *et al.* (2008)	United States	The market reacts positively before and after the effective date of FIN 48, suggesting that investors can leverage the tax benefits of uncertainty in disclosure to obtain more information and mitigate firm agency problems.
Koester (2011)	United States	Firms with higher uncertainty tax benefits have higher share prices in the first two years that FIN48 is in effect.
Tong *et al.* (2016)	China	Firms with lower tax compliance rates may face more agency problems due to the final reduction in the efficiency of the firm's operations.
Song *et al.* (2019)	China	Tax risk reduces firm value and diminishes the firm's incremental value of tax avoidance.
Shi *et al.* (2019)	China	The authors do not find higher future tax volatility for firms with higher tax avoidance. Instead, they argue that firms adopt a stable and continuous tax strategy ex-ante so that tax avoidance does not dramatically increase the firm's tax risk.
Juan and José（2023）	Spain	Tax avoidance may, on the one hand, increase the firm's cash flow, yet on the other hand, it elevates agency costs, informational risk, and the risk of scrutiny by tax authorities, thereby indirectly affecting the cost of debt.
Mkadmi & Ali（2024）	UK	Tax avoidance activities may heighten a firm's tax risk, rendering it more predictable and susceptible to regulatory oversight by tax authorities and potentially impacting its tax compliance and reputation.
Panel B: Accounting information risk (21 studies)		
Hanlon (2005)	United States	Lower earnings persistence for firms with large tax differences.
Blaylock *et al.* (2012)	United States	Investors can identify the causes of accounting tax differences and adopt lower pricing for accounting tax differences resulting from earnings managers and higher pricing for large accounting tax differences resulting from tax avoidance.

Authors	Country	Findings
Dhaliwal *et al.* (2004)	United States	When firms are not expected to meet analysts' forecasts, managers use to meet analysts' forecasts by adjusting downward the tax accruals.
Frank *et al.* (2009)	United States	Firms with higher levels of tax avoidance have lower-quality accounting accruals, suggesting that firms with aggressive tax avoidance may have lower-quality accounting information.
Balakrishnan *et al.* (2011)	United States	Firms with aggressive tax avoidance have higher information asymmetry, greater earnings forecast errors, and lower information quality, suggesting that tax avoidance triggers deterioration in the quality of accounting information.
Hope and Thomas (2012)	United States	Multinational firms that are reluctant to report earnings distribution reports have lower effective tax rates, suggesting that firms that practice tax avoidance reduce the transparency of accounting information to avoid the attention of others.
Bonsall and Koharki (2017)	United States	Tax avoidance triggers increased opacity of accounting information, which leads to rating agency disagreement. Conversely, lower tax avoidance or more tax footnote information disclosure leads to convergence ratings.
Hanlon *et al.* (2005)	United States	Accounting earnings provide more information to the market than taxable income, but both income metrics provide incremental information to investors.
Hanlon *et al.* (2008)	United States	Firms with higher tax differences have higher information return content than those with lower tax differences.
Lennox *et al.* (2012)	United States	Firms with aggressive tax avoidance are less likely to commit accounting fraud, i.e., a negative relationship exists between tax avoidance and accounting fraud.
Blaylock *et al.* (2015)	United States	Firms with high congressional tax differences have lower levels of earnings managers.
Jiang (2013)	China	Strengthening tax collection and managers' efforts can help reduce firm tax avoidance and risk.
Che (2012)	China	Based on the accounting robustness perspective, firms with higher tax differences have lower accounting robustness.
Wang (2016)	China	Compared to low-tax firms, high-tax firms tend to use expensing to implement effective tax avoidance for R&D expenditures.
Zhao and Xu (2012)	China	Firms with lower tax rates use downward earnings managers to reduce their firm tax burden. As a result, tax-averse firms have lower-quality accounting information and a higher risk of litigation for auditors.
Tan and Bao (2015)	China	Firms with larger tax differences have higher audit fees.
Tan and Bao (2015)	China	Tax-averse firms have higher earnings persistence, suggesting that firms with aggressive tax avoidance have higher-quality accounting information.
Tang *et al.* (2022)	China	Tax avoidance increases the risk of deterioration in the quality of accounting information while increasing the level of standardization in tax enforcement, which can help curb the risk of deterioration in accounting information arising from tax avoidance.
Lü *et al.* (2023)	China	Tax avoidance exerts a direct influence on various operational and managerial decisions, thereby affecting the value relevance of earnings.
Cheng Xiaojing (2023)	China	Firms with a higher degree of tax avoidance may increase the quantity of information disclosure while diminishing its quality. Such practices, accompanied by heightened earnings management and moderated by agency costs, impact both the quality and quantity of disclosure, thereby exacerbating information asymmetry.
J.P. Sánchez-Ballesta and J. Yagüe (2023)	Spain	Tax avoidance may, on the one hand, enhance the firm's cash flow, yet on the other, it also heightens agency costs, information risk, and the likelihood of scrutiny by tax authorities, thereby indirectly impacting the cost of debt.

Authors	Country	Findings
Panel C: Reputational Risk (9 studies)		
Hanlon and Slemrod (2009)	United States	The reputation of firms with aggressive tax avoidance is severely damaged, reducing customers' willingness to buy and pay.
Hardeck and Hertl (2014)	Germany	The reputation of firms with aggressive tax avoidance is severely damaged, reducing customers' willingness to buy and pay.
Graham *et al.* (2014)	United States	Direct questioning of firm executives and finding that fear of damage to the firm's reputation is one of the main reasons for reluctance to seek higher tax avoidance.
Chyz and Gaertner (2018)	United States	Firms with lower tax avoidance than their peers have CEOs more likely to be forced to rotate.
Gallemore *et al.* (2014)	United States	The rotation rate of CEOs and CFOs of tax-sheltered firms is not significantly affected over the next three years compared to other firms, and tax-sheltered firms do not impact the firm's Forbes listing.
Lu *et al.* (2011)	China	Defensive strategy firms choose to have a low level of tax avoidance. Moreover, for well-known firms with a defensive strategy, concerns about the firm's reputation risk can reinforce a more cautious tax avoidance strategy.
Ma *et al.* (2019)	China	A significant negative relationship between tax avoidance and a firm reputation indicates that aggressive tax avoidance may damage a firm reputation.
Zhang *et al.* (2019)	China	Aggressive tax avoidance triggers uncertainty about a firm's future operations, and damage to reputation caused by tax avoidance may be an important cause.
Arnaud and Giordano (2024)	France	The study hypothesizes a positive correlation between tax disclosure and corporate reputational risk (RRs), suggesting that companies facing reputational risk are inclined to enhance tax disclosure to restore trust and reputation.
Panel D: Financial risk (34 studies)		
Crabtree and Maher (2009)	United States	Abnormal tax differences lead to analysts' concerns, and analysts downgrade the firm's debt rating accordingly.
Shevlin *et al.* (2013)	United States	The higher the degree of tax avoidance, the higher the interest rate on the firm's publicly offered securities.
Isin (2018)	United States	A positive correlation between tax avoidance and loan spreads in the syndicated loan market.
Guedhami and Pittman (2008)	United States	IRS reviews help better monitor firm tax behavior and thus reduce the interest rate on public bonds.
Kim *et al.* (2010)	Korea	Tax avoidance helps firms reduce bank lending rates and relax non-pricing terms.
Guenther *et al.* (2017)	United States	Tax avoidance does not lead to increased tax risk and further share-return volatility.
Desai *et al.* (2007)	United States	Tax avoidance increases the risk of shareholder short-selling and weakens the firm's value.
Goh *et al.* (2016)	United States	The higher the degree of firm tax avoidance, the lower the cost of equity capital.
Cook *et al.* (2017)	United States	There is no linear relationship between tax avoidance and the cost of equity capital. Too little or too much tax avoidance can increase a firm financing risk, increasing the cost of equity financing.
Desai and Dharmapala (2009)	United States	Overall, tax avoidance does not reduce the overall firm value. Still, tax avoidance contributes to increased firm value for firms with higher corporate governance.
Hines (1999)	United States	Raising the firm tax burden leads to decreased FDI and a significant out-migration of domestic firms.
Shackelford *et al.* (2007)	United States	Tax avoidance without increasing the cost of accounting information promotes firms to choose the region for investment.
Foley *et al.* (2007)	United States	Multinational firms with higher repatriation in-country tax rates have higher cash holdings.

Authors	Country	Findings
Xing (2018)	United States	Firms are holding less cash after-tax rate decreases based on the reduction in the domestic tax rate on repatriation by Japanese multinationals.
Hanlon *et al.* (2017)	United States	The higher the tax risk a firm discloses, the higher its cash holdings.
Dhaliwail *et al.* (2011)	United States	Tax avoidance negatively affects cash holdings. The higher the level of firm tax avoidance, the lower the value of cash holdings.
Liu and Yeh (2013)	China	Tax-averse aggressive firms are more likely to overinvest, which leads to a loss of efficiency in the firm's investment.
Ling and Zhu (2015)	China	The higher the degree of tax avoidance, the lower the efficiency of firm investment
Hu *et al.* (2017)	China	The authors investigate tax avoidance and bank credit supply and find that the higher the degree of firm tax avoidance, the lower the bank credit growth.
Fu and Liu (2016)	China	The higher the firm's tax avoidance, the higher the interest rate on bank borrowing, and the shorter the loan term. It suggests that tax avoidance increases a firm's borrowing risk and leads to higher financing costs.
Wang and Zhang (2017)	China	The higher the tax avoidance, the less efficient the firm's operations, as evidenced by higher overhead and total asset turnover ratios.
Ye and Liu (2014)	China	The higher the tax avoidance, the less efficient the firm's operations, as evidenced by higher overhead and total asset turnover ratios.
Wang *et al.* (2014)	China	Tax avoidance leads to higher on-the-job consumption and overinvestment, while effective corporate governance can mitigate the effects of tax avoidance.
Zhang *et al.* (2019)	China	Aggressive tax avoidance leads to greater firm risk, suggesting that the agency risk that may arise from tax avoidance affects the firm's future operating uncertainty.
Wang *et al.* (2015)	China	The relationship between tax avoidance and the cost of equity capital decreases and then increases, suggesting that the increase in agency costs significantly affects the firm's financing costs only when the level of tax avoidance is high.
Hu *et al.* (2017)	China	An increase in tax avoidance exacerbates firm overinvestment only when the firm has more capital, indicating increased agency costs.
Chen and Jia (2016)	China	Chinese firm tax avoidance increases the value of cash holdings, suggesting that firm tax avoidance is not about appropriating cash assets but reducing the firm tax burden.
Zhang *et al.* (2015)	China	Tax avoidance does not increase the value of cash holdings.
Zheng and Cao (2018)	China	Tax avoidance does not increase the firm's cash holding value, but tax avoidance can increase the firm's cash holding value for firms with low agency costs.
Wang *et al.* (2019)	China	Aggressive tax avoidance can make agency problems prominent and lead to excessive cash consumption by firm insiders. They find that tax avoidance reduces the level of cash holdings.
Zhou and Huang (2019)	China	The higher the degree of tax avoidance, the lower the firm's value.
Song *et al.* (2019)	China	Tax avoidance enhances firm value, while higher tax risk hurts the increase in firm value.
Cheng *et al.* (2016)	China	The impact of tax avoidance on firm value depends on the external economic policy environment.
Letdin *et al.*(2024)	United States	There exists a nonlinear relationship between tax avoidance and the cost of debt. At lower levels of tax avoidance, the relationship is negative, whereas at higher levels, tax avoidance is positively correlated with the cost of debt.

2.1 Tax Risk

Tax uncertainty is the magnitude of the probability that an adverse effect of tax authorities results in a loss of tax proceeds claimed by the firm (Dyreng *et al.* 2019). For example, aggressive tax avoidance may increase tax uncertainty and further impact firm risk (Guenther *et al.* 2017). In 2006, the FASB issued Interpretation No. 48 (FIN 48), which requires firms to disclose potential tax risks, known as Uncertain Tax Benefits (UTB). Dyreng *et al.* (2019) examine the correlation between tax avoidance and tax risk for U.S. listed firms using UTB as a proxy variable for tax risk and find that tax avoidance significantly increases contemporaneous tax risk and is more pronounced in the sample group with a higher likelihood of tax havens, asset transfer pricing. Subsequently, studies have explored in depth the impact of uncertainty on tax revenue generation. For example, Ciconte *et al.* (2016) examine the economic consequences of disclosing relevant tax avoidance risks based on enacting the FIN 48 interpretation. It was found that the enactment of FIN 48 can effectively predict the U.S. firm's tax cash outflows in the next three years, which has high information value and can reduce the uncertainty of future cash outflows caused by tax uncertainty. In addition, Saavedra (2018) finds that firms with higher tax exposure have higher financing costs. In addition, Law and Mills (2015) find that firms with financing constraints have higher tax exposure and greater IRS audit adjustments. It suggests that tax avoidance creates tax risks and that auditors are concerned about such risks, requiring firms to make more adjustments. However, the risk of uncertain tax benefits disclosed in the current period allows tax benefits to be retained and potentially recognized in the future, and in addition, uncertain tax benefits signal to the market that the firm is actively engaged in activities that reduce its tax burden and contribute to increased shareholder wealth. Consistent with this, Frischmann *et al.* (2008) find that the market reacts positively before and after the effective date of FIN 48, suggesting that investors can leverage the tax benefits of uncertainty in disclosure to obtain more information and mitigate firm agency problems. In addition, Koester (2011) finds that firms with higher uncertainty tax benefits have higher share prices in the first two years that FIN48 is in effect.

Unlike developed countries such as the United States, which require disclosure of tax risks, many emerging countries are concerned about tax risks but lack sufficient information. For example, most of China's research on tax risk has focused on indirect approaches, such as strengthening enforcement to reduce tax risk. Tong *et al.* (2016) find that reducing tax risk through enhanced enforcement improves firm operations' efficiency. Similarly, Song *et al.* (2019) find that tax avoidance can enhance firm value while tax risk can harm firm value. However, the findings vary widely based on similar thematic studies. Juan and José (2023) found that tax avoidance may lead to more stringent tax scrutiny and could incur heightened tax risk (Mkadmi and Ali, 2024). Shi *et al.* (2019) provide more direct evidence testing the correlation between tax avoidance and tax volatility risk. Shi *et al.* (2019) do not find higher future tax volatility for firms with higher tax avoidance. Instead, they argue that firms adopt a stable and continuous tax strategy ex-ante so that tax avoidance does not dramatically increase the firm's tax risk. However, increased tax exposure can lead to a firm's share price volatility.

2.2. Accounting Information Risk

Tax avoidance aggressiveness is accompanied by complex business processing and information asymmetry, decreasing the quality of accounting information of aggressive firms' tax avoidance, leading to increased accounting information risk (Desai *et al.* 2007; Bennedsen and Zeume, 2018). Therefore, large tax differences are a sign of firm tax avoidance and an essential indicator of earnings managers, a risk point to which investors must be alert (Hanlon, 2005). In line with this, Hanlon (2005) finds lower earnings persistence for firms with large tax differences. Further, Blaylock *et al.* (2011) distinguish between book-tax differences resulting from earnings managers and tax avoidance and find that investors can identify the causes of accounting tax differences and adopt lower pricing for accounting tax differences resulting from earnings managers and higher pricing for large accounting tax differences resulting from tax avoidance. In addition, tax avoidance generates income tax accrual, which affects the income statement. Although this tax-based accrual is not very large, some evidence links tax avoidance and earnings managers. For example, Dhaliwal *et al.* (2004) find that when firms are not expected to meet analysts' forecasts, managers use to meet analysts' forecasts by adjusting downward the tax accruals. Therefore, tax accrual information is the "last resort" to adjusting accounting accrual (Hanlon and Heitzman, 2010). In addition, Frank *et al.* (2009) find that firms with higher levels of tax avoidance have lower-quality accounting accruals, suggesting that firms with aggressive tax avoidance may have lower-quality accounting information.

Similarly, Balakrishnan *et al.* (2011) found that firms engaging in aggressive tax avoidance exhibit higher information asymmetry, greater earnings forecast errors, and diminished information quality. Consistent with these findings, within the framework of agency theory, it has been observed that higher levels of tax avoidance

lead to a reduction in the value relevance of earnings (Lü Jincheng and Zhang Weixi, 2023) and an increase in earnings management (Cheng Xiaojing, 2023). The evidence above suggests that tax avoidance precipitates a decline in the quality of accounting information.

In addition, based on a study of voluntary disclosure of earnings distribution reports, Hope and Thomas (2012) find that multinational firms that are reluctant to report earnings distribution reports have lower effective tax rates, suggesting that firms that practice tax avoidance reduce the transparency of accounting information to avoid the attention of others. Finally, based on evidence from rating agencies, Bonsall and Koharki (2017) find that tax avoidance triggers increased opacity of accounting information, which leads to rating agency disagreement. Conversely, lower tax avoidance or more tax footnote information disclosure leads to convergence ratings.

However, tax avoidance also brings incremental information, which provides relevant information for investors' decision-making and thus reduces the risk of accounting information. For example, accounting and taxable income are the results of measuring a firm's income under accounting and tax rules. They both have content that provides incremental information about a firm's current and future operating income and value (Hanlon and Heitzman, 2010). Hanlon *et al.* (2005) find that accounting earnings provide more information to the market than taxable income, but both income metrics provide incremental information to investors. The market can respond to relevant information, which shows a large surplus response coefficient. It shows that the information related to tax avoidance can deepen investors' understanding of the firm's financial information, optimize their decision-making behavior, and improve the quality of accounting information. In line with this, Hanlon *et al.* (2008) examine the effect of changes in tax laws on the quality of earnings information and find that firms with higher tax differences have higher information return content than firms with lower tax differences. This view suggests that the existence of tax differences helps investors to obtain adequate information. Some evidence suggests that firms with aggressive tax avoidance may have higher-quality accounting information. Lennox *et al.* (2012) argue that tax avoidance is informative and rational. Investors and government regulators scrutinize firms with aggressive tax avoidance. Hence, firms try to improve the quality of accounting information. Consistent with that view, they find that tax-averse aggressive firms are less likely to commit financial fraud. It is contrary to the conclusion of Frank *et al.* (2009) that tax avoidance reduces the quality of accounting information.

The reason is that their research perspectives are different. Frank *et al.* (2009) investigated the impact of tax avoidance on earnings managers. Earnings managers are relatively secretive, and the possibility of discovery and the cost of punishment after discovery is little. Therefore, listed firms avoid tax and manage earnings at the same time when making decisions to achieve the purpose of obtaining tax savings and hiding adverse information. However, Lennox *et al.* (2012) examine how tax avoidance affects accounting fraud, a severe financial information quality problem with extremely high costs once detected. The trade-off is that listed firms focus on sacrificing tax avoidance benefits to reduce external attention and suspicion of accounting fraud. In addition, firms with large accounting and tax differences help to convey information to outsiders, thus limiting firm earnings managers' practices. Consistent with this, Blaylock *et al.* (2015) find that firms with high congressional tax differences have lower levels of earnings managers.

More studies have been conducted on the relationship between tax avoidance and accounting information quality in emerging market countries. However, most of them are based on their own systems or tax reforms as a background to explore the relationship between tax avoidance and accounting information risk. For example, based on income tax reform as a background, Che (2012) shows that tax avoidance is negatively related to accounting conservatism, indicating that tax avoidance deteriorates the quality of accounting information. Wang (2016), using the tax incentives for R&D expenditures as a background, found that Chinese listed firms manipulate earnings to avoid taxes, indicating that tax avoidance raises accounting information risks.

Zhao and Xu (2012) find that firms with lower tax rates use downward earnings managers to reduce their firm tax burden. As a result, tax-averse firms have lower-quality accounting information and a higher risk of litigation for auditors. Consistent with this, Tan and Bao (2015) find that firms with larger tax differences have higher audit fees. In contrast, Tian *et al.* (2019) find that tax-averse firms have higher earnings persistence, suggesting that firms with aggressive tax avoidance have higher quality accounting information. Jiang (2013) suggests that improving tax enforcement can help introduce external governance and improve the quality of accounting information. Tang (2022) finds that tax enforcement helps reduce the risk of accounting information.

2.3. Reputation Risk

Aggressive tax avoidance often attracts media attention and scrutiny from tax regulators, resulting in high reputational costs. Hanlon and Slemrod (2009) find that share prices fall when the market is informed of tax

sheltering behavior. It suggests that aggressive tax avoidance triggers reputational costs for firms, leading to a decline in firm value. Based on the customer-based perspective, Hardeck and Hertl (2014) find that when the firm is involved in adverse reports of tax avoidance in the media, customers reduce their desire to buy goods, indicating that radical tax avoidance damages the reputation image of the firm in the minds of consumers, causing consumers to reduce their willingness to pay and punish firms that are radical tax avoidance. Arnaud and Giordano (2024) discovered that companies facing higher reputational risk are more inclined to enhance tax disclosure to restore trust and reputation. On the contrary, when firms are involved in responsible tax avoidance reports, consumers are more willing to buy company products. In addition, Graham *et al.* (2014) use direct questioning of firm executives and find that fear of damage to the firm's reputation is one of the main reasons for reluctance to seek higher tax avoidance.

However, not all evidence suggests that aggressive tax avoidance incurs reputational costs. In contrast, a firm implementing less tax avoidance can also create a reputational cost problem. For example, Chyz and Gaertner (2018) find that firms with lower tax avoidance than their peers have CEOs who are more likely to be forced to rotate. In addition, tax avoidance is legally adopted and generates after-tax cash flows. As a result, the firm does not incur reputational costs. Gallemore *et al.* (2014) investigated 118 firms reported by the media due to tax evasion. They found no evidence that the firm or its executives had incurred significant reputation costs because of being accused of engaging in tax avoidance activities. The firm's tax avoidance behavior did not decrease after the discovery of tax evasion. Second, no apparent resignations of CEO and CFO executives have occurred due to negative tax avoidance news. Finally, the market reacts negatively to news about tax shelters, but the impact of this negative news wears off after a few weeks. In short, tax avoidance does not result in negative reputational costs at the firm level.

Chinese studies have also researched whether tax avoidance raises reputational risk. Lu *et al.* (2011) examine the relationship between firm strategy type and tax avoidance degree. They find that defensive strategy firms choose to have a low level of tax avoidance. Moreover, for well-known firms with a defensive strategy, concerns about the firm's reputation risk can reinforce a more cautious tax avoidance strategy. Finally, Ma *et al.* (2019) directly investigate the correlation between tax avoidance and firm reputation and find a significant negative relationship between tax avoidance and firm reputation, indicating that aggressive tax avoidance may damage a firm reputation. Zhang *et al.* (2019) examine the relationship between tax avoidance and corporate risk. They find that aggressive tax avoidance triggers uncertainty about a firm's future operations and that damage to reputation caused by tax avoidance may be an essential cause.

2.4. Financial Risk

Tax avoidance can affect a firm's financial risk, which can be divided into financing, investment, and cash holding risk.

Bond and equity financing are the two most common external financing channels for listed firms. However, an increase in tax avoidance can affect creditors' evaluation of the firm, leading to an escalation of debt financing risk (Letdin *et al.* 2024). As a result, aggressive tax avoidance may lead to a risk transfer from shareholders to creditors, leading to an increased risk of defaulting on the firm's debt. Crabtree and Maher (2009) examine the impact of congressional tax differences and bond analyst rating classifications in line with this. High or low tax differences indicate a potential financial risk to the firm, increasing bond default risk. Therefore, firms with unusually high or low tax differences have a higher risk of default and lower ratings than other firms. In addition, Shevlin *et al.* (2013) find that the higher the degree of tax avoidance, the higher the interest rate on the firm's publicly offered securities, suggesting that investors are wary of tax-averse firm risk and demand a higher risk rate as compensation.

Further, Isin (2018) finds a positive correlation between tax avoidance and loan spreads in the syndicated loan market. The evidence above suggests that tax avoidance creates agency problems and accounting information risks, leading to lenders' concerns about firm risk. Although tax avoidance may raise issues such as agency risk and reduced information transparency, increased tax avoidance may help firms increase earnings and reduce the risk of default if external creditors access internal information and monitor the firm by setting debt terms (Lietz, 2013). Consistent with this, Guedhami and Pittman (2008) find that IRS reviews help better monitor firm tax behavior and thus reduce the interest rate on public bonds. Based on how the implementation of tax avoidance by Korean firms affects the pricing of bank debt, Lim (2011) finds that tax avoidance helps firms to save on tax costs, reduce cash expenses, mitigate financial risk and bankruptcy risk, and thus reduce the cost of corporate debt.

An increase in firm tax avoidance may also affect the concerns of the firm's shareholders, which in turn may lead to an increase in equity financing risk and reduce the firm's value. Kim *et al.* (2009) find that firms with higher levels of tax avoidance face higher risks of share price crashes. Guenther *et al.* (2017) argue that tax avoidance increases tax risk and further volatility in share return. However, the empirical results do not support the relevant conclusions. Guenther *et al.* (2017) find that tax avoidance does not necessarily lead to increased corporate risk because companies generally adopt moderate tax avoidance strategies rather than aggressive ones. Based on more comprehensive evidence, Desai *et al.* (2007) argue that tax avoidance is a cover for insiders to tunnel shareholders. They find that increasing the tax enforcement level increases the firm's share value. It suggests that tax avoidance increases the risk of shareholder short-selling and weakens the firm's value.

In contrast, other studies argue that tax avoidance can reduce the cost of equity financing and increase a firm's wealth by saving money. The evidence is that Goh *et al.* (2016) find that the higher the degree of firm tax avoidance, the lower the cost of equity capital, especially among firms with higher quality accounting information, stronger external monitoring, and stronger tax-saving value-added effects. Further, Cook *et al.* (2017) find no linear relationship between tax avoidance and the cost of equity capital. Too little or too much tax avoidance can increase a firm financing risk, increasing the cost of equity financing. Based on more comprehensive evidence, Desai and Dharmapala (2009) find that overall tax avoidance does not reduce the overall firm value. Still, tax avoidance contributes to increased firm value for firms with higher corporate governance.

Tax avoidance may also influence the choice of location and foreign direct investment (FDI). For example, Hines (1999) finds that raising the firm tax burden leads to a decrease in FDI and a significant out-migration of domestic firms. Shackelford *et al.* (2007) find that tax avoidance without increasing the cost of accounting information promotes firms to choose the region for investment.

Cash is a firm's most liquid asset, and how it invests its cash is influenced by many factors, with taxes being one possible influence. Taxes affect the actual investment behavior of firms through quantitative, timing, risk, and tax credit factors (Hanlon and Heitzman, 2010). For example, investing multinationals must pay tax on profits repatriated to their home countries, while profits that remain invested internationally are exempt from taxation. Therefore, for tax avoidance reasons, the firm keeps the profits offshore for further investment, resulting in a large amount of cash held by the firm. In line with this, Foley *et al.* (2007) find that multinational firms with higher repatriation in-country tax rates have higher cash holdings.

Conversely, Xing (2018) finds that firms holding smaller cash after-tax rates decrease based on the reduction in the domestic tax rate on repatriation by Japanese multinationals. However, the firm may also increase cash holdings to prevent tax risks. Hanlon *et al.* (2017) find that the higher the tax risk a firm discloses, the higher its cash holdings. It indicates that tax avoidance risk invites uncertainty about the firm's future cash flows, causing it to increase its cash holdings to address possible future financial risks.

However, there is also evidence that increased levels of tax avoidance may lead to lower firm cash holdings. For example, Dhaliwail *et al.* (2011), based on the agency theory framework, argues that increased tax avoidance helps managers tunnel the firm's wealth, leading to a decrease in the firm's cash holdings. Moreover, Dhaliwail *et al.* (2011) empirically show that tax avoidance negatively affects cash holdings. The higher the level of firm tax avoidance, the lower the value of cash holdings.

Emerging countries such as China are weaker in governance and more concerned about the economic consequences of tax avoidance. In particular, investment, financing, operations, cash holding and firm value, and financial risk are discussed. In addition, agency problems due to tax avoidance can worsen investment efficiency (Liu and Ye, 2013). Conversely, when tax enforcement is strengthened, investment efficiency is improved. These conclusions are based on the condition that tax avoidance leads to agency problems. Conversely, when agency problems are less severe, tax avoidance savings promote investment efficiency (Hu *et al.* 2017).

Tax avoidance may also affect firm finance risk. For example, existing Chinese studies find that tax avoidance leads to higher financing and credit costs in terms of firm credit financing (Fu, 2017), bank credit supply (Fu and Liu, 2016), and loan pricing and maturity (Hou *et al.* 2016; Wang and Zhang, 2017), respectively. Based on the equity financing perspective, moderate tax avoidance reduces financing risk, and only aggressive tax avoidance increases financing risk (cost of equity financing (Wang *et al.* 2015).

Tax avoidance may incur a loss of efficiency in a firm's operations. Therefore, tax avoidance's effectiveness depends on the manager's strategic objectives and the governance environment. When a manager's strategies are not for firm growth, tax avoidance can lead to the manager's laziness and overspending (Ye and Liu, 2014), resulting in lower firm cash holdings (Wang *et al.* 2019). A good governance environment helps to curb agency risk arising from tax avoidance (Wang *et al.* 2014; Wang *et al.* 2019; Hu *et al.* 2017).

Studies in China have explored how tax avoidance affects firm cash holdings' level and holding value. Due to agency risk, firm tax avoidance does not promote the growth of cash holding value (Zhang *et al.* 2015; Zheng and Cao, 2018), leading to increased uncertainty and firm risk (Zhang *et al.* 2019).

Tax avoidance may also affect the firm's overall value (Zhou and Huang, 2019). However, more studies consider that it depends on the extent of tax avoidance and the impact of the governance environment (Cheng *et al.* 2016; Song *et al.* 2019). Therefore, moderate tax avoidance and effective governance are key to managing risk and enhancing value.

In summary, emerging countries have been rich regarding the economic consequences of tax avoidance. Diversified research and increased focus on financial risk. Research themes are more integrated with localized elements, such as political affiliation (Li and Xu., 2013), tax enforcement flexibility (Ling and Zhu, 2015), and ownership system differences (Wu, 2009; Wang *et al.* 2010).

2.5 Summary of Economic Consequences of Tax Avoidance

Most studies on the economic consequences of tax avoidance are based on tax agency theory along the logical lines of firm tax avoidance - agency problem - tax avoidance risk to carry out empirical studies. That is when firms implement tax avoidance, complex tax shelters facilitate self-interested behavior by insiders, who can take the opportunity to hide unfavorable information or conceal self-interested behavior, leading to a corresponding rise in risk. However, even though empirical findings on tax avoidance risk are growing yearly, some empirical studies still do not support the tax agency theory. Therefore, further and more direct evidence is needed on whether tax avoidance raises risks, and which risks it raises.

3. Discussion and Future Research

This study summarizes three decades of empirical literature on tax avoidance's impact factors and economic consequences. Based on tax agency theory, a three-factor theoretical framework of the impact of tax avoidance and a four-consequence theoretical framework of tax avoidance are proposed. The three-factor theoretical framework of tax avoidance is based on the tripartite framework of managers, firms, and stakeholders to explore the following three issues: (1) Do managers' characteristics affect firm tax avoidance? (2) What characteristics of firms are more aggressive in tax avoidance? (3) Which stakeholders influence firm tax avoidance? The theoretical framework of the four consequences of tax avoidance revolves around whether tax avoidance raises tax risk, accounting information risk, reputation risk, and financial risk. The above theoretical framework can provide researchers with a systematic understanding of the factors and economic consequences of tax avoidance and has implications for researchers, managers, policymakers, and regulators.

First for the researcher: this study draws on tax agency theory to systematically organize the empirical research framework on the factors and economic consequences of tax avoidance, responding well to Halon and Heitzman's (2010) call for more research on tax agency issues and actively exploring who is influencing tax avoidance. This study is helpful for a systematic understanding of tax avoidance, its theoretical basis, and the focus of the debate.

Second, managers should coordinate their self-interest, the interests of shareholders, and the government's interests. Suppose the manager ignores the interests of other stakeholders. In that case, he may incur the attention of market and policy regulators (Lennox *et al.*,2012) and damage his reputation (Graham *et al.* 2014).

Finally, for policymakers: effective allocation of benefits according to accounting contracts, compliance with laws and regulations, and efficiency of firm operations are important objectives for policymakers (Jensen and Meckling, 1976), so whether accounting information risks (Frank *et al.* 2009) and firm financial risks (Liu and Ye, 2013; Lim, 2011) increase are the key detection directions.

In addition, this study is an essential reference for emerging countries such as China in achieving high-quality tax avoidance. The rapid economic development in emerging countries like China coincides with weak governance and lenient tax enforcement, making tax agency issues more concerning (Lin *et al.* 2018). There is an open debate in developed countries such as the United States about whether the tax agency problem is widespread. However, many studies have shown that tax avoidance does not increase risk (Blaylock, 2011; Guenther *et al.* 2017). Although a few studies in emerging countries such as China also point out that tax agency risk is conditional (Zhang *et al.*,2015; Hu *et al.* 2017), studies on tax agency issues have become more numerous in recent years and mostly tend to support the conclusion that tax avoidance triggers risk. For example, tax avoidance increases risk only in poorly governed firms. Among well-governed firms, tax avoidance does not increase risk and reduces firm risk (Hu *et al.* 2017). With the growing call for high-quality development in

emerging and new developing countries, optimizing governance structures, managing tax avoidance risks, and achieving a coordinated distribution of benefits among multiple parties is an inevitable path for other emerging economies such as China. This study provides a detailed theoretical overview of how to influence tax avoidance and what the consequences of tax avoidance are. It also provides a basis for subsequent firm management of tax avoidance risks and sustainable tax policies.

Acknowledgments

1. Guangdong Province Philosophy and Social Sciences Project (GD24XYJ42). "Can digital transformation improve the information environment of capital markets? Based on the perspective of stock price informativeness."
2. 2023 Guangdong Philosophy Social Science Planning Project (GD23CGL18), "Research on the Accounting Monitoring Mechanism for Ecological Anti-Dumping Based on Carbon Transfer Governance."
3. 2023 Guangdong Education Science Planning Project (2023GXJK893), "Research on the Effectiveness Evaluation and Enhancement Strategies of Vocational Education Promoting Common Prosperity under the Background of Chinese-style Modernization: Evidence from Guangdong Province's Practice."

Credit Authorship Contribution Statement

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Wunhong Su: Conceptualization, Validataion, Methodology, Writing – review and editing, Project administration, Supervision.
Wong Ming Wong: Conceptualization, Methodology, Writing – review and editing, Project administration, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

Data Availability Statement: The data supporting this study's findings are available from the corresponding author upon reasonable request.

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DOI: https://doi.org/10.14505/tpref.v15.4(32).04

The Determinants of SME Credit Rationing in Morocco. Case of SMEs in the Casablanca Settat Region

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Article info: Received 14 September 2024; Received in revised form 9 October 2024; Accepted 8 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: In this article, we are concerned with a central element of the Moroccan economy, namely small and medium-sized enterprises (SMEs), which often find themselves in a situation where alternative sources of financing are not easily accessible, including bank financing. Indeed, Moroccan SMEs are closely dependent on banking institutions to obtain the financial support necessary for their projects. However, these businesses frequently face the phenomenon of credit rationing, necessitating improved access to credit. In this research work, we have contributed to the study of this phenomenon, focusing specifically on the Casablanca Settat region. Our research revolves around two essential objectives. Firstly, we aimed to evaluate the impact of credit rationing on SMEs in this region. Next, we focused on empirically identifying the determinants of this phenomenon. To achieve these objectives, we selected a target population of 218 SMEs from the Casablanca Settat region. Our initial statistical tests revealed that SMEs in the Casablanca-Settat region are facing both total credit rationing and partial credit rationing.

Subsequently, the results obtained from multinomial logistic regression tests reveal that the SME's sector of activity, age, reputation, legal status, size, gender of its manager, age, education, nature of the relationship with the bank, and professional experience all play an important role in explaining this phenomenon.

Keywords: Moroccan SMEs; information asymmetry; credit rationing; bank financing.

JEL Classification: G23; G32; D82; C10.

Introduction

In addition to its role as a driver of economic growth, private investment plays an important socio-economic role as the primary creator of jobs, justifying the special attention and regular support of public authorities for this sector. Small and medium-sized enterprises (SMEs) are essential players in all sectors of the Moroccan economy, generating quality jobs. With a share of 29% in the economic fabric, they employ 40% of the active population, contribute 30% to GDP, 26% to added value, and 21% to exports. These performances illustrate the ability of SMEs to effectively address concerns related to economic growth and employment. Their essential role in the Moroccan economy highlights the need for sustained attention to their development and strengthening.

However, small and medium-sized enterprises often need help obtaining bank financing due to limited profitability and an inability to meet the requirements of financial institutions. According to Daoui and Haj Khalifa (2013), restricted access to bank financing is one of the main obstacles that Moroccan SMEs face in terms of development.

According to Dietsch and Mahieux (2014), the financing needs of SMEs rely on external resources, particularly bank credit. However, even though the number of funding requests is on the rise, it remains difficult to meet the credit demand of small and medium-sized enterprises. This situation encourages banks to adopt a more rigorous approach to analyzing these requests and to implement drastic financing conditions that can sometimes

be discriminatory, such as increasing interest rates, requiring additional collateral worth significantly more than the amount of credit requested, or even refusing to provide financing. Furthermore, the credit market imperfection, which arises from information asymmetry, creates uncertainty regarding the granting of financing, particularly in the context of relationships between banks and SMEs.

Indeed, in our opinion, the persistence of information asymmetry puts Moroccan banks in a difficult position, as it is challenging to distinguish reliable borrowers from those with ill intentions who pose a significant default risk. This uncertainty can lead small and medium-sized enterprises to adopt an opportunistic approach once they have secured funding. As a result, in the face of this dilemma, banks in Morocco must adopt a conservative stance, which may lead to a rationing of credit demand.

Furthermore, in Morocco, there is a lack of information regarding the volumes of rejected bank financing requests. Indeed, the automatic overwriting or, in rare cases, archiving of the application file upon rejection of a funding application prevents SMEs from understanding the true reasons for the rejection of their funding request.

Furthermore, the review of previous studies on the financing of Moroccan SMEs revealed the existence of research examining the credit rationing of Moroccan SMEs, which is both limited in scope and restricted in time. Consequently, the issue remains insufficiently explored. Given these observations, we deemed it appropriate to analyze the phenomenon of credit rationing for SME.

A deeper exploration of this phenomenon in the Moroccan context, particularly in the Casablanca-Settat region, which is at the heart of Morocco's economic activity, is crucial for SMEs. This will allow them to identify their weaknesses in terms of funding requests. Furthermore, we believe that this study will enable Moroccan financial oversight bodies, such as Bank Al Maghreb, to assess the effectiveness of the financing and recovery plans granted to SMEs by banks.Thus, this scientific investigation seeks to answer the following question: What factors explain the credit rationing of SMEs in the Casablanca-Settat region?

Our reflection begins with a theoretical analysis of credit rationing and the presentation of the research variables and hypotheses. The second section presents the methodology, while the final section analyzes the results of the empirical study.

1. Literature Review

1.1. Theoretical Definition of the Concept of Credit Rationing

We have identified several definitions of credit rationing through our theoretical analysis. According to Jaffe and Russell (1976), credit rationing occurs when the amount of credit the bank grants is less than the amount requested. Two types of credit rationing are distinguished by Keeton (1979): Type I rationing, which results from a partial refusal of all borrowers within a group, and Type II rationing, which occurs when some borrowers receive the total amount requested within a group while others are restricted. According to Stiglitz and Weiss (1981), credit rationing occurs when the borrower is willing to accept the bank's terms and the bank has sufficient funds yet still refuses to grant the loan or moderates the requested amount.

In the same spirit, Bester (1987) assumes that credit rationing occurs when specific borrowers do not receive credit, even if they are willing to pay a higher interest rate or provide collateral. This situation can be explained by an imbalance in the credit market, where supply exceeds demand. Jaffe and Stiglitz (1990) adopt a more dynamic approach by incorporating the borrowing interest rate into the credit rationing equation. They identify four types of rationing:

-Type I Rationing: A borrower can obtain a loan of a smaller size than requested at a given interest rate. The borrower must pay a higher interest rate to obtain a larger loan.

-Type II Rationing: There are differing opinions on rationing. Some borrowers deemed low-risk cannot borrow at the interest rate and under the terms they consider appropriate, given their likelihood of default.

-Type III Rationing: "Redlining" distinguishes a situation in which the bank has all the information about the borrower that can reduce information asymmetry and assess their likelihood of default. In this situation, the bank decides to refuse the loan.

-Type IV rationing: Pure credit rationing occurs in a situation of significant information asymmetry, where the bank rations credit even for identical borrowers.

In general, based on the various theoretical definitions of credit rationing already mentioned, it is possible to conclude that under certain circumstances, credit rationing manifests either as a refusal of the financing request or as a limitation on the amount of credit requested.

1.2. Information Asymmetry and Credit Rationing

Several researchers have raised the issue of financing policy for SMEs in their work, whether from the perspective of the lender or the borrower. Furthermore, the theory demonstrates a causal link between credit rationing and information asymmetry Stiglitz and Weiss (1981); Binks and Ennew (1997).

Regarding credit rationing, in the credit market, information asymmetry refers to the information disparity between the lender and the borrower. On the one hand, the borrower is distrustful and refuses to share relevant information about themselves, their business, or their financing project. On the other hand, the lender, being rational, does not wish to incur additional costs to obtain the information deemed relevant Roger (1988). In this context, when the information provided is deemed poor quality or irrelevant by the bank's decision-making center, it may proceed to ration credit in various ways.

Credit rationing is more likely when information asymmetry is high, as Stiglitz and Weiss (1981) point out. Jensen and Meckling (1976) argue that ignoring information asymmetry can lead to unintended allocation of funds through asset substitution. When creditors lack knowledge about the projects they are financing, they become more vulnerable. In fact, managers have a better understanding of the quality of their investments than creditors because they do not have the same interests Jensen and Meckling (1976). When corporate managers find project ideas that have potential, they are reluctant to provide the bank with the necessary details. Thus, the leader of a small or medium-sized enterprise can conceal information deemed relevant by the bank in order to obtain a loan or to benefit from more favorable credit terms (Lobez and Vilanova 2006). This can lead to adverse selection upstream. Once the credit is obtained, the manager will seek to maximize profit, disregarding the existing agreement.

Van der Wijst (1989) demonstrates that access to credit for SMEs is directly related to the costs associated with information asymmetry. Binks and Ennew (1996) show that information asymmetry is a characteristic of small borrowers. Thus, the high cost associated with information production would explain why information asymmetry is more common in small businesses, which experience more credit rationing than their medium and large counterparts St-Pierre and Bahri. (2011). According to Binks *et al.* (1992) and Bruns and Fletcher (2008), the main problem faced by SMEs when trying to obtain financing is the need for more symmetric information about the project to be financed.

Williamson (1987) revealed a causal link between credit rationing and excessive agency costs related to monitoring the borrower's performance. In other words, rationing results from a cost-based reflection, and it will be considered if the bank believes that the costs incurred for controlling the SME exceed the profits to be made. Stiglitz (1986) demonstrates that agency costs increase in the context of moral hazard and information asymmetry, which explains why banks ration credit.

1.3. Implications of Prior Information Asymmetry on Credit Rationing

Akerlof (1970) was the first theorist to highlight the impact of information asymmetry in financial transactions. He stated that actors do not have the same information in the market. To explain his reasoning, Akerlof gave the example of the used car market in his article "The Market for Lemons" Akerlof starts from the general idea that the seller of a used car knows the characteristics of their car better than the potential buyer. Initially, buyers are aware that the market includes low-quality cars. They are therefore looking to pay a lower price for cars.

However, owners of good-quality cars refuse to sell at this price and are permanently withdrawing from the market. As a result, only low-quality cars remain on the market. Indeed, a buyer who needs to have all the information about the quality of the cars offered sets an average purchase price based on the market price. At this price, only sellers of inferior-quality cars remain in the market, creating adverse selection. To counter this distorted interpretation from the buyer, the honest seller must make an extra effort to signal on the market to justify their car's condition. According to Spence 1973, the signaling technique safeguards against negative interpretations in markets characterized by information asymmetry.

In theory, we have seen that information asymmetry leads to adverse selection resulting from an informational imbalance. Indeed, the market is constantly disrupted and affected by the fact that one party better understands the characteristics of the exchanged goods at the time of the contract signing (ex-ante). In this case, the price no longer serves its role as a credible indicator of value.

In a credit market, information asymmetries refer to the disparity between the information held by the firm seeking credit and that of the fund providers, who are often at a disadvantage in information. Regarding SMEs, Psillaki (1995) states that the existence of a challenging nature in these companies can lead to a specific adverse selection in the case of a credit request, thereby resulting in credit rationing. A preference for self-financing over external financing may be adopted in such a situation.

In the same vein, Jappelli and Pagano (2005) estimate that when information exchanges are appropriate, there can be four consequences, namely: 1) a decrease in adverse selection, 2) a decrease in borrower retention and banking information rents, 3) a decrease in disciplinary effects on borrowers, and 4) the elimination of incentives for over-indebtedness related to relationships with multiple banking institutions. When small and medium-sized enterprises actually provide the information required by banks, the latter grant loans more easily.

1.4. Implications of Post-Contractual Information Asymmetry on Credit Rationing

The issue of credit rationing, in addition to worrying businesses, has long sparked the interest of researchers in the economic and financial fields. Although the characterization of a rationing situation seems to be widely agreed upon (demand for credit consistently exceeding supply at the prevailing market rate), the analysis of the origins of this phenomenon has remained superficial for a long time. The concept being precisely defined a true explanation of the origin of a credit rationing equilibrium situation was only provided by Stiglitz and Weiss (1981). Our two theorists consider the following interaction between a bank and risk-neutral, companies: At time t=0, a bank is faced with borrower candidates, each needing to borrow an amount B to finance an investment. The bank accepts or refuses to grant credit without having the ability to assess the candidate's risk. If the financing is approved, the bank sets an interest rate r and a guarantee amount C. At t = 1, the revenues from each funded project are generated. Let R be the revenue generated. Two states are possible: if $R+C \geq B(1+r)$, the bank is fully reimbursed. On the other hand, if $R+C \leq B(1+r)$, the borrower is in default and the bank captures all generated income.

One of the key points of the analysis by Stiglitz and Weiss (1981) also rests on the banks' inability to observe the risk of loan applicants. Consequently, in the case of a credit agreement, the bank applies the same rate R to all borrowers.

However, the application of a single rate, in the terminology of contract theory, does have consequences for the quality of loan applicants. The logic of Stiglitz and Weiss is based on the fact that the expected profit of borrowers is an increasing function of the risk of their project. The rule of limited liability for shareholders implies that a company's profit is a convex function of the outcome of its project. Indeed, shareholders have a loss limited to C in the event of default, while their gains are unlimited in the case of success. Thus, borrowers with the highest risks, who have a higher probability of generating high incomes, have a higher profit expectation than other firms. On this basis, Stiglitz and Weiss put forward the following proposition: for a given interest rate (r), there exists a risk threshold ô such that only firms with a higher risk ($o > ô$) will seek a loan. It is clear that a firm will only want to borrow if its profit is greater than 0. Knowing that the borrower's expected profit is an increasing function of its risk, only borrowers with a risk ($o > ô$) will have an incentive to apply for a loan.

The consequences of this proposal are significant. Firstly, we can consider the bank's incentive to raise the interest rate (r), as an increase in the interest rates charged leads to a change in the profile of loan applicants, with the bank then facing borrowers who are, on average, riskier.

The impact of an increase in interest rates on bank profits and ratios is significant. In response to risk aversion, the increase in borrowing interest rates will drive away good borrowers, leaving room for riskier borrowers. Thus, an increase in the rate generates two opposing effects on the bank's expected profit:

-A positive effect where the banking margin increases and the quality of borrowing candidates remains unchanged.

-A negative effect where the bank records a deterioration in the average quality of its clients.

That said, according to Stiglitz (1981), credit rationing can result from two actions: either because one party holds more information than the other or due to the costs deemed too high to obtain and process the information, which can likely lead to the phenomenon of credit rationing. Stiglitz (1981) also suggests two direct consequences of information asymmetry: adverse selection and moral hazard. Indeed, the lender does not possess all the information about the financing object. At the same time, the borrower holds all the information regarding the financing object and the likelihood of success of their project. This situation recalls the example of the "lemons" market. In such circumstances, adverse selection becomes predominant. Banking institutions offer high interest rates to protect themselves against the likelihood of default by dishonest borrowers considered to be bad borrowers. However, these conditions may discourage good borrowers and discriminate against them. The increase in interest rates can serve as a protective measure against risky borrowers. However, there is a threshold beyond which the increase in risk outweighs the rise in interest rates, leading banks to refrain from further increasing the interest rate. This then leads to the rationing of credit Stiglitz et Weiss (1981).

1.5. Signal Theory: Towards a Moderation of Information Asymmetry

The signaling theory, founded by Stephen Ross, who initiated the main work in this field in 1977, was developed to address the shortcomings of equilibrium market theory. It starts from the observation that each financing structure will have its price in the market in a situation of information asymmetry, as every financing decision will impact the firm's image.

In a context of informational asymmetry, where the bank can only rely on its assessment power to address issues related to moral hazard and adverse selection, the situation is considerably different for the fund seekers. Indeed, candidates with good intentions and a low risk of default are often undervalued by the bank, which forces them to use all available means to demonstrate their true worth.

According to Ross (1977), the transmission of an actual image of the company through signaling is not systematic, as it requires that the signal cannot be imitated on the one hand and that the marginal cost of the signal decreases with the quality of the sender on the other hand. Moreover, the role of the signal attributed to short-term debt, as highlighted by Flannery (1986), is based on the idea that this form of debt allows for the adjustment of the credit contract terms in light of new information.

Thus, to reduce issues related to information asymmetries, the leaders seek to signal their level of indebtedness to share certain credibility of the firm. The increase in debt thus reflects the confidence of lenders. By opting for a short-term financial solution, the leader sends a message to the market about their willingness to cooperate, highlighting their short-term performance by publishing cash flows. Thus, the funder can observe the company's performance over a short period and ultimately decide whether it deserves its long-term commitment.

According to Flannery (1986), investors can infer private information from issuers by observing the maturity of their debt. On their part, Leland and Pyle (1977) believe that a leader with a risk aversion can signal the quality of their projects to funders by investing a significant portion of their wealth in their business.

However, the inherent constraint of signaling is that poor signaling can lead to misinterpretation by the market, which will subsequently trigger an adverse reaction from investors. This difficulty arises even in the case of the most successful firms. However, the leader will strive to make the signals issued by the company as true to reality as possible to stand out distinctly.

Consequently, indebtedness can be seen as the preferred signal company leaders use to inform less informed agents about their financial situation. It is important to note that a less-performing firm cannot imitate the signal emitted by the leader of a high-performing firm due to its high cost and the negative consequences in the event of a misleading signal.

Ross (1977) has also examined bank borrowing from the perspective of signaling theory. Indeed, Ross (1977) suggests that a manager whose salary depends on the firm's current and future value will use debt to signal the quality of the company (which only he knows) in the market. The dependence of his salary on the company's current value encourages him to report, while a penalty in the event of bankruptcy pushes him to overestimate that value. Narayanan (1988) suggests that signaling results from the correlation between two elements: the status of the manager, who is the only person better informed about the firm's situation, and the context of information asymmetry.

Indeed, a competent business leader, confident in the profitability of the investments made and the availability of projected positive cash flows, will not hesitate to seek external financial support in the form of debt. Thus, the outside world perceives the use of debt as evidence of a strong potential for growth.

1.6. Microeconomic Factors of SMEs Influencing Credit Rationing

We have already mentioned that the persistent information asymmetry in the credit market impacts banks' decisions regarding lending to SMEs. From an empirical standpoint, numerous scientific studies have sought to establish a relationship between credit constraints and the characteristics of the company and its leader.

Due to the complexity of evaluating intangible assets compared to tangible assets, SMEs operating in the service sector face more financial constraints than those in the manufacturing sector Cressy and Olofsson, (1997). Briozzo and Vigier (2014) assert that companies in the manufacturing sector have a larger pool of assets available for loan collateral. This parameter helps reduce information disparities between the company and lenders, which increases the chances for these businesses to obtain access to credit. SMEs operating in the service sector encounter greater challenges when seeking external financing (Guercio *et al.* 2020).

According to the conclusions of Andrieu *et al.* (2018), SMEs operating in the manufacturing sector have a higher likelihood of obtaining bank loans and commercial credit compared to those in other sectors. The choice of funding sources affects SMEs in India engaged in export activities, according to Baker *et al.* (2020). Research

confirms that Mexican companies operating in the manufacturing sector have a higher probability of obtaining bank loans compared to those in other economic sectors, while those in the services sector have the lowest probability of accessing bank financing. Jiménez-Rico *et al.* (2023). Since the late 1980s in the United States, Levenson and Willard (2000) have observed that the size of a company in terms of workforce influences the financing decisions of small businesses.

Due to large companies' greater access to external financing sources and lower borrowing costs than small companies, Rao and Kumar (2018) found a positive correlation between the size of companies and their level of indebtedness.

According to Guercio *et al.* (2020), the legal structure of a company, such as a corporation or a limited liability company, which limits financial liability, impacts credit acquisition due to its increased transparency compared to companies without financial liability limitation.

In a similar context, Baker *et al.* (2020) highlight the fact that limited liability companies show a stronger preference for all sources of financing compared to sole proprietorships. According to Briozzo and Vigier (2014), companies operating as limited liability companies should benefit from more favorable bank credit conditions.

Berger and Udell (1995), in a study involving a sample of 3,000 SMEs, concluded that the longer the relationship between the SME and the bank, the more it benefits from privileges in terms of interest rates and collateral requirements.

Bellemare (2000), focused on credit constraints in urban Morocco, concludes that microenterprises in Casablanca face credit rationing. Business size, number of employees and apprentices, and bank account ownership affect this phenomenon. Due to large companies' greater access to external financing sources and lower borrowing costs than small companies, Rao *et al.* (2018) found a positive correlation between the size of companies and their level of indebtedness.

An international ISO certification, which attests to quality management and environmental management systems, increases the chances of accessing bank financing, according to empirical studies like the one Hattou (2016) conducted on SMEs in East Africa.

Quamar (2008) shows that the new method of credit risk assessment, which takes qualitative forms due to the lack of transparency in SMEs' financial statements, is likely to influence the relationship between banks and SMEs in Morocco within the framework of the Basel II banking regulations. The variables on which the bank bases its rating of small and medium-sized enterprises (SMEs) are all qualitative. Quamar (2008) distinguishes two forms of qualitative variables. The first concerns the level of commitment from the management team and shareholders, measured by the leader's involvement in the project, the company's transparency, and the quality of support. The second form concerns the level of industrial risk of the company's activity, measured by the duration of its operations, the position of the sector in the economic cycle, and its position within its sector.

Rao *et al.* (2018) highlighted a positive correlation between the seniority of the company and its access to financing. Established companies are more likely to access credit, in contrast to newer companies that primarily rely on their internal resources and avoid external financing due to their limited credibility in the credit market.

As SMEs age, the share of bank loans gradually increases while the reliance on informal financing decreases Nizaeva and Coskun (2019). Small businesses in Mexico have a lower probability of obtaining bank loans. In reality, the age of the company proves to be the most reliable predictor of bank credit approval; according to the profile analysis, as the company's duration of existence increases, the likelihood of obtaining a bank loan gradually increases Jiménez-Rico *et al.* (2023).

Buttner and Rosen (1988) found that 106 banking executives were more likely to support businesses led by men than by women. According to Carrington (2006), women in leadership positions are much more exposed to banking discrimination in terms of access to financing. Naranchimeg (2015) noted that credit denials are more common for women-led businesses.

Chaudhuri *et al.* (2020) observed that there is approximately a 10 to 12% higher probability for male-owned businesses to obtain formal financing compared to female-owned businesses. Moreover, their conclusion highlights the obstacles faced by women-owned businesses due to sexist discrimination in the credit field. Phung (2009) conducted a study on Vietnamese small and medium-sized enterprises that revealed that manager characteristics, such as age, experience, and skills, often influence the decision to credit rationing.

Amrhar (2019) made a significant scientific contribution by examining the issue of credit rationing for companies operating in the Souss Massa region. The main results of this study are as follows: debt ratio, type of activity, type of company, turnover, age of the company and manager, location, legal aspects, debt level, location,

experience, age, and education level of the manager explain credit rationing for companies in Morocco, particularly in the Souss Massa region.

Companies in Mexico do not rely on the gender or experience of the manager as determining factors in obtaining bank financing (Jiménez-Rico *et al.* 2023).

Building on the previously mentioned elements, we propose to verify the following hypotheses:

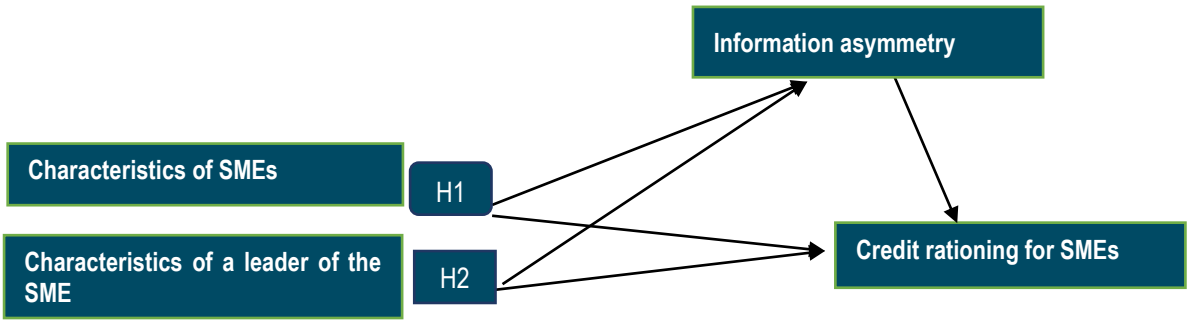
Hypothesis no 1: The characteristics of the SME are determinants of total and partial credit rationing.

Hypothesis no 2: The characteristics of the SME leader are determinants of total and partial credit rationing.

1.7. Conceptual Model

Our literature review has identified various microeconomic factors that could impact the decision to grant a loan to a small or medium-sized enterprise, particularly those related to these businesses' internal environment. From this perspective, we have developed a conceptual model highlighting the correlation between credit rationing and the characteristics of the SME and its leader. The general idea of our theoretical reflection on the phenomenon of credit rationing for SMEs in the context of information Asymmetry is summarized and illustrated by the conceptual model we propose. We also estimated that introducing the concept of information asymmetries as a mediating variable in the conceptual model we propose will allow for a more accurate assessment of the strength of the relationship between our variables and, thus, a more rigorous explanation of the phenomenon of credit rationing.

Figure 1. Conceptual model



Source: Compiled by the authors

2. Methodology

We asked small and medium-sized enterprises in the Grand Casablanca Settat region to voluntarily complete a simple questionnaire. The questionnaire we created is based on our literature review, particularly the works of Phung (2009) and Amrhar (2019). He proposes a combination of dichotomous questions and multiple-choice questions with selectable answers.

2.1. Sample

Based on the following criteria, we decided to select our sample: The SME must be located in the Casablanca-Settat region, operate in a specific sector of activity and achieve an annual turnover excluding taxes of between 10 and 175 million dirhams, according to the definition of SMEs given by Bank Al-Maghrib, (circular n°8/G/2010). 850 SMEs in the Casablanca-Settat region responded to our survey, 218 of them have at least used bank financing. It is essential to note that the data collection process began in the last quarter of 2021 and required a survey on our part over 12 months (from 09/2021 to 08/2022).

2.2. Characteristics of the Sample

Before starting the analysis of our database, which is composed of responses provided by SMEs, it is essential to present a statistical overview of the critical properties of our research subject. This preliminary step will enhance our understanding of this population, the structure of the observed subjects, and the characteristics under investigation. The table below presents the most notable characteristics of the sample.

Table 1. characteristic of the rationed SMEs in our sample

Variable	Mesure variable	Modality	Frequency	Valid percentage
Characteristics of SMEs	Activity	Commerce	21	17,2
		Industry	35	28,7
		Construction	5	4,1
		Service	61	50
	Legal status	Limited liability company (LLC)	68	55,7
		Sole proprietorship	29	23,8
		General partnership (GP)	4	3,3
		limited company	11	9
		Limited partnership company	10	8,2
	Family business	No	76	17,4
		Yes	46	10,5
	Number of employees	Fewer than 5 employees.	32	26,2
		Between 5 and 10 employees.	46	37,7
		Between 10 and 20 employees.	24	19,7
		Between 20 and 40 employees.	14	11,5
		Plus 40 employees.	6	4,9
	The age of the SME	Before 1990	2	1,6
		Between 1990 and 2000	5	4,1
		Between 2000 and 2008	39	32
		Between 2008 and 2018.	43	35,2
		Between 2018 and 2020.	33	27
	reputation	No	97	79
		Yes	25	21
	Accounting document	No	19	16
		Yes	100	84
Characteristics of a leader of the SME	Sex leader	Feminine	23	18,9
		Masculine	99	81,1
	Age of leadership	Under 30 years old.	22	18
		Between 30-40 years old.	49	40,2
		Between 40-50 years old.	36	29,5
		Over 50 years old.	15	12,3
	Category Training Leader	Literary	30	24,6
		Scientific	32	26,2
		Technical	60	49,2
	Level Leader	Baccalaureate level	7	5,7
		Two-year degree	45	36,9
		Three-year degree or bachelor's degree	37	30,3

Variable	Mesure variable	Modality	Frequency	Valid percentage
		Master's degree (Bac +5)	30	24,6
		Doctorate	3	2,5
	Training Management	No	69	56,6
		Yes	53	43,4
	Professional experience	No experience.	67	54,9
		Between 1 - 5 years	39	32
		Between 5 - 10 years.	6	4,9
		More than 10 years.	10	8,2
	Bank relationship Executive	Between 1 and 3 years.	61	50
		Between 3 and 5 years.	27	22,1
		Between 5 and 10 years.	20	16,4
		More than 10 years.	14	11,5

Source: Compiled by the authors

2.3. Measurement of Variables

We drew inspiration from the research of Phung (2009) and Amrhar (2019) on business credit rationing. Thus, six variables are used to measure the qualities of the SME: the type of business, the governance mode, the size of the workforce, the age of the SME and the reputation of the company as determined by its ISO certification and the certification of its accounting documents. The seven criteria used to measure the qualities of a manager are: the age of the manager, his gender, his level of education, his training specialty, his management training, his experience and his relationship with the bank.

Table 2. Variables of the study

Variable	Nature variable	Mesure variable
Total or partial credit rationing	Dépendent	The credit application may be rejected or the requested credit amount may be lowered.
Characteristics of SMEs	Independent	Activity, Age, Legal form, Size of the SME, family-owned SME,ISO Certification(reputation), Certification of accounting documents
Characteristics of the SME leader.	Independent	Sex, Age, Education, Level of education, Management skills, Professional experience, Banking relationship with executives

Source: Compiled by the authors

2.4. Statistical Data Analysis Methods

The statistical tests we used in this scientific work include Chi-square contingency tests and multinomial logistic regression.

2.4.1. Cross Table (chi-square)

The Chi-squared analysis allows for evaluating the relationship between two categorical variables. We use this statistical test to ascertain the independence of the two variables. By default, the null hypothesis (H0) states no relationship between the variables. The decision rule is based on the (p-value), which represents statistical significance. If the (p-value), is less than (0.05), we reject (H0), which suggests a significant relationship between the two variables.

The test statistic for the Chi-Square Test of Independence is computed as:

$$\chi 2 = \sum_{i=1}^{R} \sum_{j=1}^{C} \frac{(oij - eij)2}{eij} \quad (1)$$

where:

– oij is the observed cell count in the ith row and jth column of the table.

- eij is the expected cell count in the ith row and jth column of the table, is computed as:

$$\mathbf{eij} = \frac{\mathbf{row\ i\ total} * \mathbf{col\ j\ total}}{\mathbf{grand\ total}} \quad (2)$$

We use Cramer's V coefficient to measure the relationship's strength. A (V value) greater than or equal to (0.70 indicates a profound relationship, while a (V value of 0.00) indicates an absence of a relationship.

2.4.2. Multinomial Logistic Regression Test

Logistic regression is used to model a variable with two binary response modalities or multiple polychromatic response modalities (K ≥ 2 classes), based on a matrix of explanatory variables X1, X2, ..., XP, whether they are quantitative or qualitative. In general, the logistic regression test allows for assessing the model's overall validity and evaluating the impact and relationship of each variable on the model. It also allows for checking the model's validity for each of the variable Y's modalities.

The following equation expresses the logistic regression model:

$$P(Y) = \beta 0 + \beta 1\ X1 + \ldots + \beta P\ XP + \varepsilon \quad (3)$$

2.4.3. Cox and Snell R^2

The Cox and Snell $\mathbf{R}^2$ coefficient measures the strength of the association (the effect size) and provides an indication of the model's fit. It represents an estimate of the variance explained by the model. The higher the values of this coefficient, the closer the predicted probability by the model is to the observed value.

The Cox and Snell R^2 is:

$$R2 = 1 - (L0|LM)^{\frac{2}{n}} \quad (4)$$

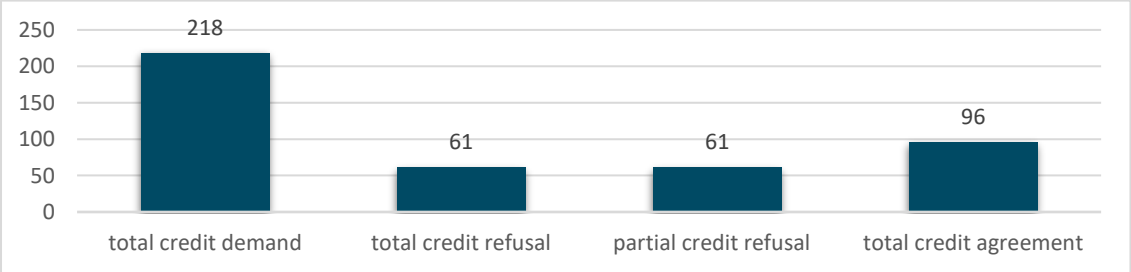
L0 is the value of the likelihood function for a model without predictors, and LM the likelihood of the estimated model.

3. Results and Discussion

3.1. Identification of Credit Rationing in Our Sample

We decided to use Jaffe et Russell (1976) and Keeton (1979) definitions, which assumes that there is rationing when the bank refuses to grant the loan or modifies the requested amount, to identify the phenomenon of credit rationing in our sample.

Graph 1. Result of the credit request from SMEs that sought bank financing



Source: Author's calculations

Previously, we presented several theoretical definitions of credit rationing. It is important to note that our base sample consists of 365 SMEs, of which 218 have already sought bank financing. We have observed that 56% of SMEs have already experienced rationing. Indeed, out of this total, 61 SMEs had their credit requests denied, and 61 SMEs received a favorable agreement but with a partial amount of the requested sum.

On the other hand, we found that of SMEs that received a favorable decision on their credit request with full acceptance of the amount requested is the highest in our sample, at 44%.

Ultimately, SMEs in the Casablanca-Settat region are experiencing both total and partial credit rationing. This situation can hinder SMEs' development and justify implementing public policies to facilitate their access to bank financing.

3.2. SMEs' Characteristics Determine Total and Partial Credit Rationing

3.2.1. Chi-Square Test

Our cross-tabulation reveals that the variables Activity, Legal Status, Company Capital, Number of Employees, Age, and Reputation are significant at the 0.05 level, indicating a relationship between the outcome of the credit application and the characteristics of the SME.

Regarding the activity of SMEs, we observe that total credit rationing primarily affects service SMEs (18%), while industrial SMEs are more impacted by partial rationing (11%). SMEs in the construction sector are less rationed, experiencing only partial rationing (5%).In terms of legal status, we observe a high level of total and partial rationing affecting limited liability companies (68%), followed by individual SMEs. Furthermore, we observe the limited company are less rationed and only experience partial rationing, but they have a high degree of acceptance of credit demand.

Family-owned and non-family-owned SMEs are experiencing total and partial rationing, although it is more pronounced among non-family-owned SMEs.Total credit rationing generally affects SMEs with fewer than 10 employees, while it is less pronounced among SMEs with more than 10 employees.

Regarding reputation, measured by the possession of an ISO certification, we find that SMEs without it are the most rationed, at 28%, and those not affected by rationing, at 23%. The limited number of SMEs with an ISO certificate in our sample explains this.

We also note that total credit rationing has the most negligible impact on the oldest SMEs. However, our statistical tests reveal that SMEs with over 20 years of experience complete rationing at 1% and partial rationing at 2% despite enjoying a credit application acceptance rate of 23%.

Table 3. Chi-Square Test results related to SME characteristics

Independent variables	Analysis variable	Chi-square test	Significance threshold
Characteristics of SMEs	Activity	X2 (6) =36,402a	0,000
	Legal status	X2 (8) =114,261	0,000
	family business	X2 (2) =7,169a	0,028
	Number of employees	X2 (8) =121,096	0,000
	Age	X2 (8) =120,867	0,000
	Reputation ISO	X2 (2) =68,497	0,000
	Accounting certification	X2 (2) =3,326	0,190

Source: Author's calculations. SPSS

3.2.2. Multinomial Logistic Regression Tests

To begin our analysis, we will conduct multinomial logistic regression tests using the explanatory variables of the SME as well as the dependent variables related to credit rationing. These variables revealed significant importance with a threshold of 5% during the previous correlation tests. Regarding total-type rationing, our results indicate that the age and activity category of the SME play an important role.

Table 4.The results of the most significant variables in our model explaining total credit rationing

Total credit rationing	B	Wald	Ddl	Sig.	Exp(B)
Constant	-73,719	0	1	0,99	
Activity category	-2,174	5,207	1	0,022	0,114
Age SME	-2,19	3,905	1	0,048	0,112

Source: Author's calculations, SPSS

Our results indicate that the legal status, the number of employees, and the possession of an ISO certification can explain partial rationing.

The pseudo R-squared of Cox and Snell, calculated in our model, is 0.70. This indicates that variables like the SME's age, activity category, and reputation account for about 70% of the variance in the risk of not receiving credit or receiving it partially. The remaining 30% remain unexplained, which may be due to other unmentioned variables.

Table 5. The results of the most significant variables in our model explaining partial credit rationing

Partial credit Rationing	B	Wald	Ddl	Sig.	Exp(B)
Constant	-1,528	0,629	1	0,428	
Legal status	-2,366	4,742	1	0,029	0,094
Number of employees	-2,275	3,644	1	0,05	9,724
Réputation ISO	2,992	7,03	1	0,008	19,932

Source: Author's calculations, SPSS

Table 6. Cox and Snell R-squared Result

	R2 Step 1	R2 Step 2
R-deux Cox et Snell	,701	,699

Source: Author's calculations, SPSS

3.2.3. Discussion of the Results

We assessed the impact of different SME characteristics on the probability of either partial loan approval or total loan denial. Our results showed that the sector of activity and the age of the SME are determinants of total credit rationing. At the same time, size, which is measured by the number of employees, the legal aspect, and reputation, which is measured by holding an ISO certification, are determinants of partial credit rationing.

According to empirical studies that try to figure out where the risks that come with small and medium-sized businesses come from, the type of business accounts for the difficulties they face in getting financing. Indeed, according to Psillaki *et al.* (2010), the industry sector impacts the credit supply due to the specific operating modes of each sector, which is a synthetic indicator of the risk associated with the company's main activity. This is consistent with our results, which show that service SMEs are more exposed to the risk of total credit rationing. Even though over 40% of Moroccan SMEs operate in the tertiary sector, they remain vulnerable to the risk of total credit rationing. This situation contrasts with the numerous government announcements aimed at addressing the issue of access to financing for the tertiary sector, raising questions about the effectiveness of the support and financial assistance programs developed by the government to encourage this category of businesses. It is therefore likely that credit distribution programs are more beneficial to industrial companies rather than to SMEs in the tertiary sector.

Furthermore, the age of the SME, measured by the number of years in operation, is a variable that can reflect the degree of maturity and experience gained by it. As a result, younger companies have more trouble getting external funding. Our results show the significant role of the age of the SME in the decision to grant bank credit, indicating that the age of the SME can explain total credit rationing. These results align with the conclusions of Amrhar (2019), who noted that the company's age is one of the determinants of credit rationing for businesses in the Souss Massa region.

In terms of the legal aspect, our logistical model shows that the public limited company is significantly and negatively correlated with partial credit rationing compared to our reference variable (the limited partnership). Thus, limited partnerships are the most exposed to partial credit rationing, unlike public limited companies.

Furthermore, we observe that the size of the SME (measured by the number of employees) significantly impacts bank credit decisions. The larger the company, the more likely it is to have its credit approved. Our model predicts that partial credit rationing will most likely affect small SMEs with fewer than 5 employees.

Finally, our estimates highlight the negative and significant impact of an SME's ISO certification on the likelihood of accessing bank financing. Our results show that SMEs without ISO certification are more vulnerable to partial credit rationing, indicating that ISO certification can prevent an outright rejection of their credit application.

These results align with those of Mohammed Hattou (2016), who found in his study on SMEs in East Africa that possessing an ISO international certification, which validates quality management systems and environmental management, increases the chances of accessing bank financing for SMEs. Furthermore, our results align with the findings of Sharma (2005), indicating a positive correlation between obtaining an ISO certification and the company's financial performance. Thus, this criterion is considered credible by the credit file evaluators, enhancing the application through the company's internal management quality by global standards.

3.3. The Characteristics of the Owner-Manager Determine Total and Partial Credit Rationing

3.3.1. Chi-Square Test

Our cross-tabulation reveals that the variable of the leader's gender is significant at the 0.001 level, indicating a relationship between the outcome of the credit application and the leader's gender. Male leaders are the most affected by credit rationing, whether total or partial and receive the highest number of credit application approvals. This result can be attributed to our sample's relatively small number of female leaders.

Regarding the age of the leader, we observe that leaders over 40 are the least affected by total credit rationing, and they receive the full amount of credit requested in 35% of cases in our sample. On the other hand, leaders under 40, particularly those aged 30 or younger, are the most rationed.

Regarding the intellectual level of the leader measured by the variables of level and field of study, our results indicate significant importance at the thresholds of (0.000 and 0.003), demonstrating that education plays a role in the bank's financing decisions. Indeed, according to our results, leaders with an education level higher than a master's degree are better protected against total credit rationing.

Furthermore, we observe that leaders with a technical background are more likely to receive the requested funding, representing 31% of our sample. Then, the relationship between management capacity and credit rationing, measured by management training and years of experience, is significant at the threshold of (0,000 et 0,000). We observe that leaders who have not received management training are the most likely to be rationed. Regarding the number of years of professional experience, leaders with significant experience are the least constrained. In other words, the more years of experience a leader has, the greater the chances of their loan application being accepted.

Finally, according to our results, leaders who are clients of the same bank as the SME they manage are the least affected by total credit rationing and are more likely to receive the requested funding.

Table 7. Results of the Chi-squared test related to the characteristics of the leader

Independent variables	analysis variable	Khi-2	materiality threshold
characteristics of a leader of the SME	Gender of the leader	X2 (2) =14,86	0,001
	Age of the leader	X2(6) =118,096	0,000
	Level of training	X2 (8) =37,588	0,000
	Field of specialization	X2 (4) =16,387	0,003
	Management training	X2 (2) =48,908	0,000
	Executive experience	X2(6) =101,684	0,000
	Bank-leader relationship	X2 (2) =52,453	0,000

Source: Author's calculations, SPSS

3.3.2. Multinomial Logistic Regression Tests

With a significant WALD statistic at the 5% threshold, the logit model, developed to measure the probability of a credit request's denial, highlights the most significant variables.

Table 8. Results of the multinomial regression model regarding total rationing

Total credit rationing	B	Wald	ddl	Sig.	Exp(B)
Constant	-7,643	27,936	1	0	
Sex leader	3,319	14,334	1	0,000	27,645
Age of leadership	4,783	15,955	1	0,000	119,46
Category of executive training	2,034	5,017	1	0,025	7,642
Banking relationship with executives	2,523	13,599	1	0,000	12,466
Executive experience	3,39	9,03	1	0,003	29,678

Source: Author's calculations, SPSS

This variables include the manager's gender, the manager's age, the manager's educational background, the bank-manager relationship, and the manager's experience.Our results, which are based on the age and

professional experience of the manager, explain partial rationing. In other words, SMEs with leaders in the 40-to-50-year age group and less than 5 years of professional experience are likely to face partial rationing.

Table 9. Results of the multinomial regression model related to partial rationing

Partial credit rationing	B	Wald	ddl	Sig.	Exp(B)
Constant	-3,283	21,711	1	0	
Age of leadership	1,849	8,811	1	0,003	6,353
Executive experience	1,807	6,892	1	0,009	6,09

Source: Author's calculations, SPSS

The pseudo R-squared of Cox and Snell, calculated in our model, is 0.61. Variables such as gender, age, education, level of training, and the bank-manager relationship explain approximately 61% of the variance in the risk of not receiving credit or receiving a partial acceptance of the requested amount. The remaining 39% of the variance is unexplained and may be due to other variables not accounted for in our model.

Table 10. Cox and Snell R-squared result

	R2 Step 1	R2 Step 2
Cox et Snell	,622	,606

Source: Author's calculations. SPSS

3.3.3. Discussion of the Results

Even though many Moroccan women have successfully ventured into female entrepreneurship, our results indicate that women who lead SMEs are the most affected by total credit rationing. Hattou (2016) research revealed that the gender of the owner-manager of a small or medium-sized enterprise (SME) contributes to the challenges SMEs in the East African region face in obtaining bank financing.

Moreover, startup investments for women are generally more partial than those for men. However, the reputation of women entrepreneurs for repaying loans and credits is enviable, particularly regarding Tijari and Smouni (2022). This justifies the significant proportion of women entrepreneurs represented in our study.

Furthermore, previous studies have concluded that bank officials are more inclined to finance businesses led by men than by women. For instance, Buttner and Rosen (1988) survey of 106 bank account managers revealed their preference for financing companies led by male executives over those led by women. Carrington (2006) also concluded that women entrepreneurs are much more likely to face banking discrimination regarding access to financing. Today, the world recognizes female entrepreneurship as a true driver of women's empowerment and one of the main sources of growth, job creation, innovation, and wealth. However, women entrepreneurs face more specific challenges due to social stereotypes and gender discrimination. Access to financing is one of the main obstacles for women with projects, as highlighted by Tijari and Smouni (2022). Moreover, they operate in a society that encourages discrimination and inequality, which makes their situation even more difficult.

Next, our results show that SME leaders who do not have bank accounts opened at the same bank where the credit application was initiated are also the most affected by total credit rationing in our study. According to Berger and Udell (2002), small banks with simple organizational structures often choose relationship financing. This close relationship between the bank agent and the SME manager allows for the collection of crucial qualitative information about the manager's personality over time.

However, it is essential to note that the bank agent may have interests that differ from those of the bank, which can lead to decisions based on business volume rather than a thorough client assessment. In this context, it is crucial for banks to carefully analyze the nature of the relationship with the company's leader.

Subsequently, the leader or owner's age significantly impacts the likelihood of obtaining credit, according to our logistic regression model. Previous studies, such as those conducted by Rutherford and Oswald (2000) and Amrhar (2019), have also highlighted the importance of the leader's age variable in rationing partial and total credit.

However, other studies, such as Phung (2009) study, note that the age of owners does not affect the decision to ration credit for SMEs in Vietnam.

Furthermore, our results show that the leader's training specialty can be considered a determinant of total credit rationing. Management literature often links the company's ability to grow or its failure to the intellectual level of the leader. Studies have highlighted that business failures are often due to a lack of general knowledge or

skills of the owner-manager or the management team, as noted by Perry and Pendleton (1983), Baldwin *et al.* (1997), and Argenti (1976).

Finally, our results indicate that total and partial credit rationing is most likely to affect SME leaders who need more than 5 years of professional experience. This means that Moroccan banks pay particular attention to the leader's profile, especially the experience, which can be an asset for the SME in obtaining the desired financing or a handicap limiting its access to funding.

In conclusion, according to our final regression model, Moroccan banks pay particular attention to the quality of leadership, which is a crucial success factor for SMEs. Several studies emphasize the leader's critical role in their company's sustainability. For example, Altman noted in (1983) that leaders' incompetence is the leading cause of business failures. Similarly, Argenti (1976), Baldwin *et al.* (1997) emphasize that the lack of experience is one of the factors contributing to business failures.

Conclusion

The objective of this scientific article was dual: first, to highlight the typologies of credit rationing experienced by SMEs in the Casablanca-Settat region, and second, to analyze the explanatory factors for each typology separately. The initial statistical tests revealed that SMEs in the Casablanca-Settat region face both types of credit rationing: total and partial.

The results indicate that the industry sector and the age of the SME are among the determining factors of total credit rationing. We have observed that service SMEs are more exposed to the risk of total credit rationing. Furthermore, the younger the company, the more it struggles to access bank financing, contributing to total credit rationing.

The results highlight that reputation, legal aspects, and the size of the SME are important determinants of partial credit rationing. Furthermore, the sex, age of the SME owner or manager, the category of training, the banking partner, and the manager's experience are also explanatory factors of total credit rationing. The manager's age and level of experience primarily influence partial credit rationing.

The study highlights managerial implications: it sheds light on the reasons for the total and partial credit rationing of Moroccan SMEs, particularly those located in the Casablanca-Settat region, which are the result of various aspects related to the SMEs and their leaders. Thus, SMEs in the Casablanca-Settat region seeking funding could, prior to submitting a financing request to the bank, look to increase their size and justify their governance and internal production systems by obtaining, for example, ISO certifications. On the other hand, the SME leader should seek further training, particularly in management disciplines, accumulate substantial professional experience, and maintain a meaningful relationship with the same bank as the SME. Furthermore, we believe that the study will enable Moroccan financial control bodies, such as Bank Al Maghreb, to assess the effectiveness of the financing and recovery strategies that banks offer to small and medium-sized enterprises in the Casablanca Settat region.

However, the study has limitations: first, the sample size only considers a single Moroccan region; second, the use of two independent variables related to the characteristics of the SME and the manager, while there are other variables such as the characteristics of the requested financing, the nature of the bank-SME relationship, and those related to the availability of guarantees that could explain credit rationing.

In this regard, the study could encourage future researchers to explore broader geographical areas and include the aforementioned variables in their econometric model in order to obtain more accurate information on the credit rationing of SMEs in Morocco.

Credit Authorship Contribution Statement

Adil Boutfssi: Conceptualization; Software; Data curation; Investigation; Formal analysis; Writing - original draft; Visualization.
Tarik Quamar: Validation; Project administration; Supervision, Methodology, review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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DOI: https://doi.org/10.14505/tpref.v15.4(32).05

Creative Mechanisms of Managing Organizational Development in Uncertainty

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Article info: Received 31 August 2024; Received in revised form 27 September 2024; Accepted for publication 30 October 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: The research was aimed at identifying innovative strategies and methods aimed at effective management of organizational development in conditions of invisibility. In the process of research were used analytical, statistical and comparative methods. In this article, the key aspects of such management of such an impact on the effectiveness of the functioning of organizations were examined. The results of the research showed that the flexibility of structures is a key aspect of management in conditions of uncertainty, as it allows organizations to react quickly to changes in the environment, adapt to new conditions and make decisions quickly. In addition, it is recognized that strategic risk management is important to ensure the stability of organizations, and innovation management is the key to successful management in conditions of uncertainty. The study examined the role of leadership in stimulating creativity and innovation in solving the problems of invisibility. The importance of the development of culture, which supports creativity and innovation, which is one of the key aspects of management of organizational development in the conditions of invisibility, was highlighted. The significance of cooperation and partnership in the renewal and development of the sports industry, especially in Ukraine, which is vulnerable to the impact of war and pandemic, was examined. The research shows that collaboration between economic sectors and government can accelerate the renewal and development of the sports industry. Consequently, a comprehensive approach to managing organizational development in uncertain conditions was presented, encompassing structural flexibility, strategic risk management, culture, innovation, and stakeholder cooperation.

Keywords: sports market; management; innovation strategies; EU countries; forecasting.

JEL Classification: M16; L21; M10; Z21.

Introduction

Today's geopolitical landscape is characterized by unpredictability and non-standard responses, which require from organizations not only adaptation, but also active implementation of efficient and innovative management mechanisms. Changes in the geopolitical context, economic turbulence and social imbalances act as a catalyst for the search for creative strategies to ensure stability and stimulate development. In this new world order, it is important not only to react to changes, but also to anticipate and actively manage the situation. Organizations are faced with the task of becoming architects of innovation and creativity in conditions of uncertainty, military conflicts, social, economic, demographic crises and transformation of the global economy.

The introduction of creative mechanisms of growth management is becoming a necessity, as stability is becoming rare, and change is turning into a permanent factor. Leaders of modern organizations are forced not only to react to turbulence, but also to actively formulate new strategies to effectively manage risks and take advantage of opportunities offered by the new world order (Saifnazarov 2024). The conditions of uncertainty, economic instability and geopolitical conflicts can cause stress and create difficulties for business (Buzhymska *et al.* 2024). However, it is in these conditions that creativity can be a key factor that helps organizations to find new ways to success. It allows rethinking tasks, using innovative approaches, integrating innovations and adapting to changes. Creativity of management is a key tool that helps organizations not only to adapt to modern conditions, but also to grow (Kyrychok 2021). This implies that managers and employees should approach tasks from non-standard positions, find creative solutions, and constantly expand their range of skills. Moreover, the development of organizations in the conditions of modern business requires the active use of creative management mechanisms for the effective solution of complex problems and challenges. It is hunting for innovations in such areas as marketing, communication, technology, and interaction with customers. Creativity in management can contribute to the sustainable success of organizations and maintain a key position in the market environment (Shahini and Shtal 2023; Tkachuk *et al.* 2024).

The problem of invisibility in the management of organizational development is the subject of many queries, which stimulates active scientific research of this aspect in economic science. Analyses of the works of famous authors allow identifying key trends and problems related to this subject. Turchynova *et al.* (2019), Bhaduri (2019) focus on the role of leadership in the management of organizational development. They examine the impact of leadership qualities of managers on the effectiveness of organizational growth strategies and the ways in which leadership can favour adaptation to change and the achievement of sustainable growth. The research of such authors as Prygara and Yarosh-Dmytrenko (2023), Sharma *et al.* (2020) focus on the study of strategies for adaptation to invisibility in the business environment. They analyse the methods and approaches that allow organizations to respond effectively to invisibility and ensure resilience in a changed environment. Vyshnevska *et al.* (2022), in turn, examine the impact of geopolitical factors on the processes of management of organizational development. It investigated how political and economic developments at the international level affect the strategies of development of organizations, and how organizations can adapt to these influences.

Such researchers as Azeem *et al.* (2021) and Gretzel (2021) focus on the study of innovative approaches to the management of organizational development in conditions of invisibility. They investigate innovative methods and strategies that allow organizations to respond effectively to changes and stimulate innovation development. Klofsten *et al.* (2019) analyse the impact of economic turbulence on management strategies for organizational development. They investigate how economic fluctuations and crises affect the strategic management of organizations and how management can adapt their approaches to these conditions. The study by Bapuji *et al.* (2020) is aimed at studying the relationship between social imbalances and management strategies for organizational development. It is analysed how social and cultural factors affect the strategies of development of organizations and how organizations can consider these factors in their management. Bustinza *et al.* (2016) also investigate the use of management technologies in the context of addressing invisibility in organizational development. They analyse how modern technologies and information systems can support strategic management of organizational development.

In general, the authors investigate various aspects of this topic. This review allows establishing the diversity of approaches and shows the importance of looking at the problem of invisibility in the context of management of organizational development. However, there is a lack of research on such issues as the role of communication in the management of organizational development, as well as the identification of different strategies for adapting to invisibility in the business environment. In addition, it is worth paying attention to the possibility of developing new methods and tools for managing organizational development in conditions of invisibility. The study of these aspects can contribute to a deeper understanding of the difficulties faced by

modern organizations, and the development of more effective management strategies to achieve success in conditions of change and instability.

The main objective of this research is to study the various aspects of management of organizational development in conditions of invisibility and to identify their impact on the success of organizational development processes. The task of the research is to study the different strategies of adaptation to invisibility in the business environment and their impact on the stability of organizational development. Another task is to study the impact of factors on the processes of management of organizational development and to identify possible ways of adaptation of organizations to geopolitical changes.

1. Literature Review

In the current business landscape, innovation management is essential for the effective operation of organizations, particularly in situations characterized by uncertainty and invisibility. Sjödin *et al.* (2020) emphasize the need to develop an innovation culture and implement innovative practices that allow companies to be competitive in the market. The use of methodologies such as Agile and design thinking allows organizations to quickly adapt to market changes and respond to customer needs. For example, Agile methodology allows software developers to quickly introduce new features and solve problems during the development process, which improves product efficiency and quality.

In addition, a culture focused on fostering creativity and innovation is an important aspect of managing organizational development in the face of uncertainty. Lam *et al.* (2021) point to strategic approaches that foster creative thinking and innovation among employees. Organizations that value creativity and innovation are willing to accept failures as opportunities for improvement and learning. A prime example is Pixar Animation Studios, which is known for its innovative culture that supports creative development and the production of successful animated films. Pixar practices fearless experimentation and the search for new ideas, creating conditions for the freedom of creativity of its employees, even if it involves risky decisions.

Leadership also plays a critical role in fostering creativity and innovation in addressing invisibility (Makedon *et al.* 2022). Lee *et al.* (2020) argue that an effective leader must have the ability to motivate and encourage the team to seek and implement new ideas and strategies. It is important to create an open atmosphere where every team member can freely express their thoughts and ideas (Tiurina *et al.* 2023). By actively working to find and develop new ideas, a leader helps the team see invisibility as an opportunity for development and improvement. Particular attention should be paid to the study of organizational development management mechanisms that focus on creativity and innovation in the sports industry. Gammelsæter (2020) emphasizes that the sports industry is complex and dynamic, constantly changing under the influence of various factors such as changes in living standards, technological innovations, competition, and geopolitical changes. Thus, for the successful functioning of organizations in this industry, it is necessary to adapt management practices to modern challenges using innovative approaches.

Szatkowski (2022) notes that this market segment is constantly evolving, expanding, and facing increased competition. The purpose of the study was to identify trends and challenges that affect the growth of this market, which indicates the growing consumer interest in sports services. This interest requires companies to adapt their offerings and improve the quality of service to meet new customer needs. European Union countries (EUCs) are known for major sporting events such as the World and European Championships, the Olympic Games, and the Tour de France. Andreff (2019) emphasizes that these events have a significant economic and socio-cultural impact on the development of the sports industry in the region. The aim of his study was to determine the role of major sporting events in stimulating infrastructure development and attracting investment, which contributes to the overall growth of the popularity of sport in the EU.

Abdel-Basset *et al.* (2020) argued that the sports media sector, which includes television broadcasts, online platforms, sports newspapers and journalists, also plays an important role. It provides broad access to sports information and entertainment and is a significant source of revenue for many sports organizations and clubs. The authors noted that the availability of information about sports through various media channels increases interest in sports events, providing more opportunities for interaction with the audience. In such conditions, pricing and promotion of goods become dynamic and adapt to the needs of consumers, taking into account their profile, previous purchases, preferences and values. Han (2019) indicates that the purpose of his study was to analyze the implementation of dynamic pricing as a way to optimize profitability by offering different pricing strategies and product features. He emphasizes the importance of using digital marketing technologies, such as Capability Maturity Model technology, search engine optimization (SEO) strategies, and email marketing,

which help companies interact with the public and consumers, contributing to the formation of effective business models, increased consumption, and improved competitiveness.

In general, to ensure the competitiveness of organizations in this dynamic and complex environment, it is important to integrate innovative management approaches, use modern technologies and adapt to changes in consumer behavior and market conditions. These actions can form the basis for sustainable development and successful operations in the sports sector and other industries. Managing innovation and developing a creative culture are key factors that determine the success of organizations in today's business environment, especially in the face of uncertainty and constant change.

2. Materials and Methods

In this research, materials and methods were used to study the management of the development of organizations in the conditions of invisibility, particularly in the context of the sports industry. The work used the analytical method for the study of the essence of management of the development of organizations in the conditions of invisibility. Analyses of scientific sources were made, which allowed getting an understanding of the main aspects of the principles of management in the conditions of invisibility. In addition, the statistical method was used to collect data on the current state of management in the sports industry, as well as current trends and triggers, which are faced by organizations in this sector.

In order to analyse the impact of the culture of organizations on the management of their development in conditions of invisibility, a complex approach was used, including monitoring within different sports organizations such as Federation Internationale de Football Association (FIFA), Ukrainian Football Association (UFA), International Olympic Committee (IOC). This approach allowed investigating not only the officially declared values and principles of the organizations' culture, but also their actual practice and internal atmosphere. To carry out research on the impact of cooperation and partnership on the renewal and development of the sports industry in the conditions of invisibility, an analysis of real cases of cooperation between different sectors of the economy, government bodies and sports organizations was used. This approach envisaged a detailed study of specific applications of partnerships, including their mechanisms, results, and impact on the development of the sports industry.

To analyse the economic and social indicators of the sports industry, various data sources were used, including statistical data and scientific research. Particular attention was paid to the analysis of the volume of trade in sporting goods and services in the European Union (EUC). This data is an important source of information, which allowed assessing the dynamics of sports industry development and identifying key trends in this sector. These data were collected and systematized for different EU countries such as Germany, France, Italy, Spain, Netherlands, Belgium, Poland, Sweden, Norway, and Greece. The information was taken for different years, from 2017 to 2022, which allowed making a comparative analysis and determining trends in the development of the sports industry in different markets. This data included information on the amount of investment in construction and reconstruction of sports facilities, procurement of sports equipment, financing of sports events and programmes. The data were also taken for different years, from 2017 to 2023, which allowed identifying trends in the development of the sports industry in Ukraine.

Summarization and analysis of the collected data allowed making conclusions about the effectiveness of different strategies for managing the development of organizations in the conditions of invisibility, as well as identifying the key factors of success in the sports industry.

3. Research Results

Management of organizational development in conditions of invisibility necessitates strategic thinking and effective mechanisms. Flexibility in organizational structures is crucial, enabling quick adaptation to environmental changes and rapid decision-making (Hillmann and Guenther 2021). For instance, an electronics company facing new customs tariffs due to geopolitical shifts must swiftly assess the impacts and make strategic decisions. Strategic risk management is vital for organizational stability, involving threat identification and risk mitigation strategies, such as developing contingency plans for negative events or crises. Research on management mechanisms focusing on creativity and innovation is particularly relevant in the sports industry, which is dynamic and influenced by various factors, including technological advancements and geopolitical developments (Gammelsæter 2020).

Forecasts indicate that the U.S. sports market could grow to USD 2.65 billion by 2024-2025, with revenues projected to reach USD 4.18 billion by 2027, reflecting a 9.66% growth rate. The sports sector presents significant opportunities for investors, with anticipated revenues from sports supplements at USD 1.58 billion and advertising

revenues at USD 0.89 billion (Sports – Worldwide, 2024). Analyzing the sports industry reveals how organizational culture impacts adaptation and innovation. Successful organizations, such as FIFA, are pioneers in strategic management and innovation. FIFA promotes a culture of innovation through initiatives like video assistant referees and women's football development, demonstrating its commitment to modernization and creativity, which is essential for overcoming invisibility in the sports sector.

The Ukrainian Football Association (UAF) plays a crucial role in developing football in Ukraine by organizing professional leagues and tournaments, fostering competition, and promoting football culture. UAF invests in children's and youth football schools, identifying young talents, and collaborates with international organizations like FIFA and UEFA to implement best practices. Similarly, the International Olympic Committee (IOC) continually introduces initiatives to enhance the Olympic Games and promote inclusivity in sports, utilizing new technologies for broadcasting and event organization. These efforts help maintain the IOC's relevance and increase public interest in sports, which is recognized for its health benefits and role in community unity. The growing popularity of sports creates business opportunities, with emerging market segments such as fitness and recreation attracting investment (Kucera and Fila 2021). Digitalization and innovative technologies enhance accessibility to sports events, offering new marketing avenues for sports brands (Smutchak *et al.* 2023; Makedon *et al.* 2020). In EU countries, the sports industry is a significant and rapidly growing economic sector characterized by professionalism and innovative strategies. Key trends include the increasing influence of digital technologies, specialized mobile apps for fans, video streaming, and data analytics to improve marketing strategies. Additionally, organizations are focusing on sustainability by reducing carbon emissions and adopting environmentally friendly practices.

The authors, while studying the sports industry market, determined that it includes several key sectors that interact with each other, forming a complex network of interconnections. The study analyzed the sporting goods sector, where leading international brands such as Adidas, Nike, and Puma compete with local manufacturers and distributors in the sale of sportswear, equipment, and accessories. The researchers presented data on trade in sporting goods within and outside the EU in Table 1. In the context of the growing popularity of fitness and active lifestyles, the authors substantiated that the demand for sporting goods is constantly growing, which stimulates competition and innovation in this sector. The next important sector is sports services, which include fitness centers, sports clubs, coaching services, and the organization of sports events. The study found that this market segment is becoming increasingly important in the context of promoting physical activity and a healthy lifestyle. The authors emphasized the constant development and expansion of these services, as well as the growing competition in the market. The third sector is sports and entertainment. The study found that EU countries are known for major sporting events such as the World and European Championships, the Olympic Games, and the Tour de France. The authors noted that these events attract considerable attention and have a significant economic and socio-cultural impact, which contributes to the development of the sports industry in the region. The last important sector is sports media, which includes television broadcasts, online platforms, sports newspapers and journalists. The study argues that these media provide wide access to sports information and entertainment for viewers and are an important source of income for many sports organizations and clubs. Thus, the authors point out the importance of integrating all these sectors to understand the complex market structure of the sports industry.

Table 1. Trade in sporting goods within and outside the EU from 2017 to 2022, million euros

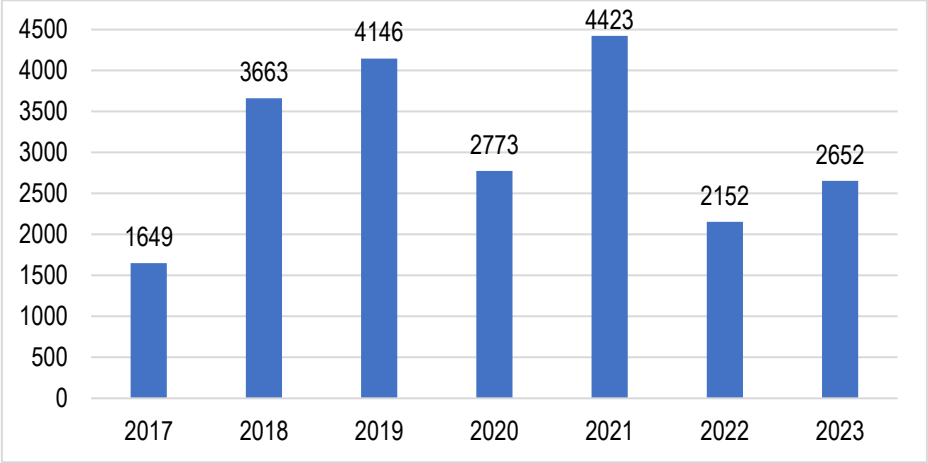
State	2017	2018	2019	2020	2021	2022
Germany	3534	3743	3837	3652	4040	4436
France	2186	2372	2431	2348	2813	3135
Italy	2389	2537	2658	2444	3076	3466
Spain	856	938	953	974	1304	1636
The Netherlands	2353	2491	2708	2968	3410	3453
Belgium	3551	3455	3566	3493	3296	3844
Poland	1092	1292	1484	1446	1765	2009
Sweden	329	324	409	459	542	574
Norway	25	26	31	33	28	35
Greece	70	85	101	82	112	169

Source: compiled by the authors.

A general upward trend in the volume of trade in sporting goods was found in all countries during the analyzed period. Germany is the leader in this area, increasing trade from 3.5 billion euros in 2017 to 4.4 billion euros in 2022. This indicates the stable development of the sports industry in the country. France and Italy show a significant increase in trade in sporting goods during the same period, which may indicate the popularity of sports brands and high demand for sporting goods in these countries. Spain, the Netherlands and Belgium also show steady growth in the production and trade of sporting goods, indicating the active development of the sports industry in these regions. This growth is leading to the expansion of markets for sports goods and services, reflecting increased consumer interest in healthy lifestyles, the development of sports culture and the growth of economic activity in the field of sports.

In Ukraine, there are also certain trends in the development of the sports industry, although its potential has not yet been fully realized. The authors found that national sports organizations and clubs are focusing on improving infrastructure, developing youth programs, and promoting sports events. However, there are numerous obstacles in Ukraine, including financial constraints, lack of effective governance, and insufficient progress in the activities of sports organizations. The study emphasized that the war that began in 2022 led to a significant decline in investment in sports infrastructure and the development of sports events (Figure 1). The suspension of sports facilities and restrictions on participation in sports events are forcing the sector to adapt to new conditions and find ways to overcome these difficulties. The war has also had a negative impact on sports brands, events and the tourism sector in Ukraine (Trusova *et al.* 2020b). The unstable situation is forcing organizations in this sector to review their strategies and look for new markets to compensate for losses in the domestic market. In addition, the war in Ukraine poses significant challenges for sports tourism, forcing organizations to rethink their strategies for attracting sports tourists. In the context of the war, the sports industry is going through a difficult period, and the challenges it faces can be an incentive to develop new and effective strategies aimed at solving difficulties and recovering from the crisis (Trusova *et al.* 2020a).

Figure 1. Capital investments in the sports industry of Ukraine from 2017 to 2023, million UAH



Source: compiled by the authors.

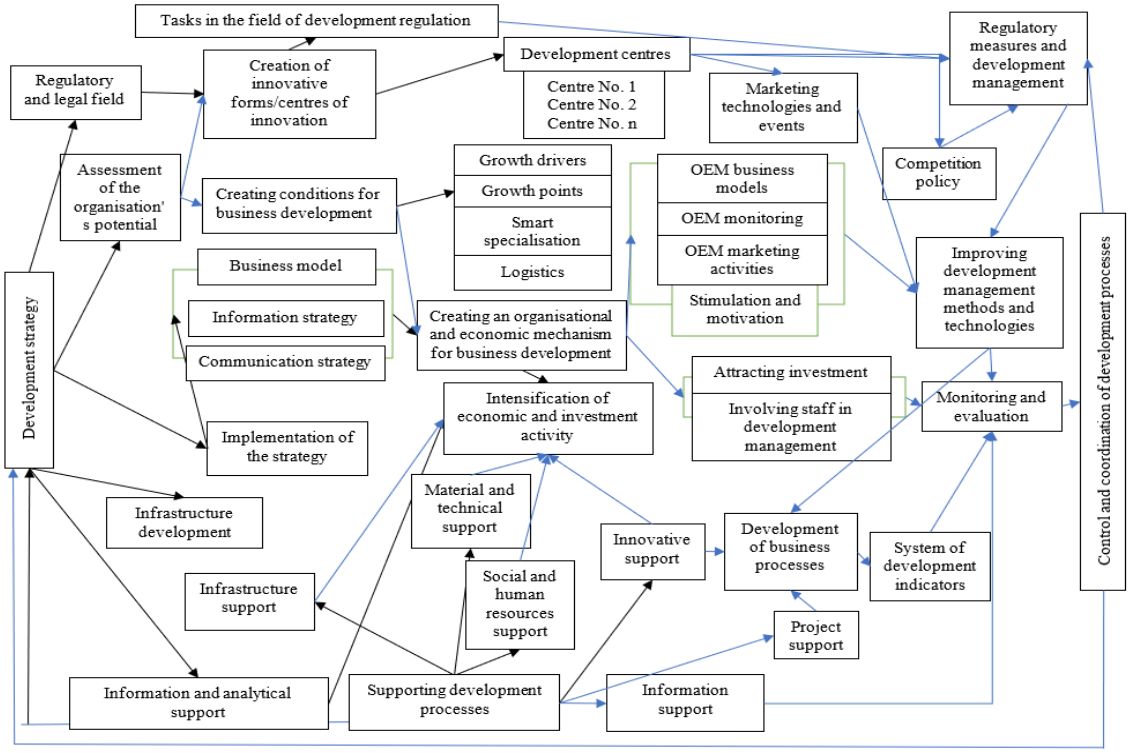
Starting from 2017, there was a steady increase in capital investments, which indicated a certain stability and interest in the development of the sports sector in the country. However, in 2020, due to the COVID-19 pandemic, there is a significant drop in investment, which reflects the impact of the crisis situation on the economy and financing of sports projects. In 2021 there is a sharp increase in investment, but in 2022, with the outbreak of war, there is a sharp decline in investment, which is associated with a decrease in economic activity, instability in the financial markets and over-subsidisation of budget funds for defence and security of the country. In 2023, although there is a slight increase in investment compared to 2022, the level of investment is still lower than before the war, which may reflect the difficult economic situation in the country and the instability of the business environment. After the war in Ukraine, the sports industry may experience significant changes that will affect its current state and future prospects. Under the influence of these events, various directions of sports business development in Ukraine have emerged. One of the key directions of development is the orientation on renewal and reforming of the industry. A large part of the sports facilities and infrastructure was damaged during the war, so it is important to reconstruct and renovate the existing facilities. In addition, the pandemic forced organizations to rethink their strategies and adapt to the new conditions, which can favour the implementation of innovations and improve efficiency.

Digital technologies and innovations play an important role in the further development of the sports industry in Ukraine. The analysis found that the sector is already actively using various digital solutions, such as online broadcasts, virtual training, and marketing tools. The recovery of the industry can be an additional incentive for the introduction of new technologies and the development of innovative products. The authors emphasize that after the war, consumers may change their views and approaches to sports activities and services. The growing popularity of healthy lifestyles and increased interest in exercise may become factors that stimulate demand for sports goods and services (Barseghyan *et al.* 2023). The study notes that sports industry organizations should be prepared for changes in consumer sentiment and offer new, innovative solutions. Collaboration and partnerships can be important factors in the renewal of the sports industry in Ukraine. Joint initiatives and projects with other sectors of the economy, government agencies and organizations can contribute to the rapid recovery and development of the industry. Cooperation with government agencies can provide the necessary support and financial resources to upgrade the sports infrastructure (Novykova *et al.* 2023; Bidolakh *et al.* 2023).

Financing of sports facilities renovation projects, stimulating investment in sports activities and programs, and participation in grant programs can significantly contribute to the recovery of the sports industry (Trusova *et al.* 2021). The study also points to the importance of cooperation with organizations to implement social programs and projects that promote sports among the population. Organizing sports events for children and youth, creating special programs for people with disabilities, and developing sports initiatives in socioeconomically challenged areas can help attract more people to sports and an active lifestyle. When considering the main aspects of the economic development of the Ukrainian sports industry, it is important to consider not only the general trends in the country's economy, but also the unique features of the sports sector. The process of regulating the development of the sports industry needs to be further clarified and adapted to the specifics of this economic segment.

Creating creative tension for the formation of organizational and economic mechanisms that ensure progress in the sports industry is a key task (Figure 2). Researchers believe that it is necessary to take into account not only traditional management methods, but also to actively implement innovative approaches and strategies. For example, taking into account the development of digital technologies, attracting investment in sports innovations, and creating new forms of cooperation between business, government, and sports organizations. Such an approach will allow for an effective response to the challenges and opportunities that arise in the sports sector and ensure the sustainable development of this important sector of the economy.

Figure 2. Creative map of regulating the development process

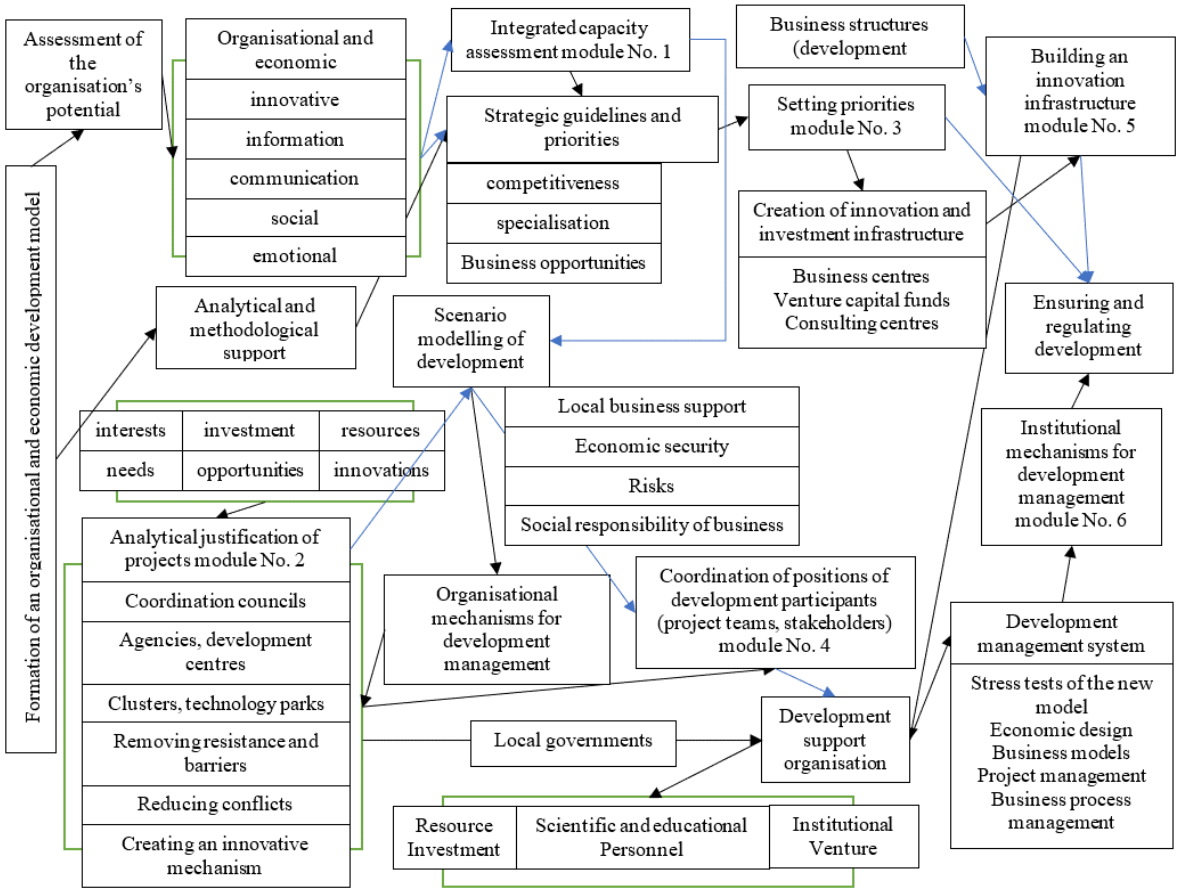


Source: compiled by the authors.

The proposed creative map for regulating the development of sports organizations includes key aspects of strategic development, such as assessing the organization's potential, developing a business model, and radically improving infrastructure in all areas. The main goal of development management is to create appropriate organizational and economic mechanisms and new links between research and production to promote innovation. The growth of digital technologies necessitates the abandonment of traditional marketing strategies in favor of new approaches that take into account the unique selling proposition, product quality, and consumer involvement in the production process. Dynamic pricing allows to optimize profitability through different price offers. The use of digital marketing technologies, such as the maturity model, SEO, and email marketing, helps to improve interaction with the public and consumers, which increases consumption and competitiveness. Development management also focuses on reforms to improve the structure and efficiency of operations, support strategic directions, and use business process management methods to optimize internal operations. The main sources of stimulating development are domestic investments and intensification of economic activity through the involvement of stakeholders (Butenko *et al.* 2023). Based on these principles, strategic decisions are made to provide comprehensive organizational and economic support, implement competition policy and monitor the development process.

As the environment of the organization becomes unrecognizable and requires effective decisions, it is important to analyse and evaluate a large flow of information, which can serve as a guide for further actions. This process requires a distinction between a strategic decision, which corresponds to a favourable environment for the organization, and strategy – a set of rules for which decisions are taken in conditions of uncertainty. It is important to understand that no decision can be made with a full understanding of the situation, which indicates the need to use a model of strategic behaviour (Abdel-Basset *et al.* 2020; Furmanchuk 2023). The prescribed creative map of development regulation is the basis for the formation of values and intentions and defines the process of development management, setting the direction of the course and the ultimate goals. It is necessary to introduce in organizations a modern, non-traditional organizing and economic mechanism to regulate the development. Figure 3 presents a creative model of such development.

Figure 3. Creative model of formation of organizational and economic mechanism of development



Source: compiled by the authors.

The proposed creative model of organizational and economic mechanism includes a conceptual framework, an assessment of the potential of the organization, and analytical and methodological support. The strategic priorities are accepted as objectives, among which are: specialization, competitiveness, business opportunities, and business opportunities. The task of designing the organizational and economic mechanism is the creation of new organizational structures (business centres, business incubators) and the development of investment infrastructure. The “blocks” of institutional and financial support are given significant attention in the creation of organizing and economic mechanism. In conjunction with the organisational-functional components of the creative model, they define the tasks of managing the development of the organization (modules No. 1-6): assessment of potential, assessment of prospects, selection of priorities, harmonization of positions and interests of participants of the development process, implementation of modern tools for development regulation.

At a time when economic progress requires constant innovation, it is important to develop an effective strategy for organizations. This means that they have to adapt to changes in their environment and respond quickly to new opportunities and responses. For this purpose, there can be used various forms of cooperation and association, which allow organizations to get significant advantages. For example, clusters, technoparks and other institutional associations ensure the possibility of knowledge and resources exchange, joint research and development of new technologies (Leonov 2020b; 2021). This favours not only the growth of productivity and competitiveness, but also the expansion of the network of contacts and opportunities for cooperation. In addition, such associations create favourable conditions for attracting investment and ensure joint protection from external threats. An important component of success in this process is the interaction between different stakeholders, such as business, government, academic community and community organizations.

Digital technologies and innovations play an important role in the further development of the sports industry in Ukraine. The analysis found that the sector is already actively using various digital solutions, such as online broadcasts, virtual training, and marketing tools. The recovery of the industry can be an additional incentive for the introduction of new technologies and the development of innovative products. The authors emphasize that after the war, consumers may change their views and approaches to sports activities and services. The growing popularity of healthy lifestyles and increased interest in exercise may become factors that stimulate demand for sports goods and services. The study notes that sports industry organizations should be prepared for changes in consumer sentiment and offer new, innovative solutions. Collaboration and partnerships can be important factors in the renewal of the sports industry in Ukraine. Joint initiatives and projects with other sectors of the economy, government agencies and organizations can contribute to the rapid recovery and development of the industry. Cooperation with government agencies can provide the necessary support and financial resources to upgrade the sports infrastructure.

4. Discussions

Management of organizational development in the conditions of invisibility requires a respectful analysis, strategic thinking and effective use of different management mechanisms. Flexibility of the organizational structure is a key aspect of management in conditions of invisibility. Bendy structure allows the organization to react quickly to changes in the environment, adapt to new conditions and quickly make decisions. Ameta *et al.* (2021) focus their attention on bendable management and Scrum methodology. They are convinced that these approaches allow organizations to effectively adapt to the unrecognisability through regular iterative cycles and maximum flexibility in decision-making. In the current research, also the importance of flexibility of management in the conditions of invisibility is covered, but it is recognized that to achieve success it is necessary to look at a wider range of tools and methods. Such an approach allows ensuring a more comprehensive approach to management, as well as taking into account the individual peculiarities of the organization and its needs.

This study found that strategic planning and risk management are critical for organizations operating in an environment of invisibility. Saeidi *et al.* (2019) emphasize the importance of these aspects, noting that effective planning can reduce the negative effects of invisibility. This is especially true in today's rapidly changing environment where organizations face unpredictable challenges. Our work confirms these claims by emphasizing the need for continuous monitoring and analysis that allow companies to respond quickly to changes in the external environment and adapt their strategies to new conditions. Leonov (2020a) also supports this view, emphasizing that a culture that fosters creativity and innovation is a key factor in managing organizational development in the face of invisibility. The author notes that organizations that create conditions for the expression of ideas and experimentation create an environment where failures are perceived as opportunities for learning and improvement. This aspect is critical for the successful implementation of innovations, as it stimulates the creativity of employees and promotes their involvement in decision-making processes.

The study by Wamba-Taguimdje *et al.* (2020) and Benbya *et al.* (2020) further extends our understanding of this issue by emphasizing the importance of modern technologies such as artificial intelligence and data analytics for optimizing management processes. They argue that these technologies can significantly facilitate decision-making and increase the efficiency of management under conditions of uncertainty. This is in line with our findings that digital transformation is an important element of modern management, but only when it is combined with a focus on human factors and organizational culture. It is interesting to note that while technology plays a significant role in modernizing management processes, its effectiveness depends to a large extent on the cultural environment of the organization. In particular, organizations that promote open communication and the exchange of ideas are more likely to benefit from the latest technological solutions. This underscores the importance of integrating innovative management approaches where technology is not used as an end in itself, but as a means to achieve strategic goals aimed at increasing competitiveness and adaptability.

The importance of interaction between employees, their emotional state and intrinsic motivation for successful management in conditions of invisibility is emphasized. Shao (2019), Adeinat and Abdulfatah (2019), in turn, draw attention to the role of corporate culture of managing invisibility. Support of a creative environment, where employees express their ideas and experiment, favours the active implementation of innovations and quick adaptation to changes in the external environment (Innola *et al.* 2022). This aspect is also reflected in the current research, where the importance of the creation and support of culture, which favours creativity and innovation, is confirmed. It also considers corporate culture as a key factor that affects the ability of the organization to adapt to the unrecognisability and achieve success in a changing market environment.

This study focuses on the role of leadership in fostering creativity and innovation to address invisibility. As noted by Mehmood *et al.* (2021), effective leaders are able to motivate and encourage their teams to seek out new ideas and strategies. This is consistent with our findings, which emphasize that an open workspace where every team member feels free to express their thoughts is critical to fostering creativity. The study also indicates that leaders should actively seek out and develop new ideas by supporting gifted employees and creating mechanisms to collect and evaluate ideas. This is an important aspect because it fosters a culture that promotes innovation, where ideas can come from any level of the organization. This approach is supported by Mehmood *et al.* who emphasize the importance of leadership in creating an environment conducive to innovation. As the study points out, successful management in the face of invisibility cannot focus on leadership alone; it is also important to consider internal factors of the organization, such as structure and culture. As our research shows, an adaptive organizational structure that allows for flexibility is a prerequisite for successfully responding to change. This is supported by research that shows that an organization's culture determines the tone and direction of the team's work, its readiness for change and innovation. Thus, the results of Mehmood *et al.* (2021) are consistent with our findings, emphasizing that leadership, organizational structure, and culture are closely related and interact with each other. Leaders should not only inspire their employees, but also provide conditions for the flexibility and adaptability of the organization as a whole (Zhumasheva *et al.* 2021; Yatsiv *et al.* 2024). This will allow organizations not only to survive in the face of uncertainty, but also to thrive, as readiness for change is key to overcoming the challenges they face.

The study of management mechanisms of organizational development, aimed at creativity and innovation, is of particular importance, especially in the sports industry. The sports industry is a complex and dynamic industry, which is constantly changing under the influence of various factors, such as changes in the marketable income, technological innovation, competition, and even geopolitical developments (Chornyi and Chorna 2017). With the help of the example of the sports industry, it is worth analysing how the culture of an organization affects its ability to adapt in conditions of invisibility. Successful sports organizations are often pioneers in the sphere of strategic management and implementation of innovative ideas (Abramov 2023). Sadeqi-Arani and Alidoust Ghahfarokhi (2022) investigated the management of invisibility in the sports industry and focus on the importance of strategic planning and response to change in this sector. The authors believe that the sports industry is dynamic and is subject to the influence of various factors, such as changes in the sales flow, technological innovations and geopolitical developments. On the other side, Meier *et al.* (2019) analysed the role of technological innovations in the management of sports organizations under conditions of invisibility. They believe that the use of new technologies, such as data analysis and piece intellect, can significantly facilitate management processes and decision-making in the sports industry. In comparison with these results, the flow study also considers the importance of flexibility and strategic thinking in the management of invisibility. The results of the flow study are supplemented and confirmed by the results of the authors, as well as expanded their scope, taking into account a wide range of aspects of the management of invisibility in the sports industry.

In EU countries, the sports industry plays an important role in social and economic life, with great potential for development. The current state of this sector is characterized by diversity and dynamic changes in its various segments. One of the key trends is the growing popularity of sports among the European population. Sport is perceived not only as a means of maintaining health, but also as an important component of social life that promotes social cohesion and stimulates the development of local sports infrastructure. The study by Hammerschmidt *et al.* (2021) examined the role of the sports industry in the social and economic life of EU countries, as well as its potential for further development. The results showed that sport is an important factor in social cohesion and stimulates the development of local sports facilities. In addition, the study revealed an increase in the popularity of sports among the European population and an increase in business opportunities in the sports industry. Compared to the results of the current study, which also analyzes the management of invisibility in the sports industry, our research is more focused on strategic management and the application of innovative management techniques to adapt to changes in this sector. In comparison, the results of our study confirm that the sports industry in Europe has great potential for development, but in order to realize this potential, it is necessary to implement innovative management solutions and strategic initiatives that allow organizations to effectively adapt to changes in the social and economic context.

In general, the authors propose various strategies such as lean management, strategic planning, use of technology, creation of corporate culture and effective leadership. They confirm the importance of flexibility, innovation, and reaction to changes in the environment for successful management in conditions of invisibility. The results of the current research supplement these approaches, considering them in the context of the sports industry and taking into account the internal factors of the organization, such as culture and structure.

Conclusions

The research in the field of management of organizational development under conditions of uncertainty has made a significant theoretical contribution, expanding our knowledge of the specific mechanisms that help organizations to adapt to the changing environment. One of the main results of the research is the discovery of the fact that flexible organizational structures are a key factor of successful management in conditions of invisibility. This means that organizations that can quickly revise their structure and adapt it to changes in the environment have a better chance of success.

The empirical findings of the article emphasize that innovation management is a key factor in successful management in the face of invisibility. The authors determined that the development of an innovative culture and the introduction of innovative practices allow organizations to remain flexible and competitive in the market. The study substantiates that the monitoring and analysis system is critical, as it allows to quickly identify changes and assess their impact on the organization's activities. Studies in the sports industry and EU countries show that the success of organizations in this sector largely depends on their culture, readiness to innovate and create new opportunities. The authors point out that cultural values, approaches to work and attitudes to change determine an organization's ability to adapt to constant changes in the environment and maintain a competitive advantage. In the context of the Ukrainian sports industry, despite the challenges it faces, there is significant potential for development and recovery from crises. Important areas of development are identified as the introduction of innovations, the use of digital technologies and cooperation between different sectors of the economy. The authors argue that the introduction of new ideas and technologies will allow Ukrainian sports organizations to compete more effectively in the international market and adapt to changes in consumer demand.

Practical recommendations, which emerge from this research, have a concrete application in real conditions. For example, managers of sports organizations can use these recommendations to create incentives for the development of creativity among staff and the introduction of smart management strategies, which allows organizations to respond effectively to changes in the environment and make decisions quickly. Managers of sports organizations can implement flexible management strategies, which will allow them to respond effectively to changes in the environment and make decisions quickly. Management consequences of the results obtained can be significant for organizations. They can stimulate changes in policy, strategy, and structure of organizations, which will allow increasing their competitiveness and adaptability to changes in the environment. The findings of the research have the potential to be used to improve management in various spheres of activity, which will favour their sustainable development and success in conditions of invisibility.

Credit Authorship Contribution Statement

Yaroslav Leonov: Conceptualization, Investigation, Methodology.
Oleksandr Zheltoborodov: Project administration, Software, Formal analysis.
Oleh Olkhovyi: Writing – review and editing, Visualization, Funding acquisition.

Ihor Prykhodko: Writing – original draft, Supervision, Data curation.
Ihor Pober: Validation, Investigation, Software.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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Volume XV, Issue 4(32), Winter 2024

DOI: https://doi.org/10.14505/tpref.v15.4(32).06

A Study of Post Keynesian Attempts at Hiding Townshend's Main Question to Keynes in His November 1938 Letter and Keynes's Answer

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Article info: Received 26 August 2024; Received in revised form 18 September 2024; Accepted 27 October 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: Keynes's letter of December 7th, 1938, provided a direct answer to Townshend, who asked Keynes the following extremely important question in his letter of November 25th:

"This is the nearest I can get to an analysis of the part played by the factor of confidence in the rationale of interest. *I believe that its further logical analysis at a deeper level of generalization is connected with the part played by the weight of evidence in your theory of probability, but I cannot see just how*….." (Keynes 1979, 292; italics added).

Now Townshend 's question actually is "Where in your *A Treatise on Probability* is your analysis supporting the connection between confidence in the GT and the weight of evidence?"

Keynes's response was direct and straightforward:

"As regards my remarks in my *General Theory*, have you taken account *of what I say on page 240*, as well as what I say at page 148, which is the passage I think you previously quoted…". (Keynes 1979; italics added).

The clue, given here by Keynes to Townshend, is to p.240 of the *General Theory*; however, it relates directly, as we will see, to Keynes's chapter XXVI of the *A Treatise on Probability*. This paper will trace out how Keynes provided Townshend with the clues needed to recognize Keynes's modeling of the conventional coefficient in chapter XXVI; however, Townshend gave up and failed to take this last step.

Keywords: Inexact measurement; approximation; estimation; mathematical expectation; evidential weight of the argument; completeness; the *degree* of the completeness of the information

JEL Classification: B10; B12; B14; B16; B18; B22.

Introduction

The paper will be organized in the following fashion. Section Two will deal with (Bateman 1996) and the Keynes-Townshend exchanges. Section Three will deal with (Feduzi 2007). Section Four will deal with (Zappia 2015). Section Five will deal with (Zappia 2016). Section Six will conclude that the (Bateman 1996, Feduzi 2007, Zappia 2015, Zappia 2016) fail completely to recognize that Keynes's evidential weight of the argument, V=V(a/h)=w, where w is defined on the unit interval as 0≤w≤1,and w=K/(K+I) in (Keynes 1921) is the mathematical foundation for Keynes's theoretical analysis of the liquidity preference theory of the rate of interest.

In (Keynes 1936), Keynes defines Uncertainty (U) to be a function of the evidential weight of the argument, so that U=g(V)=g(w). Keynes defines confidence (C) to be a function of uncertainty, which is a function of weight. By the composite function rule, C=f(w). In chapter 13, Keynes defines Liquidity Preference, LP, to be a function of uncertainty. Again, by the composite function rule, LP =h(w). None of these results can be derived from (Bateman 1996, Feduzi 2007, Zappia 2015, Zappia 2016) or any other Post Keynesian paper.

What Keynes explicitly tells any and all readers of page 240 the General Theory is that there is no discussion of how to estimate/calculate the risk and liquidity premiums in (Keynes 1936):

"The owners of wealth will then weigh the lack of "liquidity" of different capital equipments in the above sense as a medium in which to hold wealth against the best available actuarial estimate of their prospective yields after allowing for risk. The liquidity-premium, it will be observed, is partly similar to the risk-premium, but partly different; — the difference corresponding to the difference between the best estimates we can make of probabilities and the confidence with which we make them… When we were dealing, in earlier chapters, with the

estimation of prospective yield, we did not enter into detail as to how the estimation is made: and to avoid complicating the argument, we did not distinguish differences in liquidity from differences in risk proper. It is evident, however, that in calculating the own rate of interest we must allow for both." (Keynes 1936, 240).

Thus, Keynes's answer to Townshend was very clear -there is no answer in the GT to Townshend's question and there is no answer in chapter 6 of the TP, which is what the first footnote states; however, there is an answer in chapter 26 of the TP of how to "estimate", "how the estimation is made" and "calculate" the risk and weight premiums because Keynes does make it clear in his letter of Dec.7th, 1938 that he did discuss both liquidity and risk premiums in his A Treatise on Probability:

"I am rather inclined to associate risk premium with probability strictly speaking, and liquidity premium with what in my Treatise on Probability I called 'weight'" (Keynes 1979, 293).

Keynes has set the stage for Townshend. Townshend knows, based on his having read the *A Treatise on Probability*, that there were only two chapters in the *A Treatise on Probability* that examine weight, chapters VI and XXVI. There is no existing evidence that Post Keynesian economists, such as (Bateman 1996, Feduzi 2007, Zappia 2015, Zappia 2016) know that there are only two chapters in the TP that discuss weight.

Keynes has already de-emphasized his footnote 1 in (Keynes 1936, 148), which mentions chapter 6 of the A Treatise on Probability, while simultaneously re-emphasizing (Keynes 1936, 240). There was only one possibility left for Hugh Townshend to consider -chapter XXVI of (Keynes 1921) contains Keynes's discussion about how to estimate/calculate both the risk (probability) and liquidity (weight) premiums.

1. Research Background

The current literature on the connections between Keynes's (1936) and (1921) is immense. I examine a representative sample of heterodox economists (Bateman 1996, Feduzi 2007, Runde 1990, Skidelsky 1992, Zappia 2015, Zappia 2016), whose work is heavily cited. The conclusions of this body of work consists of the following main conclusions about Keynes's logical theory of probability;

- Keynes's technical skills were poor
- Keynes erroneously presented three different definitions of evidential weight of argument
- Keynes's logical, objective, probability relation was proven by Ramsey to be a mere metaphysical speculation on Keynes's part that was based on Plato's theory of forms and G E Moore's intuitionism
- Keynes's propositional logic was based on unrelated pairs of propositions like "My carpet is blue; Napoléon was a great general"
- Keynes's A Treatise on Probability is a logically flawed book

A more thorough examination of Keynes's work demonstrates that *none* of these standard, heterodox conclusions have any foundation in anything written by Keynes in his lifetime. The main reason for the failure of current heterodox assessments of Keynes's book is the ignorance of the Boolean foundations.

2. Research Result I: Bateman in 1996.

There is no mention of Townshend's question about

"This is the nearest I can get to an analysis of the part played by the factor of confidence in the rationale of interest. I believe that its further logical analysis at a deeper level of generalization is connected with the part played by the weight of evidence in your theory of probability, but I cannot see just how…." (Keynes 1936, 292).

in (Bateman 1996).

There is no mention in Bateman of what question on the part of Townshend Keynes is responding to with his

"As regards my remarks in my General Theory, *have you taken account of what I say on page 240,*as well as what I say at page 148,which is the passage I think you previously quoted…". (Keynes 1936; italics added)

No one reading (Bateman 1996) would have the slightest idea that Keynes is answering a question regarding the connections between Keynes's TP concept of weight and Keynes's GT concept of confidence. At best, Bateman's coverage of the Keynes -Townshend exchanges is vague, ambiguous, unclear and confusing. See Arthmar and Brady (2018) for a more detailed and precise critique of Bateman's confused and confusing attempt at analyzing this correspondence.

3. Research Result II: Feduzi in (2007)

There are many errors in this paper, which is built on the premise that Keynes' theory is an ordinal one. These other errors will be dealt with in another paper. Feduzi is completely unaware of Part II of the TP and chapters 15-17 where Keynes applies his improved Boolean approach to interval valued probability. These chapters are

identical to Keynes's work in his 1908 second Fellowship dissertation at Cambridge University. This paper will deal with Feduzi's apparent ignorance of what Keynes is responding to in his (Keynes 1979).

Consider the following passage from Feduzi (2007):

"Analogously, in chapter 17 of (Keynes 1936), on the 'Essential Properties of Interest and Money', he writes:

"The liquidity-premium, it will be observed, is partly similar to the risk-premium but partly different; – the difference corresponding to the difference between the best estimates we can make of probabilities and the confidence with which we make them (CW VII, p. 240)."

And in a footnote to this sentence, Keynes refers to the footnote mentioned above.

Keynes is even more explicit in linking confidence to evidential weight in a letter he wrote later to Hugh Townshend:

"I am rather inclined to associate risk premium with probability strictly speaking, and liquidity premium with what in my Treatise on Probability I called 'weight'. An essential distinction is that a risk premium is expected to be rewarded on average by an increased return at the end of the period. A liquidity premium, on the other hand, is not even expected to be so rewarded. It is a payment, not for the expectation of increased tangible income at the end of the period, but for an increased sense of comfort and confidence during the period (CW XXIX, p. 293–294)." (Feduzi 2007, 562).

The problem is that (Feduzi 2007) is misquoting Keynes by leaving out some very crucial parts of each quote.First, it is impossible for any reader to realize from the account of Feduzi (2007) that Keynes's reply on page 293 of Vol.29 of the CWJMK in his letter of Dec. 7th is to Townshend's question about the *connection between the confidence of the GT and the 'weight 'of Keynes's TP*:

"This is the nearest I can get to an analysis of the part played by the factor of confidence in the rationale of interest. *I believe that its further logical analysis at a deeper level of generalization is connected with the part played by the weight of evidence in your theory of probability, but I cannot see just how*…." (Townshend, 1979, CWJMK, Vol., p.292; italic added).

Similarly, (Feduzi 2007) misquotes page 240 of the GT severely. Feduzi (2007) gives only a part of the quote:

"The liquidity-premium, it will be observed, is partly similar to the risk-premium but different; – the difference corresponding to the difference between the best estimates we can make of probabilities and the confidence with which we make them. (CW VII, p. 240)." (Feduzi 2007)

It is easy to see that [Feduzi 2007] is trying to disguise or camouflage Keynes's analysis when we look at the entire quotation:

""The owners of wealth will then weigh the lack of "liquidity" of different capital equipments in the above sense as a medium in which to hold wealth against the *best available actuarial estimate of their prospective yields after allowing for risk*. The liquidity-premium, it will be observed, is partly similar to the risk-premium, but partly different; — the difference corresponding to the difference between the best estimates we can make of probabilities and the confidence with which we make them… *When we were dealing, in earlier chapters, with the estimation of prospective yield, we did not* enter *into detail as to how the estimation is made: and to avoid complicating the argument, we did not distinguish differences in liquidity from differences in risk proper. It is evident, however, that in calculating the own-rate of interest we must allow for both."* (Keynes 1936, 240; italics added).

The comparison of Feduzi's "quote" from [Keynes 1936] and the material in italics above shows the material that Feduzi has left out.

Feduzi (2007) leaves out of Keynes's discussions all of the material about "…best available *actuarial* estimate…", "…with the estimation of prospective yield", "how the estimation is made" and "… that in calculating the own-rate of interest we must allow for both." because these discussions contradict and directly conflict with (Feduzi 2007) (as well as in Runde (1990), plus many other Post Keynesians who have written on the topic) insistence that Keynes's theory of probability is an ordinal one only that does not allow for the estimate, estimation and calculation of probabilities and weight.

Of course, the way in which these calculations are performed is on p.315 of the TP and involves the conventional coefficient, c, that Runde has attacked his entire life starting in 1990. Post Keynesian intellectual deficiencies and confusions are on full display here in Feduzi's "analysis" of Keynes's Evidential Weight of the Argument.

It is impossible to figure out from anything presented in Feduzi (2007) that, for Keynes, V=V(a/h)=w, 0≤w≤1,and w=K/(K+I).

4. Research Result III: Zappia in (2015)

In (Zappia 2015) "Section 4. The Ultimate meaning of the correspondence", we have an even more pronounced attempt at intellectually deficient claims.

Zappia (2015) omits all mentions of Townshend's question concerning the connection between the confidence of the GT and the weight of the TP. Instead, Zappia (2015) cites completely irrelevant material that has nothing to do with the main goal of the correspondence, which is the correspondence between confidence and weight:

"…. leaves open the question whether, as you suggest in your letter, it may not be possible to develop a logical doctrine of equivalent certainties free from the assumption of numerical probabilities and perhaps of wider economic application (CWJMK,Vol.29,p.292;Townshend letter of Nov.25th, 1938)." (Zappia 2015).

and an alleged main conclusion:

"…the element of arbitrariness in judgments of probability, to which you refer…" (CWJMK, Vol.29, p.292; Townshend letter of Nov.25th, 1938)." (Zappia 2015)

Zappia (2015) carefully avoids Keynes's crucial commentary on p.240 that is the new clue Keynes provided to Townshend in his letter of December 7th, 1938:

"The owners of wealth will then weigh the lack of "liquidity" of different capital equipments in the above sense as a medium in which to hold wealth against the best available actuarial estimate of their prospective yields after allowing for risk. The liquidity-premium, it will be observed, is partly similar to the risk-premium, but partly different; — the difference corresponding to the difference between *the best estimates we can make of probabilities and the confidence with which we make them. (*Brady 2023a*) When we were dealing, in earlier chapters, with the estimation of prospective yield, we did not enter into detail as to how the estimation is made: and to avoid complicating the argument, we did not distinguish differences in liquidity from differences in risk proper. It is evident, however, that in calculating the own rate of interest we must allow for both.*" (Keynes 1936, 240; italics added).

As pointed out above in my discussion of Feduzi (2007), Zappia (2015) avoids any full discussion of p.240 because it represents a complete and total repudiation of the Runde (1990, 20) musings about "the application of probability to conduct. "concerning"…best available actuarial estimate…", "…with the estimation of prospective yield", "how the estimation is made" and "… that in calculating the own-rate of interest we must allow for both." because these discussions contradict and directly conflict with the insistence of Feduzi (2007) that Keynes's theory of probability is an ordinal one only .

The only conclusion possible, which it is impossible for any reader of Zappia's paper to figure out from anything written in Zappia (2015), is that for Keynes, V=V(a/h)=w ,0≤w≤1, and w=K/(K+I), which has nothing to do with the claims of Runde (1990) about Keynes's three supposedly different ways of measuring weight.

5. Research Result IV; Zappia (2016)

Zappia (2016) is another attempt to avoid any discussion of the crucial question asked by Townshend of Keynes, which was

"This is the nearest I can get to an analysis of the part played by the factor of confidence in the rationale of interest. I believe that its further logical analysis at a deeper level of generalization is connected with the part played by the weight of evidence in your theory of probability, but I cannot see just how…." (Keynes 1979, 292).

Zappia (2016) gives us the same identical, misleading, irrelevant material that is contained in Zappia (2015):

"Since this is the single place in the whole correspondence about the GT reproduced in the Collected Writings in which the TP is mentioned, it seems safe to assume that the exchange with Townshend reveals Keynes's actual thoughts on the subject of uncertainty in the years of the defense of the GT. Indeed, it is upon suggestion by Keynes that, in a letter of November 1938, Townshend examines the "alternative lines" followed by "those [scholars] who, following on the appearance of the GT, are trying to develop further an expectational economic analysis."

Townshend provides a long analysis of "methods hitherto used for expectational economic analysis" arguing that "the question whether, as you suggested in your letter, it may not be possible to develop a logical doctrine of equivalent certainties free from the assumption of numerical probabilities and perhaps of wider than economic application" is left open. But his conclusion is that the element of arbitrariness in judgements of

probability, to which you refer really implies a criticism, or at least calls for further, of the basic concept of economic man, defined as determinately motivated by (his) judgements of maximum (in some sense) anticipated profitability. (CW XXIX, p. 293)." (Zappia 2016, pp.838-840)

Nowhere in Zappia (2016) "Section 2. The correspondence with Hugh Townshend", is there any mention made about the crucial question asked by Townshend of Keynes, which I repeat again below:

"This is the nearest I can get to an analysis of the part played by the factor of confidence in the rationale of interest. *I believe that its further logical analysis at a deeper level of generalization is connected with the part played by the weight of evidence in your theory of probability, but I cannot see just how….*" (Keynes 1979, 292; italics added).

6. Discussion

Bateman (1996), Feduzi (2007), Zappia (2015), Zappia (2016) are all trying to conceal from their readers the question that Townshend asked concerning where in the (Keynes 1921) did Keynes discuss the connections between his use of confidence in the (Keynes 1936) and weight in (Keynes 1921).

Bateman (1996), Feduzi (2007), Zappia (2015), Zappia (2016) are all trying to conceal from their readers the answer Keynes gave to Townshend about p.240 of the GT dealing with "estimates, estimation of and calculation of" the risk and liquidity premiums not being in (Keynes 1936).

Bateman (1996), Feduzi (2007), Zappia (2015), Zappia (2016) are all trying to conceal from their readers the answer that Keynes gave to Townshend about the discussion in (Keynes 1921) about weight as it relates to the liquidity premium in the letter of December 7th,1938.

Keynes's p.240 analysis in (Keynes 1936) was suppressed by Bateman (1996), Feduzi (2007), Zappia (2015), Zappia (2016) because it represents a complete and total repudiation of the Post Keynesian claims about Keynes's approach, which supposedly can only use ordinal probability on some occasions:

"In fact, *most probabilities in Keynes's Treatise are non numerical; they permit approximate rather than exact comparison-'more or less likely'*-with the possibility of being able to assign numbers to probability limited to certain restricted states of knowledge" (Skidelsky 1992, 59; italics added).

Of course, Skidelsky's 'more or less likely' has NOTHING to do with approximate comparison. Skidelsky's 'more or less likely' are ordinal probabilities. On pp.160-163 of (Keynes 1921), Keynes completely and totally rejected Skidelsky's assertions about non numerical probabilities being ordinal probabilities. Of course, contrary to Runde (1990) and Skidelsky (1992), Keynes's nonnumerical probabilities are INTERVAL VALUED probabilities derived from Boole (1854).

The position of Runde (1990) is identical to that of Skidelsky (1992), with both Skidelsky (1992)and Runde (1990) asserting, without providing a shred of relevant evidence from (Keynes 1921), that Keynes had capitulated to Ramsey.

Therefore, Keynes's p.240 quote, provided below for the reader again, must be ignored by Post Keyesians, which was what Bateman (1996), Feduzi (2007), Zappia (2015), Zappia (2016) have done:

"The owners of wealth will then weigh the lack of "liquidity" of different capital equipments in the above sense as a medium in which to hold wealth against the best available actuarial estimate of their prospective yields after allowing for risk. The liquidity-premium, it will be observed, is partly similar to the risk-premium, but partly different; — the difference corresponding to the difference between the best estimates we can make of probabilities and the confidence with which we make them (Brady 2023a). When we were dealing, in earlier chapters, with the estimation of prospective yield, we did not enter into detail as to how the estimation is made: and to avoid complicating the argument, we did not distinguish differences in liquidity from differences in risk proper. It is evident, however, that in calculating the own rate of interest we must allow for both." (Keynes 1936, 240).

The question of where this appears can only be found in Keynes (1921) in one chapter. The only place in (Keynes 1921) is in chapter XXVI on pp.310-315.

Conclusions

The Keynes-Townshend correspondence of 1938 points decisively to p.315 of chapter XXVI of (Keynes 1921) and Keynes's application of the conventional coefficient, c, which Bateman (1996), Feduzi (2007), Zappia (2015), Zappia (2016) had been trying to ignore in all of their published work, as it completely undermines their claims about the supposed or alleged ordinal nature of Keynes's approach to probability, as well as their claims about Keynes having given three different, conflicting definitions of evidential weight. Such an ordinal approach is not applied in (Keynes 1921), except for Keynes's acknowledgement that there are such things as ordinal

probabilities, just as there are such things like exact, precise numerical probabilities. However, the applicability problem of probability (ordinal, numerical, interval) ends with Keynes's position that it is the formal, interval valued approach to probability in Parts II and III of (Keynes 1921), that was built on interval probability (Boole 1854), that is the more applicable in the real world of actual decision making .That concept was easily translated by Keynes into his conventional coefficient, c, in chapter XXVI of Part IV of (Keynes 1921).

A final point to consider is that anyone reading the Keynes-Townshend material of 1937-38 will soon realize that this correspondence completely destroys any and all claims made about how Ramsey supposedly demolished and destroyed Keynes's logical theory of probability, which was based on Keynes's Boolean relational, propositional logic and Boole's objective, logical, probability relation, as analyzed by Boole (1854) in chapters I, XI, XII and XVI in his *The Laws of Thought*. Runde (1990), Bateman (1996), Boole (1854), Zappia (2015), Zappia (2016) are all longtime supporters and adherents of the position that claims that Ramsey destroyed Keynes's logical theory of probability in both his 1922 *Cambridge Magazine* review, as well as in his 1926 "Truth and Probability" paper. See (Brady 2022).

Nowhere in the correspondence between Keynes and Townshend (Boumans 2019, Keynes 1979) are any of the claims made by (Bateman 1996, Feduzi 2007, Runde 1990, Zappia 2015, Zappia 2016) mentioned either directly or indirectly. Nowhere is subjective probability mentioned in any way by Keynes. Nowhere is there any mention of intersubjective probabilities made by Keynes. Nowhere does Keynes state that he has accepted any of Ramsey's criticisms of logical probability. The only theory discussed by both Keynes and Townshend is Keynes's logical theory of probability. The only book on probability discussed by both Keynes and Townshend in their correspondence is the *A Treatise on Probability*.

The only conclusion possible is that the Keynes-Townshend correspondence of 1937-38, like the 1938-1940 Keynes- Tinbergen correspondence, establishes that (a) Keynes never accepted any part of Ramsey's subjectivist approach, (b) never capitulated to Ramsey in any way ,shape or form because of the extremely poor claims made by Ramsey about Keynes's Boolean, relational, propositional , formal logic and (c) never entertained any such thing as either a subjective theory, frequency theory or an intersubjective theory of probability .Similarly, Keynes never mentions his *1937 Quarterly Journal of Economics* article. Nor is there is any mention of any such thing as fundamental, radical or irreducible uncertainty in the Keynes-Townshend correspondence. See Brady (2024, 2023a, 2023b, 2022, 2017, 2012, 2004a, 2004b), Brady and Arthmar (2012), and Arthmar and Brady (2018, 2016).

Those who would dispute these conclusions need to explain why there is no mention made by Keynes or Townshend of any of the above-mentioned topics in either the Keynes-Townshend or Keynes-Tinbergen correspondences.

Acknowledgement

I thank the referees for their assessments and input.

Declaration of Competing Interests

There are no known competing financial interests or personal relationships that could have appeared to have influenced the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The author declared that he has not used generative AI and AI-assisted technologies during the preparation of this work.

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Green Credit Policy and Firms' Green Total Factor Productivity: The Mediating Role of Financial Constraints

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Article info: Received 1 September 2024; Received in revised form 27 September 2024; Accepted 8 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: In recent years, environmental pollution has emerged as a critical global challenge, prompting increasing attention toward the Green Credit Policy as a tool for environmental regulation. These policies aim to align financial systems with sustainability objectives, yet their impact on corporate development remains controversial. This study adopts the Propensity Score Matching-Difference-in-Differences (PSM-DID) method to analyze the effects of the Green Credit Policy on the green total factor productivity (GTFP) of Chinese listed companies over the period 2007–2022. The results reveal that while the Green Credit Policy is designed to enhance environmental performance, they have exacerbated financing constraints for enterprises, leading to a significant decline in GTFP. This negative impact is particularly pronounced in large enterprises and firms in eastern China, regions often subject to stricter environmental regulations. In contrast, the ownership type - whether state-owned or non-state-owned - does not significantly influence the outcomes, suggesting the pervasiveness of financing constraints across firms. The findings underscore the critical need for policymakers to design targeted green credit strategies that account for regional and enterprise-specific characteristics. For example, tailoring green finance mechanisms to address the challenges larger enterprises or firms face in economically developed regions could mitigate unintended consequences. Moreover, the study highlights the importance of integrating financial support mechanisms, such as tax incentives, subsidies, or green innovation funds, into the future Green Credit Policy. Such measures can promote investment in green technologies by alleviating financial pressures and fostering environmental and economic goals. Ultimately, this study advocates for a balanced, context-sensitive approach to green finance, ensuring sustainable development without compromising firms' productivity.

Keywords: green credit policy; firm's green total factor productivity; financial constraints.
JEL Classification: D00; D02; Q01.

Introduction

The escalating global environmental concerns have made sustainable development a critical objective for nations worldwide (Aghion *et al.* 2016). As the world's largest carbon emitter, China faces the dual challenge of balancing rapid economic growth with urgent pollution reduction and transitioning to sustainable development (Zhang, 2000;

Zhang, 2017; Zhang, 2021). China's commitment to peaking carbon emissions by 2030 and achieving carbon neutrality by 2060 underscores the complexity of fostering environmentally friendly, circular, and low-carbon development (Zhang *et al.* 2021b). Recognizing the importance of green finance for sustainable development, China has introduced vital regulations, including the Green Credit Policy issued by the China Banking Regulatory Commission in 2012.

Firms' GTFP integrates energy consumption and environmental pollution into the framework of economic growth, representing a significant advancement over traditional total factor productivity (Xia and Xu, 2020). Lv *et al.* (2021) noted that China has developed a comprehensive green finance policy framework, surpassing many other nations in this domain (Wang *et al.* 2021). These policies restrict investment in high-pollution industries (An *et al.* 2021). However, it remains uncertain whether the Green Credit Policy effectively enhances firms' GTFP (Yan *et al.* 2020; Yuan *et al.* 2020; Wu *et al.* 2020b; Gao *et al.* 2021), raising important questions about the mechanisms and outcomes of such policies.

1. Literature Review

1.1 Green Credit Policy and Firms' GTFP

Environmental regulations are policies enacted by governments to protect the environment, encouraging businesses to reduce pollution and adopt cleaner technologies. The impact of these regulations on firms' productivity has been widely debated, resulting in three primary theoretical perspectives. The first perspective, restraint theory, argues that stringent environmental regulations increase production costs, thereby reducing firm competitiveness, particularly for those requiring substantial compliance resources (Wagner, 2007; Colea, 2010; Korhonen, 2015). The second perspective, known as the win-win hypothesis, suggests that environmental regulations promote innovation, leading to technological advancements that help mitigate compliance costs and improve competitiveness (Porter, 1995; Lanoie, 2011; Asano, 2014; Chakraborty, 2017; Costa-Campi *et al.* 2017). This hypothesis suggests that environmental and economic objectives can be simultaneously achieved. The third perspective, uncertainty theory, emphasizes that the effect of environmental regulations depends on several factors, such as the regulations' effectiveness, the specific environmental challenges faced, industry characteristics, and levels of industrial development (Rassieral, 2015; Rubashkina, 2015; Feng, 2018). This theory highlights the complexity and variability in the outcomes of environmental regulations, suggesting that their impact on firms' GTFP must be contextually evaluated.

This study, grounded in restraint theory, proposes that the Green Credit Policy, functioning both as a financial instrument and a regulatory mechanism, may negatively affect firms' GTFP. Stringent environmental regulations often raise production costs, weakening firms' competitive positions when substantial resources are allocated to compliance (Wagner, 2007). Empirical evidence supports this view, showing that the Green Credit Policy, combined with stringent regulations, increases compliance costs and reduces financial flexibility (K. Li *et al.* 2023). These increased costs can offset the potential benefits of green credit on industrial productivity. Additionally, the dual role of the Green Credit Policy - as financing tools and regulatory measures - imposes further costs for securing credit and managing pollution control. These financial burdens limit resources available for green innovation and efficiency improvements (J. Li *et al.* 2023). Based on these insights, we propose the following hypothesis:

H1: There is a significant negative relationship between the Green Credit Policy and firms' GTFP.

1.2 The Mediation Effect of Financial Constraints

Restraint theory also suggests that stringent environmental regulations elevate production costs, thereby diminishing firm competitiveness, particularly for companies required to allocate significant financial resources for compliance (Korhonen, 2015). Empirical studies indicate that such policies may inadvertently impose financing constraints on firms, adversely affecting firms' GTFP. For instance, the Green Credit Policy often restricts debt financing for enterprises, particularly non-state-owned firms (Yin *et al.* 2023). These constraints hinder investments in green technologies, slowing progress in green innovation and resource efficiency (Fang *et al.* 2024). Moreover, the financial burden of increased pollution control costs can counteract the benefits of green credit, exacerbating challenges for firms attempting to sustain or enhance their GTFP (J. Li *et al.* 2023).

Green credit policies significantly affect capital investment, often reducing the availability of total and long-term bank loans for energy-intensive industries. This limitation restricts their capacity to invest in green technologies and improve resource use efficiency (Wang *et al.* 2020). In regions with underdeveloped digital economies, green credit integration has not substantially enhanced firms' GTFP, underscoring the critical role

financing constraints play in limiting policy effectiveness (Guo *et al.* 2022). Consequently, financial constraints emerge as a pivotal factor impeding Green Credit Policy from fully enhancing firms' GTFP across different regions and enterprise types. Based on the analysis above, while the Green Credit Policy aims to promote green innovation and sustainability, it also imposes financial constraints that undermine its effectiveness. The dual function of these policies - as both regulatory mechanisms and financial instruments - creates challenges for firms balancing compliance and innovation. Thus, we propose the following hypothesis:

H2: Financial constraints significantly mediate the relationship between Green Credit Policy and firms' GTFP.

2. Method

Data Source

This study investigates the impact of the Green Credit Policy on firms' GTFP using data from Chinese listed companies from 2007 to 2022. The dataset is derived from the China Stock Market & Accounting Research (CSMAR) database, encompassing 31,152 firm-year observations during the sample period. The following preprocessing steps were undertaken to ensure data quality: (1) records with missing values were excluded; (2) observations from the financial sector were removed; and (3) companies with abnormal listing statuses were omitted.

Variable

Dependent Variable

This study employs the SBM directional distance function and the Global Malmquist-Luenberger (GML) index model to measure firms' GTFP (Xia and Xu, 2020; Färe *et al.* 2007; Yu *et al.* 2022). The GTFP of companies from 2007 to 2022 was computed by multiplying each year's GML index by the GML index of the preceding year, using 2012 as the base year. The measurement framework incorporates three types of indicators: input indicators, desired outputs, and undesired outputs (Li *et al.* 2023; Tone, 2001).

Independent Variable

Policy Dummy Variable (Time): This study leverages the 2012 implementation of the Green Credit Policy by the China Banking Regulatory Commission as the pivotal event for constructing a PSM-DID model. The policy dummy variable is assigned a value of 0 for 2007–2011 and 1 for 2012–2022.
Group Dummy Variable (Treated): Following the implementation of the Green Credit Policy, financial institutions were expected to account for the environmental and social impacts of businesses they finance and their associated entities. This shift is anticipated to significantly constrain highly polluting firms' funding and operational expansion while exerting a relatively minor influence on non-polluting businesses. Using the classification method developed by Yang and Zhang (2022), this study categorizes heavily polluting firms as the treatment group (Treated=1) and low-polluting firms as the control group (Treated=0).
Difference-in-Differences Variable (PSM-DID - TimeTreat): This study primarily investigates the joint effect of the Green Credit Policy and the treatment group on firms' GTFP. This combined impact is evaluated through the interaction term between the policy dummy variable and the treatment group dummy variable.

Mediating Variable

Financing Constraint (Cost): The Green Credit Policy primarily influences how banks and financial institutions restrict firms' access to financing. Following the method used by Wang *et al.* (2020), this study evaluates financing constraints by measuring the ratio of total financial expenses—including interest payments, fees, and other related charges—to the total liabilities recorded at year-end.

Control Variables

Based on existing research, this study incorporates several control variables that may influence the primary variable. These include the firm's debt level (leverage ratio), liquidity (current ratio), board size, ownership concentration (percentage held by the largest shareholder), asset efficiency (total asset turnover), and growth performance (revenue growth rate). Detailed definitions and descriptions of these variables are provided in Table 1.

Table 1. Variable definition

	Variable Name	Variable Meaning	Measurement	Author source
Dependent variable	GTFP	Green total factor productivity	SBM-GML index	Li *et al.*(2023), Lee & Lee (2022)
Independent variable	PSM-DID	Difference-in-Differences Variable	TimeTreat	Yang & Zhang (2022)
Mediating variable	Cost	Financing constraint	(Interest expenses + Fees + Other financial expenses) / Total liabilities at year-end	Wang *et al.* (2020)
Control variable	Lev	Leverage Ratio	Total assets / Total liabilities	Li *et al.*(2023), Lee & Lee (2022) Yang & Zhang (2022) Wang *et al.* (2020)
	Liquid	Liquidity Ratio	Current assets / Current liabilities	
	Board	Board size	Natural logarithm of the number of board members	
	Top1	Shareholding Ratio of the Largest Shareholder (Top1)	Number of shares held by the largest shareholder / Total number of company shares	
	ATO	Total Asset Turnover Ratio	Operating income / Average total assets	
	Growth	Revenue Growth Rate	Current year's operating income / Previous year's operating income	

Source: Compiled by the author

Model Specification

This study employs a PSM-DID model to examine the effect of the Green Credit Policy on firms' GTFP. By categorizing the sample into an experimental group and a control group, the PSM-DID model addresses potential endogeneity concerns and facilitates a comparative analysis of changes in crucial variables between policy-affected and unaffected scenarios.

Before introducing the Green Credit Policy, companies applied for loans through traditional credit evaluation methods. However, following the policy's implementation, financial institutions began incorporating environmental factors into their loan assessment criteria. Firms with high resource consumption, pollution, and emissions faced stricter credit restrictions due to their environmental impact.

In this study, heavily polluting firms constitute the experimental group, while low-polluting enterprises are the control group. The analysis employs a PSM-DID model to evaluate the effect of the 2012 Green Credit Policy on the firms' GTFP. The specific model equation is presented as follows:

$$Y_{it}=\beta_0+\beta_1*TimeTreat_{it}+\beta_2*Time_{it}+\beta_3*Treat_{it}+\beta_4*Cons_{it}+\varepsilon_{it} \quad (1)$$

$$Cost_{it}=\beta_0+\beta_1*TimeTreat_{it}+\beta_2*Time_{it}+\beta_3*Treat_{it}+\beta_4*Cons_{it}+\varepsilon_{it} \quad (2)$$

$$Y_{it}=\beta_0+\beta_1*TimeTreat_{it}+\beta_2*Time_{it}+\beta_3*Treat_{it}+\beta_4*Cons_{it}+\beta_5*Cost_{it}+\varepsilon_{it} \quad (3)$$

The equation shown above includes several vital variables, where $TimeTreat_{it}$ is the independent variable, Y_{it} is the dependent variable, an β_0 is the intercept term. A notably positive coefficient of determination β_1 suggests that adopting the Green Credit Policy may improve the firm's GTFP. Conversely, a considerably negative coefficient of determination$\beta_1$show the opposite impact. The symbol $Cons_{it}$ identifies the control variables, $Cons_{it}$ represents the mediating variable, $i$represents the person, and t specifies time.

3. Research Results

Descriptive Statistics

This paper presents a statistical overview of the sample, including the variables' number, mean, standard deviation, minimum, and maximum values. The firms' GTFP has a mean of 0.9976, a standard deviation of 0.1178, and minimum and maximum values of 0.7345 and 1.1712, respectively. Most variables, except for TimeTreat and the operating income growth rate, exhibit a standard deviation close to or less than the mean, indicating relatively stable data with minimal variation. Detailed descriptive statistics for all variables are provided in Table 2.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
GTFP	31,152	0.9976	0.1178	0.7345	1.1712
TimeTreat	31,152	0.0356	0.1852	0.0000	1.0000
Time	31,152	0.8411	0.3656	0.0000	1.0000
Treat	31,152	0.0469	0.2114	0.0000	1.0000
Lev	31,152	0.4160	0.1947	0.0558	0.8442
Liquid	31,152	2.4382	2.3705	0.3405	15.2672
Board	31,152	2.1328	0.1996	1.6094	2.7081
Top1	31,152	34.3673	14.8403	8.4804	74.2950
ATO	31,152	0.6706	0.4538	0.0927	2.7144
Growth	31,152	0.1653	0.3359	-0.4965	1.8333

PSM-DID Results

The regression results presented in Table 3, obtained using the Propensity Score Matching-Difference-in-Differences (PSM-DID) method, indicate a significant negative correlation between the Green Credit Policy and firms' GTFP at the 5% significance level (coefficient = -0.012, t-value = -2.432). After PSM matching, the coefficient of the TimeTreat variable is -0.033 with a t-value of -2.395, further confirming a significant negative correlation at the 5% significance level. The findings suggest that the Green Credit Policy significantly reduces firms' GTFP in both the baseline and PSM-DID regression models. Additionally, the time variable in the control group demonstrates a significant positive correlation in both models. Other variables, such as Liquid and Board, exhibit varying degrees of significance across the models. Using the PSM-DID approach enhances the robustness of the analysis, reinforcing the conclusion that the Green Credit Policy has an adverse effect on firms' GTFP.

Table 3. Baseline results: the Green Credit Policy and firms' GTFP

Variables	Baseline Regression	PSM-DID Regression
	GTFP	GTFP
TimeTreat	-0.012** (-2.432)	-0.033** (-2.395)
Time	0.229*** (174.838)	0.201*** (32.057)
Treat	0.003 (0.721)	0.019 (1.396)
Lev	0.007** (2.083)	0.070** (2.341)
Liquid	-0.001*** (-4.596)	-0.003 (-1.128)
Board	-0.048*** (-20.465)	-0.068*** (-3.586)
Top1	-0.000*** (-15.842)	-0.000* (-1.835)
ATO	-0.008*** (-7.991)	0.004 (0.318)
Growth	-0.003** (-2.148)	0.010 (0.909)
_cons	0.930*** (164.184)	0.947*** (21.733)
N	31152.000	1570.000
r2	0.545	0.082
F	4136.481	188.571

Note: t statistics in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

Parallel Trend Test

This study performed a parallel trend test to examine the relationship between the Green Credit Policy and firms' GTFP before and after the policy's implementation. The analysis utilized data from three periods before the policy and five periods after, with the pre-implementation period serving as the baseline. Detailed results of the parallel trend test are provided in Table 4.

Table 4. Parallel Trend results

GTFP	Coefficient	Std. err.	t	P>t	[95% conf.	interval]
pre_3	0.0051	0.0107	0.4700	0.6350	-0.0159	0.0260
pre_2	0.0316	0.0106	2.9700	0.0030	0.0108	0.0525
current	-0.1440	0.0101	-14.1900	0.0000	-0.1639	-0.1241
post_1	-0.1208	0.0100	-12.0500	0.0000	-0.1405	-0.1012
post_2	-0.0913	0.0099	-9.1800	0.0000	-0.1108	-0.0718
post_3	-0.0703	0.0098	-7.1400	0.0000	-0.0896	-0.0510
post_4	-0.0412	0.0096	-4.2800	0.0000	-0.0601	-0.0223
post_5	0.0559	0.0064	8.8000	0.0000	0.0435	0.0684
time	0.2290	0.0013	177.8900	0.0000	0.2265	0.2316
Treat	-0.0045	0.0056	-0.8100	0.4170	-0.0154	0.0064
Lev	0.0066	0.0031	2.1300	0.0340	0.0005	0.0126
Liquid	-0.0011	0.0003	-4.3500	0.0000	-0.0016	-0.0006
Board	-0.0460	0.0023	-20.0000	0.0000	-0.0505	-0.0415
Top1	-0.0005	0.0000	-15.7900	0.0000	-0.0005	-0.0004
ATO	-0.0079	0.0010	-7.6800	0.0000	-0.0099	-0.0059
Growth	-0.0041	0.0013	-3.0200	0.0030	-0.0067	-0.0014
_cons	0.9256	0.0056	166.0100	0.0000	0.9147	0.9366

As presented in Table 4, the parallel trend test shows no significant correlation in the pre_3 period before the policy's implementation (P-value=0.6350), while a significant positive correlation is observed in the pre_2 period (P-value=0.0030). This indicates that the parallel trend assumption before the policy implementation is satisfied. Upon the policy's implementation (current), firms' GTFP decreases significantly (P-value=0.0000), with a coefficient of -0.1440, demonstrating a significant negative impact of the Green Credit Policy on firms' GTFP. In the post-implementation periods (post_1 to post_4), firms' GTFP continues to decline significantly (P-values=0.0000 for all periods), with coefficients of -0.1208, -0.0913, -0.0703, and -0.0412, respectively. These findings highlight that the policy consistently negatively influences firms' GTFP during these periods. However, in the post_5 period, firms' GTFP increases significantly (P-value=0.0000), with a coefficient of 0.0559. This suggests that, over time, companies gradually adapt to the policy, leading to a recovery and improvement in GTFP. These results validate the PSM-DID model and illustrate that while the Green Credit Policy negatively affects firms' GTFP in the early stages of implementation, firms adapt over time, resulting in improved GTFP in the later stages.

Mechanism Test

This study employs a mediation effect model to examine how the Green Credit Policy impacts the firm's GTFP. The findings indicate that TimeTreat significantly increases corporate debt financing costs at the 1% significance level (coefficient = 0.004) and substantially reduces firms' GTFP at the 10% significance level (coefficient = -0.008). Additionally, corporate debt financing costs significantly decrease firms' GTFP (coefficient = -0.945) at the 1% significance level. These results support the hypothesis that the Green Credit Policy reduces firms' GTFP by increasing financing constraints. Detailed results are presented in Table 5.

Table 5. Mediation effect estimation results: financial constraints as a mediator

Variables	(1)	(2)	(3)
	GTFP	Cost2	GTFP
TimeTreat	-0.012** (-2.432)	0.004*** (4.793)	-0.008* (-1.672)
Time	0.229*** (174.838)	-0.002*** (-8.011)	0.227*** (175.701)
Treat	0.003 (0.721)	0.004*** (5.420)	0.007 (1.625)
Lev	0.007** (2.083)	0.018*** (33.105)	0.023*** (7.450)
Liquid	-0.001*** (-4.596)	-0.001*** (-20.666)	-0.002*** (-8.017)
Board	-0.048*** (-20.465)	0.000 (0.635)	-0.048*** (-20.637)
Top1	-0.000*** (-15.842)	-0.000*** (-16.938)	-0.001*** (-18.768)
ATO	-0.008*** (-7.991)	-0.001*** (-8.190)	-0.010*** (-9.442)
Growth	-0.003** (-2.148)	-0.003*** (-13.760)	-0.006*** (-4.437)
Cost2			-0.945*** (-29.155)
_cons	0.930*** (164.184)	0.018*** (18.896)	0.948*** (168.565)
Observations	31152.000	31152.000	31152.000
R — squared	0.545	0.149	0.557
F	4136.481	604.879	3909.323

Note：t statistics in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

Heterogeneity

Regional Heterogeneity

The regression results presented in Table 6 illustrate the varying relationships between the Green Credit Policy and firms' GTFP across different regions.

Table 6. Regional heterogeneity

Variables	East Region	Midwest Region
	GTFP	GTFP
TimeTreat	-0.012* (-1.742)	-0.010 (-1.383)
time	0.229*** (144.801)	0.228*** (97.392)
treat	0.002 (0.408)	0.004 (0.589)
Lev	0.008** (2.280)	0.004 (0.677)
Liquid	-0.001*** (-4.804)	-0.001 (-0.921)
Board	-0.049*** (-17.645)	-0.041*** (-9.252)
Top1	-0.001*** (-15.158)	-0.000*** (-5.896)
ATO	-0.008*** (-6.840)	-0.009*** (-4.443)

Variables	East Region	Midwest Region
	GTFP	GTFP
Growth	-0.006*** (-3.894)	0.005** (2.056)
_cons	0.936*** (139.155)	0.906*** (85.203)
Observations	22637.000	8509.000
R — squared	0.529	0.578
F	2821.441	1291.747

Note: t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 6 demonstrates that the Green Credit Policy significantly negatively impacts firms' GTFP in the eastern region, with a coefficient of -0.012, statistically significant at the 10% level. However, the policy's impact in the Midwest region is not statistically significant, with a coefficient of -0.010. The time variable shows a significant positive effect on firms' GTFP in both regions, with coefficients of 0.229 in the eastern region and 0.228 in the Midwest regions, both significant at the 1% level. Among the control variables, leverage (Lev) positively influences GTFP in the eastern region, while board size (Board), the shareholding ratio of the largest shareholder (Top1), and total asset turnover (ATO) negatively affect GTFP across both regions. Liquidity (Liquid) significantly negatively affects GTFP in the eastern region. Still, it is not significant in the Midwest regions, whereas the growth rate (Growth) negatively impacts GTFP in the eastern region but positively influences it in the Midwest regions. These findings highlight the heterogeneous effects of the Green Credit Policy on firms across different regions while also reflecting regional variations in the direction and significance of the control variables.

Ownership Type Heterogeneity

The regression results presented in Table 7 illustrate the varying impact of the Green Credit Policy on firms' GTFP across different ownership types.

Table 7. Ownership type heterogeneity

Variable	State-Owned Enterprises	Non-State Owned Enterprises
	GTFP	GTFP
TimeTreat	-0.006 (-1.119)	-0.009 (-0.545)
time	0.224*** (125.083)	0.229*** (116.250)
treat	0.003 (0.666)	-0.004 (-0.230)
Lev	0.001 (0.247)	0.026*** (6.038)
Liquid	0.001* (1.660)	-0.001*** (-3.921)
Board	-0.030*** (-7.821)	-0.049*** (-15.523)
Top1	-0.000*** (-4.738)	-0.001*** (-12.054)
ATO	-0.011*** (-7.478)	-0.005*** (-3.554)
Growth	0.004* (1.828)	-0.009*** (-5.301)
_cons	0.878*** (91.691)	0.928*** (121.576)
Observations	11360.000	19194.000
R — squared	0.623	0.444
F	2087.514	1702.461

Note：t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

As shown in Table 7, the Green Credit Policy does not have a statistically significant impact on firms' GTFP for state-owned enterprises (SOEs) or non-SOEs, with coefficients of -0.006 and -0.009, respectively, which are not significant. However, the time variable has a significant positive effect on firms' GTFP for both ownership types, with coefficients of 0.224 for SOEs and 0.229 for non-SOEs, both significant at the 1% level. Among the control variables, leverage (Lev) is not significant for SOEs but significantly impacts GTFP for non-SOEs. Liquidity (Liquid) positively affects GTFP for SOEs but negatively impacts GTFP for non-SOEs. Board size (Board) negatively influences GTFP in both SOEs and non-SOEs, as do the shareholding ratio of the largest shareholder (Top1) and total asset turnover (ATO). The growth rate (Growth) impacts GTFP for SOEs but negatively affects GTFP for non-SOEs.These findings highlight that the effects of the Green Credit Policy and the control variables on firms' GTFP vary significantly depending on ownership type, reflecting the differing dynamics and characteristics of SOEs and non-SOEs.

Corporate Size Heterogeneity

The results presented in Table 8 illustrate the varying impact of the Green Credit Policy on firms' GTFP across different corporate sizes.

Table 8. Corporate Size heterogeneity

Variables	Small enterprises	Large enterprises
	GTFP	GTFP
TimeTreat	-0.014 (-1.269)	-0.012** (-2.056)
Time	0.229*** (125.517)	0.227*** (120.160)
Treat	-0.010 (-1.111)	0.005 (1.050)
Lev	0.028*** (5.331)	-0.014*** (-3.199)
Liquid	-0.000 (-1.443)	-0.001 (-1.574)
Board	-0.055*** (-15.953)	-0.045*** (-13.846)
Top1	-0.001*** (-10.857)	-0.001*** (-12.574)
ATO	-0.009*** (-5.132)	-0.008*** (-6.464)
Growth	-0.003* (-1.780)	-0.003 (-1.305)
_cons	0.936*** (110.460)	0.938*** (113.943)
Observations	15571.000	15581.000
R — squared	0.547	0.545
F	2089.533	2070.144

Note：t statistics in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

As shown in Table 8, the Green Credit Policy negatively impacts firms' GTFP in small and large enterprises. However, this impact is statistically significant only for large enterprises, with a coefficient of -0.012 at the 5% significance level, while the impact on small enterprises is not statistically significant. The time variable has a significant positive effect on firms' GTFP in both small and large enterprises, with coefficients of 0.229 and 0.227, respectively, both significant at the 1% level. Among the control variables, leverage (Lev) positively influences GTFP in small enterprises but negatively affects GTFP in large enterprises. Liquidity (Liquid) does not significantly impact GTFP for either firm size. Board size (Board) negatively influences GTFP in both small and large enterprises, as do the shareholding ratio of the largest shareholder (Top1) and total asset turnover (ATO). The growth rate (Growth) negatively affects GTFP in small enterprises but does not significantly impact large enterprises. These findings indicate that the effects of the Green Credit Policy and control variables on firms'

GTFP vary significantly depending on the size of the enterprise, reflecting different dynamics between small and large firms.

4. Discussions

This study provides valuable insights into the relationship between the Green Credit Policy and firms' GTFP in China. The findings reveal a significant tradeoff: while the Green Credit Policy aims to promote environmental sustainability, it also imposes considerable financing constraints that negatively affect firms' GTFP. This challenges the prevailing assumption that the Green Credit Policy universally enhances productivity through sustainable practices. Instead, the results uncover a more nuanced reality: the financial burden associated with compliance can hinder the very firms' GTFP these policies are intended to improve.

Our analysis demonstrates that the negative impact of the Green Credit Policy on firms' GTFP is particularly pronounced in large enterprises and firms located in the eastern region of China. These firms, facing stricter environmental regulations, encounter heightened financial pressures that constrain their ability to invest in green technologies. This finding aligns with existing literature on the financial constraints posed by regulatory compliance but extends current understanding by highlighting the differential impacts across firm sizes and regional contexts. The observation that larger firms and those in more economically developed regions bear a disproportionate burden emphasizes the necessity for a tailored approach to implementing the Green Credit Policy. Interestingly, the ownership structure of firms - whether state-owned or non-state-owned - does not significantly alter the impact of the Green Credit Policy on firms' GTFP. This finding suggests that financing constraints introduced by the Green Credit Policy are pervasive and affect firms across ownership types. This challenges the conventional wisdom that state-owned enterprises might have more resources or preferential access to credit to mitigate the financial impacts of such policies.

In the broader context of sustainable development, this study highlights the complexities of designing and implementing an effective Green Credit Policy. While well-intentioned, the effectiveness of these policies can be compromised if they are not adapted to the unique needs and characteristics of various industries, regions, and firm sizes. The unintended negative consequences observed in this study underscore the importance of adopting a more nuanced and context-sensitive approach to policy design. Policymakers must carefully balance the environmental objectives of the Green Credit Policy with the economic realities targeted firms face to ensure the policies achieve their intended goals without stifling firms' GTFP.

Conclusions and Further Research

This study sheds light on the intricate relationship between the Green Credit Policy and firms' GTFP in China. While these policies promote environmental sustainability, they impose significant financing constraints that can hinder firms' GTFP. This challenges the assumption that the Green Credit Policy universally enhances productivity through sustainable practices and underscores the complexity of balancing environmental objectives with economic realities. The findings highlight the need for policymakers to adopt a more tailored approach, recognizing the diverse impacts across firm sizes, regions, and industries.

The results also have broader implications for policymakers and financial institutions. Policymakers must integrate complementary financial mechanisms, such as tax incentives, subsidies, and green innovation funds, to reduce the financial burden on firms while encouraging green investments. Additionally, financial institutions should develop more flexible green credit products and adjust loan terms better to accommodate smaller enterprises or those in disadvantaged regions. These strategies can mitigate the adverse effects of the Green Credit Policy and promote sustainable development while safeguarding firms' GTFP.

Future research should investigate the long-term effects of the Green Credit Policy on firm-level innovation, competitiveness, and environmental performance. Comparative studies across countries and industries could offer deeper insights into how regulatory and financial frameworks influence outcomes. Furthermore, exploring alternative green financing mechanisms, such as green bonds and sustainability-linked loans, could reveal innovative ways to align environmental sustainability with economic growth. This study underscores the importance of context-sensitive policies and lays the groundwork for future research to advance the understanding and implementation of green credit systems.

Acknowledgments

This research was supported by the Qingdao City University Scientific Research Project, titled *"The Impact of Green Credit Policy on Firms' Green Total Factor Productivity under the 'Dual Carbon' Background: An Empirical Study Based on the DID Model"* (Project Number: QCU22RB04).

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Haslinah Muhamad: Software, Validation, Writing, review and editing, Visualization.
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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that no generative AI or AI-assisted technologies were used in the writing process before submission.

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DOI: https://doi.org/10.14505/tpref.v15.4(32).08

The Effectiveness of International Financial Reporting Standards in Minimizing Information Asymmetry

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Article info: Received 24 September 2024; Received in revised form 19 October 2024; Accepted for publication 8 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: Information asymmetry is an important problem of financial markets, which creates unequal conditions for different investors. The aim of the research is to analyse the impact of the implementation of International Financial Reporting Standards (IFRS) on the change in the relationship between a number of financial indicators and the company's market value. The latter was taken as an indicator of information asymmetry arising from investors' speculative expectations. The research employs methods of correlation, regression, and comparative analysis. The study established an increase in the correlation between Price-to-Earnings (P/E) ratio and market capitalization (Market cap) for a sample of Saudi Arabian companies after the IFRS implementation. However, the previously obtained conclusions were not confirmed after checking

the results with the data of each individual company. Moreover, it was found that for most companies the correlation between P/E ratio and Market cap significantly weakened after the IFRS implementation. It can be assumed that before the mandatory IFRS implementation, the increase in Market cap could occur mainly on the basis of investors' expectations. However, expectations could not be met because of a significant level of information asymmetry. Therefore, the decrease in correlations between P/E ratio and Market cap may indicate a more critical assessment of companies by investors due to increased transparency of financial information. Further research may focus on the analysis of other factors influencing the level of information asymmetry, such as improving the quality of integrated reporting and corporate governance.

Keywords: international financial reporting standards; information asymmetry; Price-to-Earnings ratio; investors' expectations; market capitalization; information transparency.

JEL Classification: D82; G10; G20; C10.

Introduction

Information asymmetry is a significant problem for investors and other stakeholders in the financial sphere (Huynh *et al.* 2020; Kong *et al.* 2022). It occurs when a certain proportion of stakeholders have important information for making strategic decisions, while others have access to publicly available data only (Myers 2020; Aben *et al.* 2021). A significant level of information asymmetry is not only a problem for an individual enterprise but can also have a negative impact on the market as a whole (Fulghieri *et al.* 2020; Zhurakhovska, 2023).

The problem of the information asymmetry is complex (Li *et al.* 2024; Alshehadeh *et al.* 2023). It arises under the influence of numerous factors, which include the level of market development, activities and priorities of various stakeholders, price fluctuations and changes in forecasts (Ullah *et al.* 2020; Corbet *et al.* 2020). Because of this, the assessment of information asymmetry and its impact on financial activity becomes a difficult task and is field-dependent (Mahdich and Lymonova 2019).

The IFRS were adopted to improve the quality and transparency of financial information (Ebaid 2022; Golshan *et al.* 2023; Kim *et al.* 2024). One of the key tasks of IFRS is reducing information asymmetry (Ertugrul and Demir 2021; Jamaani and Alidarous 2022). This task can be achieved by providing investors and other economic agents with adequate access to financial data to make informed strategic decisions (Khan *et al.* 2024).

At the same time, the consequences of IFRS implementation regarding their impact on information asymmetry remain insufficiently disclosed in modern economic literature. Moreover, there is a lack of empirical research on how a reduction in information asymmetry affects investors' expectations and decisions. According to the historical data, high investor expectations expressed through the P/E ratio are accompanied by bearish trends in the stock market (Shen 2000). Among other things, this can evidence the information asymmetry, if not all possible risks have been considered.

The aim of the work is to analyse the impact of the IFRS introduction on the change in the relationship between a number of financial indicators and the company's market value. The latter was taken as an indicator of information asymmetry arising from investors' speculative expectations. The identified relationships can provide information on how investors' expectations change because of the reduction of information asymmetry due to the IFRS implementation. The aim of the research involved the fulfilment of the following research objectives:

- Conduct a correlation analysis between the P/E ratio and a number of financial indicators of the studied companies;
- Supplement the results of correlation analysis with regression analysis of key indicators;
- Deepen the obtained results by carrying out a correlation analysis between indicators related to preliminary estimates for each of the studied companies separately;
- Draw analytical conclusions based on the calculation results.

1. Literature Review

The reseachers agree that accounting and financial reporting play a critical role in decision-making and resource selection (Mangu *et al.* 2023). Accordingly, completeness, availability and transparency of information are necessary requirements for financial reporting, in particular, in the investment field (Shakespeare 2020). Many researchers have testified that IFRS ensure compliance with these requirements and therefore reduce information asymmetry. The study of Ahmed *et al.* (2024) provides corresponding conclusions, who proved that IFRS play an important mediating role between corporate governance and the reduction of information asymmetry. Nejad *et al.* (2020) conducted an empirical analysis and found a statistically significant inverse relationship between IFRS implementation and information asymmetry. Benkraiem *et al.* (2022), agreed with a significant impact of accounting regulation through IFRS on the information environment. Tawiah and Oyewo (2024) studied the impact of IFRS implementation on investment activities in the banking sector. The researchers

found that the introduction of uniform standards in developing countries not only increases investment due to the facilitated compliance with regulatory requirements, but also due to the reduction of information asymmetry. Chala *et al.* (2023) proved the impact of IFRS implementation on information quality and business transparency. Mohammed (2022) confirmed that conservative accounting is a critical factor in reducing information asymmetry as well as reducing the cost of capital under IFRS.

A number of researchers consider the impact of the IFRS adoption on reducing the information asymmetry as a generally recognized fact, so they continue their research through the analysis of additional areas. Bessler *et al.* (2023) noted that the IFRS introduction is a shock that leads to a reduction in information asymmetry. The researchers sought to reveal how these phenomena affected the companies' propensity to pay dividends. A similar line of research can be observed in the work of Agarwal and Chakraverty (2023), who additionally investigated the change in the relationship between the company's growth opportunities and its dividend policy in response to a reduction in information asymmetry.

In addition to the IFRS impact on reducing the information asymmetry, some researchers noted the important role of integrated reporting in this process (Hryn 2021; Orlov 2023). At the same time, Hryn (2021) notes that the IFRS developers also emphasize the need to maintain a balance between information disclosure and preservation of confidential information.

The reviewed studies provide important evidence regarding the reduction of information asymmetry due to the IFRS implementation. However, the market implications remain unclear. In particular, how the reduction in the information asymmetry through the IFRS introduction is related to the change in investors' expectations in the context of the companies' market value.

2. Materials and Methods

2.1 Research Design

The preparatory stage of the research involved making a sample of indicators and companies for analysis. The main stage included direct analysis of the indicators identified as key for the study. The aim of the correlation analysis between the P/E Ratio and other indicators for the entire sample of companies was to reveal the relationship between them. The aim of the regression analysis was to check the results of the correlation analysis taking into account the impact of several indicators on the dependent variable (P/E Ratio) at the same time. The identified correlations were the basis for determining the indicators for further analysis. A correlation analysis was conducted between them for each individual company. The purpose of these actions was to deepen the preliminary conclusions and to provide an analytical evaluation of the obtained conclusions, which became the final stage of the work.

2.2 Sample

The literature lacks a single approach to the assessment of information asymmetry, as well as final indicators of its level. Therefore, it was necessary, first of all, to determine such an indicator that can indicate a change in the level of information asymmetry in accordance with the goals set in the article. P/E Ratio was chosen as such indicator. This indicator is often used for the company's market evaluation in view of its current or future profits. In other words, an increase in the P/E Ratio may indicate high investor expectations for the company's future earnings. The expected profitability, which determines the P/E Ratio, may be overestimated, thereby increasing and the information asymmetry.

Market Cap, Operating Margin, and Earnings were taken for comparison with the P/E Ratio. These indicators are one of the key indicators of the company's activity and can influence the investors' expectations expressed through the P/E Ratio. Assessment of the impact of indicators on the P/E Ratio can help to identify changes in information asymmetry.

After determining the indicators, a sample of companies was made for analysis. All companies operate in Saudi Arabia, being among the country's leaders in terms of market capitalization. A total of 18 companies were included in the sample: Al Rajhi Bank, SABIC, Saudi Telecom Company, The Saudi National Bank, Maaden, Alinma Bank, Riyad Bank, Saudi Electricity, The Saudi British Bank, Almarai, Saudi Arabian Fertilizer Company, Bank Albilad, Banque Saudi Fransi, Arab National Bank, Etihad Etisalat (Mobily), Kingdom Holding, Savola Group, Yanbu National Petrochemical. The number of companies is sufficient to carry out the research, and their selection is determined by belonging to the top 30 companies of the country by market capitalization. These companies are major players in the market, so their approaches to accounting set the trend for others and determine the overall level of trust and transparency. All 30 companies from the leaders of the rating were not included in the work, because the analysis required data for the period up to 2017, which is not available for a

number of companies. The choice of Saudi Arabia as a country for research is determined the importance of studying the impact of IFRS on the transparency and reliability of financial reporting in the context of rapid economic changes. The country is implementing these changes as part of the Vision 2030 strategy, which involves ensuring efficiency, accountability and transparency at all levels of governance.

2.3 Methods

The research employed the method of correlation analysis, which made it possible to check whether there is a connection between the studied indicators. It was also useful in the context of the study to determine the direction of such a relationship (positive or inverse). The changes in the identified correlations in the dynamics was performed using a comparative analysis, which made it possible to identify differences in investors' expectations before and after the IFRS introduction. The results of the correlation analysis were supplemented by regression analysis, which expanded the conclusions obtained by taking into account the influence of several variables on the dependent indicator.

3. Research Results

3.1 Correlation Analysis

The results of the correlation analysis between the P/E ratio, on the one hand, and the Market cap, Operating margin, and Earnings, on the other, are presented in Table 1. Table 1 contains the results for the period before the mandatory IFRS implementation in Saudi Arabia and after. The comparison of the results obtained for the two periods revealed certain discrepancies, which may indicate the impact of IFRS on the level of information asymmetry.

Table 1. Results of the correlation analysis between the P/E ratio and Market cap, Operating margin, and Earnings before and after the IFRS introduction

	P/E ratio (before the IFRS introduction)	P/E ratio (after the IFRS introduction)	Change
Market cap	0.103755	0.379212432	+0.275457
Operating margin	0.450125	-0.059138389	-0.50926
Earnings	0.196526	0.055559073	-0.14097

Source: calculated by the author based on (CompaniesMarketcap 2024)

Table 1 shows that before the IFRS introduction, the correlations between P/E ratio, Market cap, and Earnings were weak, and the correlation with Operating margin was moderate. After the IFRS introduction, the correlation between the P/E ratio, the Operating margin, and Earnings indicators decreased, while the correlation with the Market cap increased significantly. The obtained results can be supplemented by applying regression analysis to the studied indicators.

3.2 Regression Analysis

The results of the regression analysis provide a more comprehensive view of the relationships between the variables by taking into account the influence of several variables on the dependent indicator. The dependent variable in this case was the P/E ratio. As in the case of the correlation analysis, the regression analysis was performed for the period before the IFRS implementation (in 2017) and after it. Table 2 contains the results of the regression analysis for the period before 2017, Table 3 – after 2017.

Table 2. Results of regression analysis for the period before the IFRS introduction

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	-223.41	171.77	-1.30	0.21	-591.83	145.01	-591.83	145.01
Market cap	0.00	0.00	0.04	0.97	0.00	0.00	0.00	0.00
Operating margin	4.72	3.34	1.41	0.18	-2.44	11.88	-2.44	11.88
Earnings	0.00	0.00	0.11	0.91	0.00	0.00	0.00	0.00

Source: calculated by the author based on (CompaniesMarketcap 2024)

The results of the regression analysis for the period before the IFRS introduction show that the model had a rather low explanatory power. This can be established through the value of the coefficient of determination, which was about 0.2247. All financial indicators included in the model did not have a statistically significant relationship with the dependent variable.

Table 3. Results of regression analysis for the period after the IFRS introduction

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	10.87	8.27	1.31	0.21	-6.87	28.61	-6.87	28.61
Market cap	0.00	0.00	2.38	0.03	0.00	0.00	0.00	0.00
Operating margin	0.00	0.00	0.29	0.78	0.00	0.00	0.00	0.00
Earnings	0.00	0.00	-1.67	0.12	0.00	0.00	0.00	0.00

Source: calculated by the author based on (CompaniesMarketcap 2024)

The coefficient of determination increases slightly after the IFRS introduction — up to 0.2947, which may indicate an improvement in the model's ability to explain variations in the dependent variable. The P-value shows that the influence of Market cap has become significant, because the P-value for it is smaller than 0.05. Therefore, the regression analysis supported the results of the correlation analysis regarding the strengthening of the relationship between the P/E ratio and the Market cap.

The obtained results suggest that the introduction of uniform standards could contribute to the strengthening of the relationship between the Market cap of the studied companies and the P/E ratio. This may indicate that after the IFRS introduction, the market began to focus mainly on more complex indicators, such as Market cap. This indicator contains an overall estimate of the company's value, as opposed to individual indicators such as Operating margin and Earnings. Accordingly, it can be assumed that due to increased transparency and quality of financial data and standardization, investors began to rely more on the value of market capitalization as a more reliable indicator. This allows them to take into account more aspects of the financial condition of companies, in contrast to the use of individual indicators, which can distort the overall picture. At the same time, the revealed connections indicate only a change in the level of investor confidence, but do not prove an actual change in the level of information asymmetry. Relying on the value of Market cap as a more comprehensive indicator (in contrast to Operating margin and Earnings) may indicate an increase in investor confidence in financial information. However, the assessment of the impact on the information asymmetry requires a more in-depth analysis. Such an analysis can provide an estimate of the correlations between the P/E ratio and the Market cap for each individual company.

3.3 Analysis Based on the Data of Individual Companies

The conducted analysis provides a broad vision of the relationship between financial indicators and the P/E ratio, which was determined in the course of the study as one that can characterize information asymmetry.

Table 4. Results of correlation analysis between P/E ratio and Market cap for each of the studied companies

Name	Correlation before	Correlation after	Change
Al Rajhi Bank	0.836	0.089	-0.747
SABIC	0.333	-0.088	-0.421
Saudi Telecom Company	0.751	0.948	0.197
The Saudi National Bank	0.991	0.798	-0.193
Maaden	-0.802	0.353	1.155
Alinma Bank	0.111	0.771	0.660
Riyad Bank	0.901	0.332	-0.569
Saudi Electricity	0.035	-0.442	-0.478
The Saudi British Bank	0.923	0.476	-0.447
Almarai	0.898	0.042	-0.856
Saudi Arabian Fertilizer Company	-0.694	-0.740	-0.045
Bank Albilad	0.953	0.342	-0.610
Banque Saudi Fransi	0.170	0.173	0.003
Arab National Bank	0.771	0.623	-0.147
Etihad Etisalat (Mobily)	0.622	0.160	-0.461
Kingdom Holding	0.830	0.210	-0.620
Savola Group	0.560	0.269	-0.291
Yanbu National Petrochemical	0.271	-0.501	-0.772

Source: calculated by the author based on (CompaniesMarketcap 2024)

However, a more accurate analysis based on the data of individual companies can deepen the obtained conclusions, for which correlation and regression analyses were repeated for each of the studied companies. Two indicators were used for this purpose:

- P/E ratio as an indicator that reflects investors' expectations regarding the company's future profit, and therefore be an indicator of the information asymmetry;
- Market cap, which is an indicator of the companies' market value.

The results of correlation analysis between P/E ratio and Market cap for each of the studied companies are presented in Table 4.

A correlation analysis conducted for each company separately revealed that for most companies the correlation between P/E ratio and Market cap decreased after the IFRS introduction. This can be explained by the fact that before the introduction of IFRS, the increase in market capitalization could occur mainly on the basis of investors' expectations. In turn, expectations could be wrong because of the information asymmetry. As some studies show, the growth of the P/E ratio was often accompanied by downward trends in the stock market. Accordingly, the decrease in correlations between P/E ratio and market cap may indicate that with the IFRS introduction, investors began to assess the situation more critically. The reason for this may be access to more transparent and accurate financial information.

4. Discussions

Therefore, the conducted analysis proves the existence of the impact of the introduction of IFRS on the reduction of information asymmetry through the assessment of changes in investors' expectations regarding the companies' market value. The obtained results give grounds to assume that investors began to evaluate companies and the situation on the market more critically. One of the important factors of such changes could be access to more transparent and complete information thanks to IFRS.

The choice of indicators is important in the analysis of the impact of IFRS or other factors on the information asymmetry. So, the researchers use various indicators that allow considering the problem from different perspectives in order to determine the level of information asymmetry and the consequences of its reduction. Chala *et al.* (2023) used the cost of capital as an indicator of information asymmetry. The reseachers proved that after the implementation of IFRS in Singapore companies, the information asymmetry expressed through this indicator decreased. Bessler *et al.* (2023) noted that information asymmetry is a factor influencing companies' propensity to pay dividends. The researchers also found that companies' propensity to pay dividends decreased after the mandatory implementation of IFRS. Agarwal and Chakraverty (2023) found an inverse relationship between companies' growth opportunities and dividend payments due to a reduction in information asymmetry. Benkraiem *et al.* (2022) found that the impact of IFRS on reducing the information asymmetry is carried out through increasing the reliability of income display only. It follows that the researchers use different indicators than the author of this study, which indicates the value of this study due to the addition of a new vector to existing achievements. At the same time, the new approach needs further expansion and testing on other samples of companies and regions.

Some evidence to support the author's conclusions can be obtained from the work of Mohammed (2022) and Prokopenko *et al.* (2022). The researcher found the impact of accounting under the IFRS on reducing information asymmetry and the cost of capital. His research is theoretical, while the impact observed in the author's research is confirmed empirically. Investors' more critical attitude towards company valuations affects their investment decisions and thus the cost of capital. Mangu *et al.* (2023) recognize the adoption of IFRS as a major reform in the field of accounting regulation. The researchers emphasized the fundamental differences in accounting under IFRS, defining this approach as a social practice, not just a technique. According to the researcher, the advantages of IFRS include a better understanding of risks, financial status and investments. Shakespeare (2020) also found the impact of accounting on the companies' financing and investment decisions. The researcher noted the role of accounting reporting in reducing information asymmetry. However, these studies also do not provide quantitative confirmation of these relationships. Therefore, the author's work can be considered as an attempt to combine existing theoretical approaches with empirical data.

As noted above, the new direction presented by the author should be additionally tested — in particular, using the example of other countries. In this context, the work of Tawiah and Oyewo (2024) is worth noting. The researchers tested the impact of IFRS implementation on information asymmetry using different samples. They analysed the practice of EU countries and countries of non-EU members. The work revealed that the introduction of IFRS contributes to the increase of foreign investments in the banking industry, however, in developing countries, this is also due to a decrease in the information asymmetry. Nejad *et al.* (2020) proved the existence of

an inverse relationship between IFRS implementation and information asymmetry using the example of ASEAN countries as developing countries. So, researchers pay considerable attention to the differences that can be observed in relation to countries with different levels of development. This is important to consider in further research along with industry differences between the studied companies.

Furthermore, the analysis of the researchers' works revealed that along with the IFRS implementation, other tools for reducing information asymmetry are often considered. IFRS increases the transparency and understanding of financial information, at the same time, some studies emphasize the importance of integrated reporting, which contributes to reducing information asymmetry (Hryn 2021; Orlov 2023). The works emphasize the need to ensure a balance between information disclosure and confidentiality, as well as improving the quality of integrated reporting. Some researchers emphasize the importance of appropriate corporate governance, which, along with the implementation of IFRS, should ensure a reduction in the information asymmetry (Ahmed *et al.* 2024; Kwilinski *et al.* 2022). These tools were not investigated in the author's work, however, the identification of additional factors affecting the information asymmetry may be a promising direction for further research. The results obtained in the work can be useful for improving regulatory approaches to increase the transparency of financial reporting. Ultimately, this should lead to more balanced investment decisions and have a positive impact on the country's economic development.

Conclusions and Further Research

The problem of information asymmetry affects not only individual companies, but also entire markets. The IFRS implementation is an important step to reduce information asymmetry. They contribute to the standardization of financial reporting, increasing transparency due to the disclosure of more detailed information, and a better understanding of risks. In other words, investors have more complete information, which is necessary for making strategic decisions.

The correlation and regression analysis for the entire sample revealed an increase in the correlation between the P/E ratio and the Market cap after the introduction of IFRS in 2017. In general, this could indicate that investors began to use a more comprehensive indicator, which is Market cap compared to Earnings and Operating Margin, to evaluate companies. However, the correlation analysis conducted in the article based on the data of selected companies did not confirm the previously obtained results. It was found that the correlation between P/E ratio and Market cap weakened significantly after the IFRS introduction for most companies. This can be explained by the fact that the increase in Market cap before the mandatory IFRS introduction could be the mostly result of the investors' expectations. However, expectations could not be justified because of information asymmetry. Therefore, the decrease in correlations between P/E ratio and Market cap may be evidence that with the introduction of IFRS, investors began to evaluate the situation more critically. One of the reasons for this state of affairs is the expansion of access to transparent and complete financial information.

Further research should be aimed at verifying the obtained conclusions on other samples of companies from other regions and considering the industry. It is also important to investigate other factors influencing information asymmetry. Improving the quality of integrated reporting and corporate governance can be considered one of such factors.

Credit Authorship Contribution Statement

Tetyana Chala: Conceptualization, Validation, Project administration.
Iryna Hrabynska: Investigation, Writing – review and editing, Methodology.
Olena Ptashchenko: Writing – original draft, Software.
Oksana Perchuk: Formal analysis, Data curation.
Oksana Posadnieva: Supervision.
Olga Bioko: Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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Volume XV, Issue 4(32), Winter 2024

DOI: https://doi.org/10.14505/tpref.v15.4(32).09

Investment Flows and Country Development in Emerging Markets: Analysing the Impact of Foreign Investment on Economic Growth

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Article info: Received 28 August 2024; Received in revised form 15 September 2024; Accepted 23 October 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: The purpose of the article is to study the impact of investment flows on the economic development of Ukraine, Azerbaijan, and Uzbekistan, considering foreign investment, as well as to assess their contribution to the formation of sustainable economic growth. The methodology is represented by such methods of scientific knowledge as economic analysis, as well as SWOT analysis (Strengths, Weaknesses, Opportunities, Threats). The results of the study showed that foreign investment has a positive impact on the economic growth of developing countries, contributing to an increase in gross domestic product, reducing unemployment and stimulating technological progress. In addition, investment flows influence structural changes in the economy, facilitating the transition to more innovative and competitive arrangements. Additionally, successful attraction of foreign investment can improve the infrastructure and environmental situation in countries, which also favours their economic development. At the same time, the results of the study highlight the importance of creating a favourable investment climate to attract foreign investment and ensure sustainable economic growth, both now and in the future. However, it is important to understand the possible negative aspects of the impact of investment on the economy, including the issue of increased risks in the formation of dependence on foreign subsidies. The findings highlight the importance of seeking and attracting foreign investment to improve the economic performance of emerging market

economies, as well as to stimulate sustainable economic growth and promote the integration of these economies into the global economic system, while minimizing negative impacts.

Keywords: financial sustainability; globalization; transformation; integration; unemployment rate; competitiveness.

JEL Classification: F21; O16; O11; G11.

Introduction

Due to globalization and increasing international economic integration, foreign investment is playing an increasingly significant role in shaping the economic dynamics of Ukraine, Azerbaijan, and Uzbekistan. However, the issue of the impact of foreign investment on economic growth and development of emerging markets remains relevant and requires detailed analysis and study. Due to certain specifics and peculiarities, such countries often face limited resources and financial capacity to ensure sustainable economic development. All this emphasizes the need to understand how exactly the inflow of foreign investment can affect key economic indicators, such as gross domestic product (GDP), infrastructure projects, and unemployment rates. At the same time, despite the considerable amount of previous research, the issue of the impact of investment flows on economic growth remains quite complex and multifaceted. It is important not only to assess the actual contribution of foreign investment to the country's economic growth, but also to identify the key factors determining the efficiency of the use of these investments.

Theoretical analysis of this issue allows us to distinguish several main concepts. On the one hand, there is a view of the positive impact of foreign investment on economic growth through technology transfer, increased production, and job creation (Lazaj *et al.* 2024). For example, within the framework of this concept researcher. Yeboua (2021) believes that foreign direct investment (FDI) has a positive impact on economic growth in emerging economies. Such influence is due to technology transfer, investment in production facilities, creation of new jobs. A similar position is held by Kondrat and Antoshchuk (2022). Hobbs *et al.* (2021) support the view of high efficiency of foreign investment, emphasizing that the effect of FDI on economic growth may be more significant than the impact of international trade. The researchers believe that this may be due to the fact that direct investment provides a more direct flow of capital and technology into the economies of developing countries.

At the same time, Nguyen (2020) emphasized in his article that the effect of foreign direct investment can be more noticeable in certain sectors, such as manufacturing, export-oriented sector, and services, which contributes to improving the competitiveness of the economy of the country receiving the investment. In addition, the scholar believes that the impact of foreign direct investment on economic growth also depends on the effectiveness of national institutions and government policies in attracting and utilizing foreign investment. Hussain *et al.* (2021) also insist on the need for a favourable institutional environment in the context of enhancing the impact of FDI on economic growth. Alfaro and Chauvin (2020) discuss the impact of FDI on economic growth, noting higher efficiency in countries with developed financial systems. This finding indicates the importance of interaction between foreign investment and the financial sector to stimulate economic development. The authors argue that a more developed financial system can ensure efficient allocation of capital, provide access to financial services, facilitate the process of financing innovation and investment.

On the other hand, some studies point to possible negative effects such as destabilization of financial markets, exploitation of natural resources and increased social inequalities. Appiah *et al.* (2023), in their research work, point out that financial development and economic growth have a positive impact on industrial development, while foreign direct investment has a negative impact on the industrial sector. Researchers Bouchoucha and Bakari (2021) also emphasize the negative impact of foreign investment in the context of economic development. In the results of the study, the authors put an emphasis on the negative impact on economic growth of both domestic and foreign direct investment in the long term, noting that in the short term only domestic investment can contribute to economic growth. In turn, Ukrainian scientists Abramov and Nasypayko (2024) highlight another significant factor that can have a negative impact of FDI on economic development – the dynamics of investment involved in the country's economy can be stochastic and unpredictable. The negative impact of foreign investment associated with unpredictability and instability is also described by Choi *et al.* (2021), noting that, in addition, the instability of public policy also negatively affects FDI, reducing the number of investments and increasing possible risks. It is in the light of these contradictions and the need for a deeper understanding of the mechanisms of the impact of investment flows on economic growth that the relevance of conducting a scientific study on this topic becomes clear. Such an analysis will not only expand

theoretical knowledge in the field of economics and finance, but also offer practical recommendations for the formation of effective investment policies in developing countries.

In general, the available research base is quite broad and detailed on the impact of FDI on the economic performance of developing countries, noting both positive and negative factors. However, most of the existing studies focus on emerging markets in Africa and Asia. Therefore, the aim of the current research work is to broaden the knowledge base on the issue of the impact of foreign investment on the economic performance of developing countries, with a focus on emerging markets in Europe. In particular, the aim of the work is to analyse the impact of investment flows on the economic development of countries such as Ukraine, Azerbaijan, and Uzbekistan, taking into account their specific characteristics, and to assess the contribution of investment to the formation of sustainable economic growth. The main objectives of the paper include:

- study of different types of foreign investments, their peculiarities, and impact on economic dynamics in Ukraine, Azerbaijan, and Uzbekistan;
- analysing the advantages and disadvantages of investing in order to identify key factors affecting the attractiveness of the countries under consideration for foreign investors;
- identifying the most attractive sectors of the economy for investment by analysing the growth and development potential of the sectors in Ukraine, Azerbaijan, and Uzbekistan;
- conducting a comparative analysis of foreign investment legislation in Ukraine, Azerbaijan, and Uzbekistan in order to identify differences and similarities in approaches to regulating investment activities;
- assessing the impact of foreign investment on the economies of the countries under consideration, taking into account their specific features and potential for sustainable development.

1. Materials and Methods

Theoretical materials developed on the basis of existing concepts in the field of economic theory, as well as official statistical information and legislative documents, including the Law of the Republic of Azerbaijan “On investment activity” (2022), Law of Ukraine No. 1560-XII “On investment activities” (1991) and Law of the Republic of Uzbekistan No. LRU-598 “On investments and investment activities” (2019).

In order to achieve the research objective, economic analysis was used to conduct an in-depth study of the impact of investment flows on the economic development of emerging market countries. This method of analysis was selected and applied in order to assess the effectiveness of using foreign investment to stimulate economic growth in the selected countries (Ukraine, Azerbaijan, and Uzbekistan). The current method allowed identifying the main economic mechanisms and factors influencing the attraction of foreign investments and their contribution to economic development. In addition, economic analysis was used to identify the main problems and possible challenges faced by developing countries in using foreign investment as a tool to stimulate economic growth, allowing to determine the real prospects of development and effectiveness of investment strategies.

An additional method of scientific knowledge used in the current research was SWOT analysis (Strengths, Weaknesses, Opportunities, Threats). SWOT analysis was applied as a methodological tool to systematically assess the strengths, weaknesses, opportunities, and threats related to the impact of investment flows on the economic development of countries. In addition, SWOT analysis allowed systematizing the findings and highlighting the main areas for further research and practical recommendations to improve the use of foreign investment to stimulate sustainable economic growth in emerging market countries. The current research began with a thorough study of theoretical materials and analysis of existing concepts in the field of economic theory. This stage allowed for the formation of a theoretical framework for the subsequent analysis. In addition, as part of determining the theoretical basis of the study, work was done to collect official statistical information and study legislative documents, including the Laws of the Republic of Azerbaijan, the Republic of Uzbekistan and Ukraine, which provided a detailed understanding of the current situation of foreign investment in the selected countries.

The choice of the research methodology was based on the results of the previous stages. Economic analysis, including the assessment of the efficiency of using foreign investment to stimulate economic growth, was chosen as the main research method. The next stage of the work was the economic analysis of the impact of investment flows on the economic development of the countries under consideration. This analysis made it possible to identify the main economic mechanisms and factors affecting the attraction of foreign investment and its contribution to economic development. The final stage of the study was a SWOT analysis, which was applied to systematically assess the strengths, weaknesses, opportunities, and threats associated with the impact of investment flows on the economic development of emerging market countries. It helped to systematize the data and to identify the main directions for further research for practical recommendations.

The use of the selected methods provided a deep and comprehensive understanding of the relationship between foreign investment and economic growth in developing countries.

2. Results

2.1 Types and Characteristics of Foreign Investments

Foreign investment flows are capital flows between countries, where an investor from one country (or region) directs its funds to invest in assets or enterprises in another country (Haudi *et al.* 2020). These flows include both direct investments (acquisition of enterprises, creation of new production facilities) and portfolio investments (purchase of stocks, bonds, or other financial instruments). In addition, it is important to know that foreign investments can be made by both private companies and public entities through various mechanisms, including direct transactions between companies, participation in joint venture projects, and the purchase of government bonds or other financial instruments (Ahamed 2022). Such investment flows play an important role in the global economy, as they contribute to technology transfer, job creation, production development and improved economic growth in both the source and recipient countries. However, foreign investment can also introduce some risks, such as dependence on foreign investment, the possibility of losing control over national assets, and negative impacts on the environment and social structures.

In order to understand the possible prospects and risks of a country receiving financial injections, it is necessary to understand what foreign investment is. Foreign investment is an important element of international economic activity, and its variety of forms reflects the different strategies and objectives of investors. Such investments include: direct and portfolio investment, international finance, as well as financial derivatives, venture capital financing, and technology transfers. Direct investment is one of the main forms in which foreign capital is invested in enterprises or assets in another country in order to establish control or influence their business processes and strategies (Ausr *et al.* 2020). This form of investment is usually associated with long-term plans and may involve the creation of new businesses or the acquisition of stakes in existing companies. In addition, direct investment may involve participation in joint projects or the development of new technologies and innovations in other countries, which contributes to the expansion of companies' activities abroad and strengthens their competitiveness in global markets. Portfolio investment, in turn, is the acquisition of securities, such as stocks or bonds, in international financial markets (Oke *et al.* 2020). This form of investment does not provide investors with control over the company's assets, but rather is a strategy aimed at generating income from changes in security prices or from dividend and interest payments. Portfolio investments are usually characterized by higher liquidity and can be quickly reallocated in order to diversify the investment portfolio and minimize risks.

International finance provides financial support from various actors, from national or international organizations (e.g. the International Monetary Fund or the World Bank), states and private companies (Braun and Koddenbrock 2022). The main instruments of this form of investment are loans and credits, which are used to finance a variety of projects and programmes. International financing can be directed to infrastructure projects, such as the construction of roads, bridges, airports, as well as the development of industrial complexes, agriculture, health care and education. One of the key features of international financing is its scale and global orientation. This form of investment makes it possible to attract significant amounts of capital from various sources and direct them to projects with high potential for socio-economic development. At the same time, international financing is often accompanied by a number of requirements and conditions set by lenders, including compliance with environmental, social and financial standards, as well as ensuring transparency and effective management of financial resources (Khalegi *et al.* 2024). Often, it is this form of foreign investment that helps to accelerate industrialization, modernization, and structural transformation processes, with an impact on improving the quality of life and well-being of the population of the countries supported.

Financial derivatives are special financial instruments based on the value of other assets (currencies, commodities, stocks, or interest rates) (Schwarcz 2020). They can include futures, options, swaps, and other contracts that are used for risk management or speculative operations in financial markets. One of the key characteristics of financial derivatives is high liquidity and flexibility, allowing investors to effectively manage risks and implement hedging or arbitrage strategies in financial markets. Venture capital financing is a special form of investment focused on financing start-ups and small companies with high growth potential (Lerner and Nanda 2020). Although such investments carry certain risks, in the case of successful development of companies, they can bring substantial profits to investors. This type of financing plays a key role in supporting innovative projects and stimulating economic growth by facilitating the emergence of new technologies, products, and services on

the market. Technological transfers are a complex process based on the transfer of knowledge, advanced technologies and innovations between different countries or organizations (Skare and Riberio Soriano 2021).

One of the most important functions of this type of investment is the dissemination of advanced technologies and innovative techniques that contribute to the development of production, improve the quality of products, and increase competitiveness in global markets. Moreover, technology transfers play a key role in improving human capital and scientific and technological capabilities in recipient countries. Each of these forms of investment has different characteristics that need to be taken into account when designing policies and strategies to attract foreign investment. Despite their high potential, investment also has significant risks (Table 1).

Table 1. Analysing the advantages and disadvantages of investing

Type of investment	Advantages	Disadvantages
Direct investments	Gaining significant control or influence over the business processes and strategies of an enterprise in another country	The possibility of losing some control as a result of the long-term strategies of the enterprise
Portfolio investments	The ability to quickly access a variety of financial instruments on the world markets	Currency risks, fluctuations in securities and potential losses due to changes in market conditions
International financing	Providing large amounts of capital for the development of projects with high profitability potential	Risks of late loan repayment and interest payment
Financial derivatives	Ability to protect against risks and speculative operations in financial markets	High complexity of use, exposure to significant losses and unpredictable market fluctuations
Venture financing	Opportunity to earn significant profits from the successful development of innovative projects and start-ups	High level of risk, especially in case of unsuccessful investments in new and unknown projects
Technological transfers	Spreading advanced technologies and knowledge to new markets, which can lead to increased competitiveness and profitability	High costs of organizing and implementing the technology transfer process, as well as the possibility of unwanted dissemination of intellectual property

Note: the prospectivity of the investment from the investors' point of view.
Source: compiled by the authors.

Despite the existing risks, investors see high potential for investing in emerging economies. The opportunity to achieve significant returns associated with rapid economic growth and market opportunities makes these countries attractive for investment. Thus, investors are actively seeking opportunities to deploy capital in such countries, taking into account both potential benefits and risks, and seeking to diversify their portfolios and achieve high returns over the long term. At the same time, understanding the various forms of foreign investment becomes essential in order to assess the prospects and risks associated with attracting financial injections into a country. Therefore, it is important not only to understand the nature of each of them, but also to analyse their impact on the economic and social spheres. In developing countries, there are several main areas that attract investors because of their potential for growth and development.

2.2 Analysing the Most Attractive Sectors of the Economy for Investment

One of such areas is the sphere of infrastructure investments (Saidi *et al.* 2020). Infrastructure, which includes transport networks, energy, communications, and water supply, plays one of the key roles in the development of the economy, providing conditions for the growth of production, trade, and services. Investments in this area contribute to improving the living standards of the population, enhancing economic stability, and attracting additional investments in other sectors. Another important area, within the framework of foreign investment projects, is agriculture and food industry (Djokoto *et al.* 2023; Ogbanje and Salami 2022). In developing countries, there is often significant potential to increase agricultural production and improve the quality of agricultural products. Investments in this area often contribute to increasing food security, creating new jobs in rural areas, and increasing the incomes of local residents.

The energy and renewable energy sector is also a significant area for investment (Khan *et al.* 2021; Shahini *et al.* 2024). Due to the increasing demand for energy in developing countries and the desire to reduce greenhouse gas emissions, investors are increasingly paying attention to projects for the development of alternative energy sources, such as solar, wind and hydropower. These investments help to reduce dependence

on energy imports and improve the environmental situation in the region. In addition, investments in education and health care also have a significant impact on the development of human capital and improving the quality of life of the population of countries receiving foreign investment (Miningou and Tapsoba 2020; Jumaniyazov and Mahmudov 2022). It is important to remember that it is education that is key to increasing labour productivity, stimulating innovation, and providing access to skilled workers. While investments in health care contribute to reducing morbidity, increasing life expectancy, and improving public welfare.

Additionally, the information technology (IT) sector acts as a catalyst for economic development in emerging markets as an attractive industry for investment (Asongu and Odhiambo 2020). In light of global challenges such as the COVID-19 pandemic, which has led to a shift towards working from home, distance learning and increased online shopping, the role of IT has become even more significant. In addition, IT is a key factor in the development of the digital economy, which is becoming increasingly integrated into the global economy (Trusova *et al.* 2021a). The adoption of digital technologies in various sectors such as finance, manufacturing, commerce, and services is helping to increase productivity, optimize business processes and improve the quality of life (Makedon *et al.* 2020). Innovative IT companies are becoming a driving force beyond the borders of the leading countries in this field, which opens up new opportunities for developing countries to participate in global technological revolutions and create their own centres of technological development. Finally, investment in tourism and hospitality also represents an important area of economic development for developing countries. The development of tourism infrastructure and the creation of new tourist destinations and offerings contribute to increasing the inflow of foreign tourists, expanding the market for services, and increasing employment (Chornyi 2013).

In general, the development of these industries is key to sustainable economic growth and social development in developing countries. Investors are increasingly looking at the potential and prospects of these industries, given their importance in building modern infrastructure and human capital development. However, in order to achieve positive results from foreign investment in developing countries, an open and favourable business climate on the part of the recipient countries itself is essential (Kalyuzhna *et al.* 2024). Inadequate government support, lack of public support and imperfect legislative regulation can be serious obstacles to successful investment. Without government assistance and support, investors may face unpredictable regulation and bureaucratic obstacles, which negatively affects the investment climate and encourages capital flight from the country (Hysi *et al.* 2024). Lack of public support can also lead to social and political instability, creating additional risks for investors. Moreover, unfavourable legislative regulation, including unclear and inconsistent laws and regulations, can create additional uncertainty and legal risks for investors. Inadequate protection of property rights and lack of transparency in the judicial system may also discourage potential investors and reduce confidence in the investment environment (Spytska 2022).

Thus, the positive results of foreign investment in developing countries depend not only on the potential of industries, but also on the willingness of recipient countries to create favourable conditions for investors. Only with appropriate government support, public loyalty and transparent legislative regulation can we expect a sustainable inflow of investment and the achievement of economic growth and social development goals.

2.3 Legislative Regulation of Foreign Investment in Ukraine, Azerbaijan, and Uzbekistan

The Law of the Republic of Azerbaijan “On investment activity” (2022) guarantees foreign investors equal rights with local investors and prohibits any kind of discrimination. It also grants foreign investors the right to free repatriation of profits and provides for various preferences, such as tax and customs privileges, as well as privileges on the lease of land plots. The bodies regulating foreign investment in Azerbaijan are the Ministry of Economy and the Export and Investment Promotion Agency.

Law of Ukraine No. 1560-XII “On investment activities” (1991) was adopted in 1991, having undergone amendments and additions. This law regulates the main aspects of investment activities in the country and provides a legal basis for attracting foreign investment. According to this law, foreign investors have equal rights and opportunities with Ukrainian investors when investing in various sectors of the economy. The Law ensures transparency of the investment climate, which favours the attraction of foreign investment to Ukraine. The main provisions of the law regarding foreign investment include guarantees of foreign investors’ rights, protection of their property and investments, as well as the right to free repatriation of profits and capital. In addition, the law establishes procedures and conditions for the registration of foreign investments and provides various forms of support and incentives for investors. The Law is aimed at creating favourable conditions for foreign investors and promotes the development of investment activity in Ukraine.

In Uzbekistan, investment activities are regulated by the Law of the Republic of Uzbekistan No. LRU-598 "On investments and investment activities" (2019). The law provides guarantees of the rights of investors, both foreign and domestic, as well as establishes the principle of equality of rights of all investors before the law. According to the Law, discrimination of investors on various grounds is prohibited. One of the most important provisions of the law is the right of investors to freely repatriate profits from their investments. The Law also provides for various privileges for investors, including tax, customs, and land lease privileges. It is important to note, however, that the Law does not regulate relations related to centralized investments. The regulatory bodies are the Ministry of Investment and Foreign Trade and the Agency for Attracting Foreign Investment.

It should be emphasized that the effectiveness of legislative regulation of foreign investment in the countries under consideration depends on the transparency, stability, and predictability of the legal and institutional environment. Favourable investment conditions are created if there is an effective judicial and administrative apparatus, as well as transparency in the process of interaction between investors and authorities. After all, as noted earlier, openness and dialogue between recipient countries and investors play a key role in attracting foreign investment and ensuring its successful implementation. A comparative characterization of the legislative regulation of foreign investment in Azerbaijan, Ukraine, and Uzbekistan is presented in Table 2.

Table 2. Comparative analysis of legislative regulation of foreign investment in Ukraine, Azerbaijan, and Uzbekistan

Similarities	Differences
Both laws guarantee foreign investors equal rights with local investors. Both laws prohibit discrimination against foreign investors. Both legislations provide for various incentives and preferences for foreign investors.	Azerbaijan's legislation is more detailed and elaborate than that of Ukraine. At the same time, Ukraine has a wider range of benefits and preferences for foreign investors. The Republic of Uzbekistan has a special body for attracting foreign investment (the Agency for Attracting Foreign Investment). In addition, the Republic also provides a special type of incentives for investors – for the lease of land plots.

Source: Law of the Republic of Azerbaijan "On investment activity", 2022; Law of Ukraine No. 1560-XII "On investment activities", 1991; Law of the Republic of Uzbekistan No. LRU-598 "On investments and investment activities", 2019

According to the above data, it is possible to conclude that the legislative regulation of foreign investment in the countries under consideration is quite liberal and attractive for foreign investors. However, it should be noted that in addition to legislation, other factors (economic and political stability, level of corruption, quality of infrastructure, level of labour force qualification) also influence the attractiveness of a country for foreign investors.

2.4 Improving the Investment Climate of Ukraine, Azerbaijan, and Uzbekistan

In today's globalized world context, emerging economies are actively competing to attract foreign investment in an effort to strengthen their economic performance and ensure sustainable growth. Ukraine, Azerbaijan, and Uzbekistan are no exception: both countries are making efforts to create a favourable investment environment, attract capital from abroad and stimulate economic development. Analysing the investment climate in Ukraine, Azerbaijan, and Uzbekistan is of particular interest as it reflects the strategic decisions of these countries and their ability to adapt to external and internal challenges.

Both countries are taking active steps to attract foreign investment, implement reforms and create a favourable investment environment. At the same time, this aspect becomes especially important in the context of geopolitical and economic instabilities, such as wars, pandemics, and other crisis situations. The beginning of a full-scale military invasion of Ukraine by Russia became an unprecedented case in the context of preserving investment attractiveness. The war led to a sharp aggravation of the situation in the region, causing instability in the economy, deterioration of the investment climate and significant risks for businesses and investors (Parkhomets *et al.* 2023). This situation has created serious challenges for attracting foreign investment and the development of Ukraine's economy in recent years and has had an impact on the near-term outlook. The analysis of the investment climate in Ukraine, Azerbaijan, and Uzbekistan for the last 5 years (2019-2023) allowed systematizing the data, identifying key trends and changes in the investment sphere of these countries (Table 3).

A characteristic and distinctive feature of the Republic of Uzbekistan is the active development of economic relations with China. To date, the People's Republic of China acts as a major investor in various sectors of the Uzbek economy, such as energy, transport, agriculture, and manufacturing. On the other hand, the onset of a full-scale military invasion has not only created instability and uncertainty in Ukraine's business environment, but has also significantly affected the region's economic prospects.

Table 3. Title of the Table

Period	Ukraine	Azerbaijan	Uzbekistan
2019-2020	Gradual improvement of the investment climate	Stable investment climate	
Impact of COVID-19	Decrease in investment activity; introduction of quarantine restrictions; decrease in economic growth rates		
2020-2022	Initiatives to stabilize economic performance; improving the investment climate		Stabilization of economic indicators, as well as decisive measures to liberalize the economy, abolish licensing for many activities and reduce administrative barriers for entrepreneurs. At the same time, there is an increasing dependence on Chinese investment flows.
2022-2023	Sharp deterioration of the investment climate; closure of markets; significant reduction in production; decline in the economy	The investment climate remains stable, with some growth in investment attractiveness	
Forecast	Total dependence on the course of the war	The investment climate depends on the development of the geopolitical situation, the level of corruption and political changes in the country. And also, increasing investments in renewable energy	

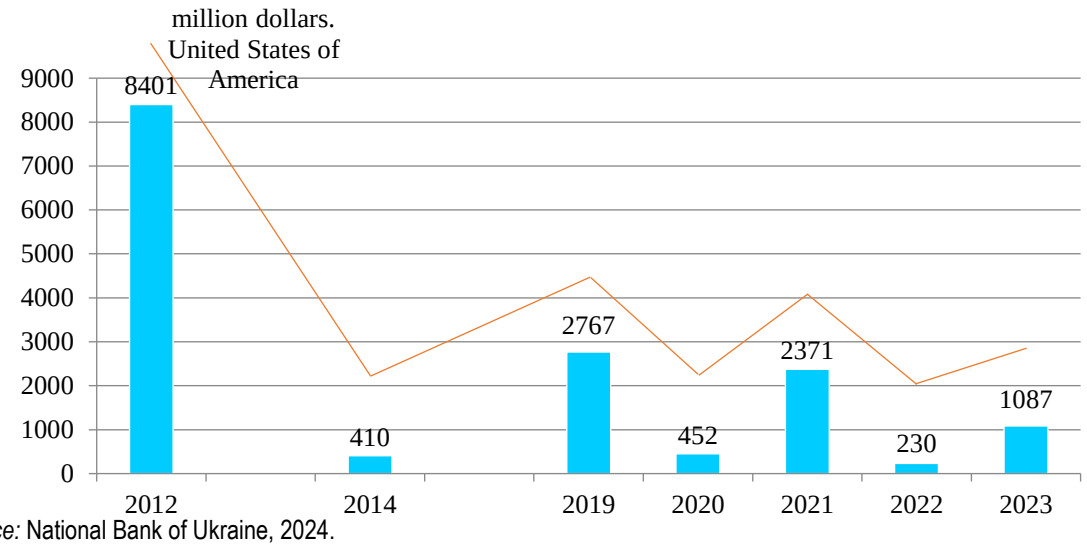
Source: Article by Mikayil Jabbarov, Minister of Economy of the Republic of Azerbaijan, in "Azerbaijan" newspaper, 2023; National Bank of Ukraine, 2024; Khitakhunov, 2022.

As a result of the war, there has been a decline in investor confidence in the Ukrainian economy, leading to capital outflow from the country, as well as freezing and delaying the implementation of investment projects (Shubalyi 2023). The war also increases the risk of investment and creates uncertainty about the future economic and political prospects of Ukraine. It emphasizes the unconventionality of the situation, drawing attention to the need to develop supportive and corrective methods to ensure economic stability.

2.5 Analysing the Impact of Foreign Investment on Recipient Countries' Economies

According to statistical indicators, geopolitical instability in Ukraine, caused primarily by Russia's military aggression, causes significant instability in the investment climate (Figure 1).

Figure 1. Direct investments in Ukraine without income reinvestment



Source: National Bank of Ukraine, 2024.

As can be seen in Figure 1, foreign investment in pre-crisis 2012 is significantly higher than in the next 10 years. The first significant drop in foreign investment was caused by Russia's occupation of parts of Ukraine's territories (Crimea and Sevastopol, parts of Donetsk and Lugansk regions) and the beginning of military aggression in eastern Ukraine in 2014. After the situation normalized and the investment climate improved, there was a second sharp drop caused by COVID-19. However, by 2021, foreign investment volumes had almost recovered. The third and most significant drop in investment volumes occurred in 2022, caused by the outbreak of a full-scale war. Also, it should be noted that Ukraine is characterized by receiving investments of the "round tripping" format. Round tripping is foreign direct investment, in which the controlling investor is a resident (Aykut *et al.* 2017). This type of investment is characterized by the return of foreign capital back to the country in the form of foreign direct investment, however, the controlling investor remains a resident of the country. This

phenomenon often occurs in countries with unstable economic and political situations, as well as in countries with a high level of tax and regulatory pressure. In addition, it is important to know that round tripping investments can be used both as a way to circumvent tax laws and other legal restrictions and as a mechanism for legitimate return of funds to the country, ensuring control over the investment. Thus, this type of investment can have both positive and negative effects on the economy. On the one hand, round tripping favours the inflow of foreign capital and stimulates investment activity. On the other hand, this phenomenon can distort the statistics of foreign direct investment and create incomplete ideas about the real volume of foreign capital in the country, as well as lead to potential violations of tax laws and regulatory risks.

In general, foreign investment has a significant impact on the Ukrainian economy, forming both positive and negative consequences. Among the positive aspects are the creation of new jobs, GDP growth, transfer of advanced technologies, and infrastructure development (Trusova *et al.* 2021b). With the inflow of foreign investments, there is an opportunity to create additional jobs, which helps to reduce unemployment and improve the living standards of the population. In addition, investments stimulate the country's GDP growth, improving the overall economic situation and fostering the development of the business environment. Technological transfer of foreign companies often improves the production efficiency and competitiveness of Ukrainian enterprises and contributes to the modernization of economic sectors (Mytsenko *et al.* 2024). Infrastructure development financed by foreign investment improves the business environment and makes the country more attractive for further investment. However, there are also negative aspects of the impact of foreign investment on the Ukrainian economy. Withdrawal of profits abroad results in the loss of part of the economic potential created in the country and limits the accumulation of domestic resources. An increase in external debt, in turn, creates an additional financial burden for the country, increasing its vulnerability to external economic pressures. In turn, the restriction of control over national assets leads to the loss of strategic importance of some sectors of the economy and reduces national sovereignty (Dankevych *et al.* 2023).

Thus, it should be concluded that the impact of foreign investment on the Ukrainian economy is rather ambiguous. In the period from 2019 to 2023, the volume of foreign direct investment in Ukraine was unstable and highly dependent on the geopolitical situation, affecting the development of the economy. In turn, the war with Russia, which started in 2022, led to a significant drop in foreign investment inflows and dramatically affected the Ukrainian economy negatively, causing serious economic and social consequences, emphasizing the danger of the country's dependence on foreign investment. Overall, taking into account the research conducted, it was possible to identify the main positive and negative factors of foreign investment in emerging markets. The results are presented in the framework of SWOT analysis (Table 4).

Table 4. SWOT analysis in the context of the impact of foreign investment flows on emerging market countries

Strengths	Weaknesses	Prospects	Prospects
1. Comprehensive development of various sectors of the economy. 2. Stimulating economic growth. 3. Technology and know-how transfer. 4. Infrastructure development. 5. Creation of new jobs. 6. Capital Raising.	1. Dependence on external sources. 2. Risk of political instability. 3. Unequal distribution of benefits. 4. Poor performance in the long term. 5. The need for a well-developed legislative framework.	1. Development of new industries. 2. Expanding international trade and achieving a competitive position. 3. Establishment of infrastructure projects. 4. Attracting tourists. 5. Implementing and developing innovations. 6. Impact on educational attainment.	1. Economic crises. 2. Political instability. 3. Currency fluctuations. 4. Competition in the global market. 5. Negative environmental impact (in case of significant investment in hazardous production sectors).

Source: compiled by the authors.

Thus, it is determined that foreign investment plays a significant role in stimulating the economic growth of developing countries. One of the strengths of investment is the comprehensive development of various sectors of the economy. By channelling capital into different sectors, foreign investors contribute to more sustainable and diverse economic growth. In addition, foreign investment inflows stimulate economic growth through job creation, infrastructure development, and technology and innovation transfer. However, there are also weaknesses that should be considered when analysing the impact of foreign investment. Dependence on external sources of investment can make a country vulnerable to external economic crises and currency fluctuations. The risk of political instability is also a significant threat, as instability in a country can alienate potential investors and reduce the country's attractiveness for investment.

Despite the weaknesses and threats, the prospects for the impact of foreign investment on the economic growth of developing countries remain encouraging. The development of new industries, the expansion of international trade, the creation of infrastructure projects and the attraction of tourists can all contribute to sustained and accelerated economic growth. However, in order to successfully realize the potential of foreign investment, it is necessary to develop a well-developed legal framework that protects the rights and interests of investors and takes into account the unique characteristics of developing economies.

3. Discussion

There is an active debate in the academic community regarding the impact of foreign investment on the development of emerging market countries. Some scholars argue that foreign investment inflows help to stimulate economic growth, job creation and technology transfer, which ultimately have an impact on improving the overall standard of living of the population. Other scholars, however, highlight negative aspects of the impact of foreign investment, such as the possibility of losing control over national assets, uneven distribution of benefits, and the risk of violating the sovereignty of the recipient country. These conflicting views emphasize the complexity and multidimensionality of the issue of the impact of foreign investment on the development of developing economies.

For example, researchers Shabbir *et al.* (2021), as well as Osei and Kim (2017) had a common goal – to assess the impact of investment on economic growth. In their research works, they came to similar conclusions, indicating the positive impact of both domestic and foreign investment on the economic growth of developing countries. Both studies highlighted the importance of investment in job creation, GDP growth, technology transfer, infrastructure development, productivity growth, export growth and economic diversification. The main differences between these studies are evident in the approach to analysis and the internal content of the findings. The article by Shabbir *et al.* focused on the characteristics of domestic and foreign private investment and their impact on economic growth. Meanwhile, the study by Osei and Kim examined the impact of foreign investment on economic growth under financial market development. The researchers believed that a more developed financial market can enhance the positive impact of foreign investment on economic growth.

However, the results of the current study also highlight the attraction of foreign investment, noting the importance of properly channelling investment across different sectors of the economy, as well as the need for effective governance to maximize the positive impact of investment on economic growth. While highlighting the possible positive impact on the development of recipient economies, the study also draws attention to the possible negative impact of such investments on developing countries. The results draw attention to the high level of risks associated with the formation of dependence on investment by the recipient country. The research work emphasizes that in the event of such a situation, the recipient country risks much more negative consequences for the economy, in case of a decrease in the volume or complete loss of foreign investment associated with the emergence of unstable situations (geopolitical, social, economic).

In this regard, it is important to note that a more detailed consideration of the impact of foreign investment on the development of the Ukrainian economy, within the framework of the current research work, is due to its unique situation in the context of significant instability of geopolitical factors. Also, Ukraine is one of the emerging economies, which makes it particularly vulnerable and dependent on external influences, including foreign investment (Oklander *et al.* 2024). Ukraine's economic dynamics and stability are closely linked to its political situation, making it a representative case study for analysing the impact of foreign investment under conditions of uncertainty and conflict. With war and geopolitical tensions, Ukraine has faced serious challenges, including capital outflows, falling investment activity, and growing economic instability, making it a unique case study that demonstrates the impact of foreign investment on emerging economies under unstable geopolitical conditions (Berdar *et al.* 2024). The analysis has confirmed the concept of the possible negative impact of foreign investment on the development of emerging market economies.

A study by Bayar *et al.* (2020) described the factors of formation of a favourable investment environment. The results of their work showed that both the shadow economy and the level of human development are significant determinants of the inflow of foreign direct investment. The analysis in the long run showed that the shadow economy has a negative impact on FDI inflows, while the level of human development has a positive impact. Countries with a higher level of human development may be more attractive to investors, as they tend to offer a more stable and reliable business and investment environment (Chornyi and Chorna 2017). That said, the results of the current study highlight that despite the risks, investors see significant prospects for investing in emerging economies. Rapid economic growth and access to market opportunities make these countries attractive for investment. Investors are therefore actively seeking opportunities to deploy capital in them, assessing both the

potential rewards and risks, and seeking to diversify their investment portfolios to achieve high returns over the long term (Mehdiyev 2024).

Turning to the concept of the negative impact of foreign investment, it should be noted the scientific work of Wartini (2016), which investigated the impact of foreign direct investment on the environment. The author analysed various aspects of the impact of foreign direct investment on the environment, including water and air pollution, soil degradation, deforestation, as well as effects on biodiversity and climate. The article looked at case studies from Indonesia to illustrate how these issues manifest themselves in practice and the implications for the environment and human health. While the research work also recognized the importance of considering the negative environmental impacts of foreign investment in developing countries, the focus was on investigating various aspects of the impact of foreign investment on economic development, including social and economic aspects, without much delving into the analysis of environmental impacts.

The scientific work of Islam (2014) highlighted a number of negative factors associated with the penetration of foreign capital into the economy, including the withdrawal of profits abroad, limitation of control over national assets, increase in foreign debt, deterioration of labour conditions and negative impact on the environment. However, the author emphasized that these negative aspects can be mitigated through the implementation of effective government policies aimed at attracting foreign investment. To maximize the positive impact of FDI, it is necessary to develop and implement policies that promote a balance between economic benefits and social and environmental aspects of development. In turn, the current study, unlike the work of Islam, has concentrated on a broader analysis of the impact of foreign investment on developing economies without giving much emphasis to certain negative aspects. In the framework of this work, the importance of considering the specifics of each recipient country in the context of attracting foreign investment, without linking it to specific negative aspects, was emphasized.

Thus, as a result of a comprehensive analysis of various aspects of foreign investment in the context of economic development, taking into account the scope of its types, its impact on sectors of the economy, as well as legislative regulation, it was determined that foreign investment can play a key role in stimulating economic growth and development. However, it should be borne in mind that successful attraction of foreign investment requires effective legislation, political stability, and the creation of a favourable investment climate. In addition, special attention, within the framework of the current article, was paid to analysing the situation with foreign investment in countries with unstable geopolitical environment, thus emphasizing the importance of a comprehensive approach to studying the impact of foreign investment on the economies of developing countries.

Conclusions

As a result of the research, considering the multifactor analysis of the impact of foreign investment on the economies of recipient countries, focusing on the examples of Ukraine, Azerbaijan and Uzbekistan, important conclusions were formulated. The research work included the study of types and features of foreign investment, analysis of the most attractive sectors of the economy for investment, as well as consideration of the legislative regulation of foreign investment in these countries. An important stage of the work was the analysis of the impact of foreign investments on the economies of Ukraine and Azerbaijan, including the assessment of positive and negative aspects of this impact. In particular, they contribute to the expansion of production, creation of new jobs, GDP growth and transfer of advanced technologies, which helps to increase labour productivity and boost economic growth. In addition, investments can attract additional resources, capital, innovation, knowledge, and expertise, which contributes to the improvement of a country's competitiveness.

Thus, the findings confirmed the importance of foreign investment, which has the potential to have a significant impact on improving economic development, but they also highlighted the need to comply with legislation and create a favourable environment to attract such investment. The study revealed the importance of political and economic stability as well as infrastructure development for the successful attraction of foreign investment. The negative impact of foreign investment on the economies of developing countries is also noteworthy. In some cases, investment can lead to environmental degradation, inequitable income distribution and increased social inequalities. In addition, dependence on foreign investment can make economies vulnerable to external shocks, such as changes in world markets or changes in the policies of investor countries.

In the context of the above-mentioned aspect, it has also been found that the high level of dependence of emerging economies on foreign investment can significantly exacerbate the negative impact of crisis situations on their economies. This is because of the loss of investments that become critical for sustained economic growth and development. When crisis situations arise, such as geopolitical conflicts or domestic economic and social problems, countries that are highly dependent on foreign investment may face even greater challenges in

maintaining economic stability and managing the crisis. This, in turn, emphasizes the importance of a multifaceted approach to economic development and resilience building, including diversifying sources of income and improving the domestic investment climate.

The findings of this study emphasize the need for a systematic approach to the study of foreign investment and its impact on the economies of recipient countries. At the same time, it should be noted that studying the impact of foreign investment on developing countries in Europe is a complex task, requiring in-depth analysis of multiple factors. However, in order to fully understand this impact, a deeper analysis is needed, taking into account a variety of factors (political stability, institutional and social aspects, environmental impacts) of the impact. In order to further investigate the impact of foreign investment on the development of countries in emerging markets, including European countries, it is necessary to complement the research database and broaden the methodological approach. It is also crucial to extend the analysis to countries with different levels of economic development in order to further develop the study.

Credit Authorship Contribution Statement

Authors have contributed equally to this research.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies in the writing process.

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DOI: https://doi.org/10.14505/tpref.v15.4(32).10

Determinants for the Decision of Delisting Companies from Stock Exchange: A Case Study of Tunisia, Egypt and Morocco

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Article info: Received 15 October 2024; Received in revised form 3 November 2024; Accepted 29 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: The Initial Public Offering (IPO) is considered a crucial step for a company, but its success is not guaranteed. This article aims to study the explanatory factors behind the delisting of a publicly traded company. To accomplish this, we have chosen a representative sample of 5 Tunisian companies, 5 Moroccan companies, and 10 Egyptian companies that were all delisted from the stock exchange between 2012 and 2021. Drawing on agency theory and signaling theory, we seek to identify the determinants that influence companies' delisting decisions. Three main findings are highlighted. This decision is positively influenced by: i) company-specific characteristics; ii) governance mechanisms; and iii) market situation. A theoretical and empirical approach is adopted to address this issue.

Keywords: Initial Public Offering; delisting; agency conflicts; information asymmetry; corporate governance.

JEL Classification: D53; E44; G3; G15; C10.

Introduction

The Initial Public Offering (IPO), or "Introduction en Bourse" in French, has long been a subject of great interest for companies and researchers in finance and accounting. This operation is often seen as a crucial step in a company's life, as it brings significant benefits, particularly in terms of fundraising. Although this operation requires a lengthy period of preparation and significant managerial considerations, the success of the IPO is not guaranteed. This is evidenced by a fairly significant wave of delistings. Contrary to the IPO, delisting from the stock exchange is the abandonment of the status of a publicly traded company. In other words, it involves the transition from a listed "public firm" to a closed company whose shares are no longer traded on the stock exchange, becoming a "private firm". This operation is referred to "Public to Private" (PtoP) or "Going Private".

This document provides evidence of the phenomenon of firms' radiation from markets, we document the impact of delisting announcement on stock returns**.** Even though the results indicate that Tunisian, Egyptian and Moroccan market react to the announcement of companies' radiation by managers. Moreover, the timing of delisting decision is affected by some different factor related to the firms' situation, corporate governance and institutional environment. Tunisian, Egyptian and Moroccan investors react negatively to the announcement to firms delisting from different market.

The reasons for delisting are often complex and varied. In this regard, the IFGE (2012) raises the following question: "Why do companies exit the stock exchange?" This question remains relevant today because, despite the significance of the phenomenon, there are few studies that focus on this issue.

According to Jensen and Meckling (1976), agency relationships result from the separation of powers and the delegation of tasks from a principal to an agent. In their view, a firm can be seen as a set of contracts, and the agency relationship is merely a contractual and conflictual relationship between the principal and the agent. In this relationship, the agent is designated and empowered by the principal to provide services on their behalf. Agency theory assumes that all agents act to maximize their own utility. Differences in interests between the principal and the agent can be resolved through a contract established to incentivize the agent to act in accordance with the principal's objectives.

This agency relationship can readily apply within a company, particularly to the relationship between shareholders and executives. Shareholders (principals) appoint the executive (agent) to manage the company, especially concerning investment and financing decisions. However, since the interests of the executive may differ from those of the shareholders, they may be tempted to use their discretionary power to appropriate a portion of the company's wealth at the expense of the shareholders. These temptations can be significant because there is no contract that can specify all of the executive's obligations, nor is there a measurement system to evaluate their efforts. Thus, the opportunistic behavior of the executive plays a central role in agency relationships and leads to conflicts between executives and shareholders.

Furthermore, agency conflicts can also arise from the relationship between shareholders-executives/creditors. Shareholders tend to make financing and investment decisions that transfer a portion of the company's market value to shareholders at the expense of creditors. This situation can lead to two problems: asset substitution and underinvestment.

According to Myers (1977), asset substitution occurs when low-variance assets (less risky) are replaced by high-variance assets (riskier) with the aim of increasing shareholder wealth at the expense of creditors. Potential gains are mostly captured by the company in the event of project success, while costs are primarily borne by creditors in case of failure.

Regarding the underinvestment problem, it occurs when projects with positive net present value are rejected because the benefits would mainly accrue to creditors. According to Myers (1977), the value of a company is the sum of the value of its existing assets and investment opportunities. Unlike the value of existing assets, which is independent of the executive's discretionary choices, the value of investment opportunities depends on these choices. However, it is important to note that in both problems, creditors are assumed to be irrational and do not anticipate the opportunistic behavior of the executive.

Due to the complexity of conflicts of interest and agency problems, it is crucial to have mechanisms in place to discipline executives and ensure that contracts are respected by all parties involved. These mechanisms incur costs known as "agency costs."

According to Jensen (1986), if companies with available free cash flows (FCF) do not find good investment opportunities, there is a risk that they will waste these cash surpluses on projects that destroy value rather than distributing them to shareholders in the form of dividends or special dividends.

According to Jensen (1986), executives tend to retain available resources and grow the company beyond its optimal size, a phenomenon known as "empire building." This goes against the interests of shareholders. To avoid this situation, Jensen (1986) suggests using debt in a way that free cash flows (FCF) are used to repay debt rather than finance unprofitable projects. By exchanging equity for debt through high leverage, credible executives commit to using their future FCF to repay debt instead of retaining them for their own benefit or investing them in value-destructive projects. Thus, according to this hypothesis, companies with high FCF have an incentive to go private by opting for a leveraged buyout (LBO). In this context, delisting from the stock exchange via an LBO is considered a mechanism to resolve agency conflicts resulting from the existence of FCF.

According to agency theory (Jensen and Meckling, 1976), the separation of ownership and decision-making functions leads to conflicts of interest between shareholders and executives, resulting in agency costs detrimental to the company's value creation. These conflicts manifest in decisions made by executives that go against the interests of shareholders. Initially, this may involve excessive compensation or privileges granted to executives due to their positions. Additionally, there may be the use of the company's existing resources to fund its growth or invest in projects with negative net present value. To mitigate these agency conflicts, it is possible to increase control over executives through various corporate governance mechanisms.

In order to test this hypothesis, the majority of studies focus on the association between corporate governance and delisting from the stock exchange (for example: Chancharat *et al.* 2012). This correlation is justified by the fact that high-quality governance involves close monitoring and control of executives, thereby reducing agency conflicts between them and shareholders. Consequently, the reduction of these agency conflicts leads to a decrease in the likelihood of delisting from the stock exchange for companies in the future.

According to Croci and Del Giudice (2014), most studies focusing on delistings from the stock exchange have overlooked a crucial factor: the high concentration of capital and the frequent presence of a dominant family-type shareholder within companies. This concentration helps reduce conflicts of interest between shareholders and executives through strong control exerted by the dominant shareholder over executives (Renneboog *et al.* 2007). However, this concentration also leads to significant conflicts of interest between majority and minority shareholders. Indeed, due to their specific advantages, majority shareholders are incentivized to extract private benefits at the expense of minority shareholders.

In their analysis of the role of family ownership, Geranio and Zanotti (2010) find mixed results. Firstly, they discover that delisting operations initiated by dominant family owners have a positive impact on shareholder wealth. However, delistings initiated by financial investors (such as LBO transactions, for example) do not have a statistically significant impact on shareholder wealth. The control hypothesis suggests that delisting from the stock exchange can be considered a mechanism for controlling shareholders (or majority shareholders) to realize private benefits at the expense of minority shareholders.

Studies related to signal theory originate from the work of Akerlof (1970). Based on the market for used cars, the author assumes that buyers only have imperfect information regarding the quality of cars, which prevents them from distinguishing between good and bad deals. Consequently, they are only willing to pay a price weighted by a probability reflecting the quality of the product. On the other hand, sellers of high-quality products can only sell their goods at a price lower than their expected real value. This drives them to exit the market where only low-quality products are offered. Buyers will then abandon this market, leading to its disappearance. Hence, it is necessary to establish mechanisms or regulatory bodies. To avoid this situation, sellers of good-quality cars have an interest in signaling the quality of their products in the market.

In the context of financial markets, early signaling models suggest that managers of high-performing companies have an interest in signaling the quality of their company in the market to distinguish themselves from lower-performing ones. Indeed, once the quality of the company is revealed, it becomes easier for investors to accurately assess the securities offered by it. Managers are aware that withholding private information would lead the financial market to evaluate their company based on average quality, which would not reflect their actual performance.

However, managers of "poor" quality companies may be incentivized to mimic the signal of "good" quality companies in order to portray themselves as higher-quality companies. However, they run the risk of facing sanctions when the market realizes that they have disclosed false information. In order to determine low-quality companies from disseminating false information to mimic high-quality companies, their works have provided insights into the conditions of signaling.

Other models have instead focused on the characteristics of the Initial Public Offering (IPO) process, particularly on the choice of reputable partners involved in the process. According to these models, managers choose partners with a good reputation, which can influence the company's value and reduce some of the uncertainty surrounding it.

Finally, the last category of models has focused on the informational advantage of the IPO candidate. Hughes (1986) demonstrates that the manager has two methods to signal the quality of the company: either they use indirect signals, such as the percentage of ownership retained after the IPO, or they use a direct presentation of private information regarding the company's cash flows. The second signal is considered credible because the company would incur penalties for disseminating false information.

In summary, managers of high-quality companies are motivated to send signals to the market to demonstrate their quality. They do this by disclosing favorable information in the documents related to the operation, in order to distinguish themselves from lower-quality companies. Consequently, investors can use the information disclosed by companies in prospectuses, offering documents, or offering memoranda to assess the quality of companies seeking an initial public offering (IPO). This information can help companies persuade investors of their performance and future prospects. On the other hand, this information can also be used to identify low-quality companies that may be at risk of delisting in the long term.

1. Literature Review

Due to the magnitude of the phenomenon of delisting companies from the stock exchange globally (sometimes surpassing the number of IPOs), it is essential to study the factors that lead to this operation and to understand its consequences. The examination of existing literature reveals that delisting from the stock exchange is influenced by three categories of factors: (1) company-specific characteristics, (2) governance mechanisms, and (3) market conditions.

1.1 Company Characteristics

Several studies have shown a tragic decline in the survival rates of companies listed on the stock exchange over the past decades, which can be explained by microeconomic factors related to the company. In line with previous empirical studies, the microeconomic variables related to the company are: (1) asset profitability; (2) dividend distribution; (3) asset growth; (4) level of indebtedness; and (5) company size.

1.1.1. Asset Profitability

Previous empirical studies have shown that a company's asset profitability plays an important role in the delisting decision. When a company exhibits low or negative asset profitability over an extended period, this can be considered a sign of poor financial and operational performance, which may raise questions about the company's ability to meet regulatory requirements, maintain financial transparency, and protect investors' interests. This relationship is highlighted by Demers and Joos (2007).

1.1.2 Dividend Distribution

Dividend distribution refers to the portion of profits distributed to shareholders in the form of cash dividends or other forms of compensation. According to financial theories, dividend distribution can impact the decision to delist companies in several ways. Firstly, according to Sawicki (2009), regular dividend distribution is often seen as a signal of financial stability and company health. Companies that have a consistent ability to generate profits and distribute regular dividends may be perceived as better positioned to survive and thrive in the long term. Thus, a company that maintains a stable and increasing dividend policy may be less likely to be delisted compared to a company experiencing fluctuations or interruptions in dividend distribution. Secondly, dividend distribution can affect the company's liquidity availability. When a company distributes a significant portion of its profits as dividends, this may reduce its ability to finance future investments or cope with financial difficulties. A company that fails to generate sufficient liquidity to support its operational activities and investments may be more likely to be delisted. Studies conducted by Koch and Shenoy (1999) highlight this relationship.

1.1.3 Asset Growth

Asset growth is generally considered an indicator of a company's expansion and development potential. Previous empirical studies have revealed that, in the context of the delisting decision, insufficient asset growth may indicate that the company is struggling to grow and adapt to market requirements. Investors and financial regulatory authorities may perceive this as a sign of increased risk and limited long-term viability. Studying delistings in the United States, Doidge *et al.* (2010) and Chaplinsky and Ramchand (2012) find that when asset growth is insufficient to maintain the company's competitiveness and profitability, financial markets may decide to delist the company.

1.1.4 Level of Indebtedness

The level of indebtedness refers to the amount of debt that a company has incurred relative to its equity. Martinez and Serve (2011) find that when investors and financial markets perceive a high level of indebtedness, they may consider it a sign of concerning risk. A heavily indebted company may be less capable of coping with economic shocks or market fluctuations, which can compromise its financial stability and ability to generate profits. Financial regulatory authorities may also closely monitor the level of indebtedness of listed companies. They often impose limits and leverage ratios to ensure financial system stability and investor protection. If a company exceeds these thresholds or fails to manage its debt effectively, it may be subject to stricter regulatory measures or even delisted from the exchange.

1.1.5 Company Size

Authors Bhabra and Pettway (2003) and Kooli and Meknassi (2007) have emphasized the importance of company size in long-term survival capacity. Large companies are assumed to be able to overcome periods of economic crisis and/or correct past strategy errors.

H1: Company characteristics have a positive influence on the decision to delist listed companies from the stock exchange.

2. Corporate Governance

In theory, corporate governance is supposed to ensure the independence and transparency necessary for the proper functioning of a company and is often seen as a means to protect the multiple interests of stakeholders.

However, in the context of a listed company, going public can lead to capital dilution, which can result in significant agency costs that may harm the company in the long term. Drawing on the interest alignment hypothesis, we postulate that there is a positive correlation between the quality of governance and delisting from the stock exchange. Indeed, conflicts between executives and shareholders are expected to be high due to weak managerial control, which could prompt companies to delist in order to realign the interests at stake.

Within the scope of this study, the quality of corporate governance is apprehended through the examination of five factors: (1) separation of the Chairman and CEO roles; (2) board size; (3) percentage of independent directors on the board; (4) foreign ownership; and (5) government ownership.

2.1. Separation of Chairman and CEO Roles

According to agency theory, the separation of roles within a company should be associated with quality governance. When the chairman is not involved in operational management, they are better able to represent shareholders' interests and exercise effective control over executives. This notion is supported by Fama and Jensen (1983), who argue that combining control and management functions under one person can lead to excessive influence of that individual on board decisions, thereby limiting its ability to perform control and oversight functions. Additionally, according to Finkelstein and D'Aveni (1994), role separation is a measure adopted by companies to combat entrenched interests. The combination of control and management roles is also a potential source of conflicts of interest. In particular, executives are incentivized to support projects they have initiated, even if they do not create value for shareholders, which can ultimately reduce company performance and increase the likelihood of delisting from the stock exchange. Studies by Abdul Rahman and Haniffa (2005) confirm this idea by finding a negative correlation between role combination and company performance. According to Jensen (1986), one possible explanation for companies' decision to go private is that they have to bear significant agency costs, partly related to role combination. In a study using various governance measures, including separation of chairman and CEO roles, Leuz *et al.* (2008) find that companies with low-quality governance are more likely to be delisted from the stock exchange.

2.2. Board Size

The issue of optimal board size has been widely debated in the literature, and studies have yielded sometimes conflicting conclusions. Some studies support the effectiveness of small boards. For example, Fischer and Pollock (2004) found that small boards facilitate decision-making by enhancing communication and coordination among members. A small board may be more efficient as discussions among members are facilitated, leading to consensus on important decisions. Thus, the negative relationship between board size and performance can be explained by coordination, communication problems, and a slower decision-making process in large boards. Jensen (1993) also notes that a small board is less easily controlled by the executive due to greater member involvement, increased responsiveness, and less frequent disagreements among members. Conversely, other studies highlight the effectiveness of large boards. The idea is that the more directors there are, the more skills there are within the board. Several authors have observed a positive correlation between board size and company performance, such as Chaganti *et al.* (1985) and Dalton *et al.* (1999). This positive relationship can be explained by the fact that a large board is likely to have a greater number of skills to effectively monitor the actions of the management team (Haniffa and Hudaib, 2006).

2.3. Independence of Directors

The presence of independent directors is generally considered a favorable governance practice. According to Fama and Jensen (1983), independent directors exercise stricter control over executives and are better able to oppose them, reducing executives' opportunistic behaviors and ensuring better protection of shareholders' interests. According to Lee *et al.* (1992), the presence of independent directors can reduce agency problems between shareholders and executives of delisted companies through leveraged buyouts (LBOs). This idea can be explained by the fact that companies tend to delist when they face significant agency costs (Jensen, 1986). Leuz *et al.* (2008) find that the presence of independent directors on the board is less common in delisted companies than in listed companies. Additionally, by reducing executives' opportunistic behaviors, the presence of independent directors should improve the quality of board decisions, ultimately increasing company performance (Raheja, 2005) and thus reducing delistings from the stock exchange.

2.4. Foreign Ownership

Foreign ownership refers to the holding of shares or stakes in a company by foreign investors. Some studies suggest that foreign ownership can have a positive effect on company survival and performance. Charitou *et al.* (2007) found evidence that companies with higher levels of foreign investor ownership are less likely to be delisted from the NYSE (New York Stock Exchange). These investors can bring financial resources, specialized knowledge, and international expansion opportunities, which can enhance competitiveness and long-term viability of the company. In these cases, foreign ownership can reduce the risk of delisting by providing financial and strategic support. Several studies have also shown that the presence of foreign investors positively affects governance quality (Chung and Zhang 2011) and company performance (Ferreira and Matos 2008), leading to a decrease in delistings from the stock exchange. However, analyzing the factors that led to involuntary delistings of Egyptian companies during the period 1992-2009, Algebaly *et al.* (2014) found that the proportion of capital held by foreign investors has a negative impact on their delisting.

2.5. Government Ownership

Shyu (2011) found a positive relationship between the percentage of capital held by the government and company performance (measured by ROA 20 and Tobin's Q) for 465 Taiwanese listed companies during the period 2002-2006. This result can be explained, firstly, by the reduction in agency conflicts between executives and shareholders in government-owned companies. Additionally, government owners tend to have a long-term investment outlook compared to other shareholders who focus primarily on short-term or immediate profits. Furthermore, according to Stein (1988 and 1989), shareholders with a long-term outlook are less likely to be influenced by executives' opportunistic behavior and reject non-profitable projects. Conversely, Hu *et al.* (2018) show, based on a sample of 28 delisted Chinese companies, those government-owned companies may be prone to operational inefficiencies or mismanagement, which can result in poor financial performance. Government ownership can pose challenges in terms of corporate governance, with decisions often made politically rather than based on economic or financial criteria. If this leads to persistent issues of transparency, accountability, and ineffective decision-making, delisting may be considered as a corrective measure; Hadfi Bilel (2020).

H2: There is a positive relationship between governance mechanisms and the decision to delist listed companies from the stock exchange.

3. Market Situation

Based on previous empirical studies, the macroeconomic factors considered are: (1) market liquidity; (2) market development; and (3) stock market index movement.

3.1. Market Liquidity

Previous empirical research has shed substantial light on the decisive impact of market liquidity on a company's decision to delist. The results of these studies have conclusively established that liquidity plays a leading role in this strategic decision. Indeed, several authors have examined this complex relationship and found significant correlations. For example, the work of Bakke *et al.* (2012) revealed that companies facing low market liquidity were significantly more inclined to opt for delisting.

3.2. Market Development

Previous empirical research has provided interesting insights into the influence of market development on companies' delisting decisions. When the market is developing and presents growth opportunities, companies tend to maintain their listing to benefit from the advantages of liquidity, visibility, and access to capital. An expanding market provides a conducive environment for business expansion, acquiring new customers, and undertaking profitable investment projects (Fungáčová and Hanousek, 2011). Conversely, in a declining or stagnant market, companies may struggle to generate revenue and meet their growth objectives. Increased competitive pressures, declining demand, or structural changes can make it difficult to achieve strong financial performance. In such circumstances, companies may be tempted to make the decision to delist to avoid the costs associated with maintaining a stock exchange listing, such as financial disclosure requirements, regulatory constraints, and governance obligations (Hadfi and Kouki 2020, 2021).

3.3. Stock Market Index Movement

Previous empirical research has clearly established that stock market index movement plays a significant role in the decision-making process regarding companies' delisting. A study by Johnson and Soenen (2003), Abeer and

Ines (2024), Hadfi (2024) revealed that companies tend to be more inclined to delist when the stock market index shows a prolonged downward trend. This decision may be motivated by the desire to minimize potential financial losses and protect against risks associated with a declining market. Furthermore, when the market is down, liquidity may decrease, making it more difficult for companies to trade their shares and attract new investors. On the other hand, companies are more likely to remain listed when the stock market index shows a sustained upward trend. In an expanding market, companies may benefit from higher valuation of their shares, greater market liquidity, and increased investor interest. This may encourage them to maintain their listing and take advantage of financing and growth opportunities offered by a favorable market.

H3: There is a positive relationship between market situation and the decision to delist listed companies from the stock exchange.

4. Data and Methodology

4.1 Sample Description

Our study, initially focused on companies delisted from the Tunisian Stock Exchange (BVMT), has been expanded to include the Moroccan and Egyptian stock exchanges to address the lack of available information and enhance the validity of our analysis on factors influencing companies' delisting from the stock exchange.

Table 1. Organization and operation of the financial markets in the countries under study

Stock Exchange Management Company					
Country	**Designation**		**Abbreviation**	**Founded year**	
Tunisia	Bourse des Valeurs Mobilières de		BVMT	1969	
Egypt	Egyptian Exchange		EGX	1883	
Morocco	Bourse des Valeurs de Casablanca		BVC	1929	
Regulatory and oversight body					
Country	**Designation**		**Abbreviation**	**Founded year**	
Tunisia	Le conseil du marché financier		CMF	1995	
Egypt	Autorité égyptienne de surveillance		EFSA	1883	
Morocco	Le conseil déontologique des valeurs		CDVM	1994	
Listing mode					
Country	**Platform**	**Stock**	**Stocks**	**Mode**	**Frequency**
Tunisia	SUPERCAC UNIX	TUNINDEX	- Less liquid stocks	- Fixing	- Daily
			- Highly liquid stocks	- Continu	- Daily
Egypt	-	EGX30	- Less liquid stocks	- Fixing	- Daily
			- Less liquid stocks	- Continu	- Daily
Morocco	NSC	MASI	- Less liquid stocks	- Fixing	- Daily
			- Less liquid stocks	- Continu	- Daily

Source: BVMT, EGX, BVC

By including these countries, we increase the size of our sample, which can strengthen the statistical validity of our results. The more observations we have, the more our conclusions can be generalized to a broader population of companies and stock markets. The stock exchanges of Egypt and Morocco hold a prominent position in the financial landscape of North Africa.

The following table succinctly summarizes the key elements of the organizational framework and operation of the financial markets examined.

We have compiled a sample consisting of 50 observations for Tunisia, 50 observations for Morocco, and 100 observations for Egypt.

By having a sufficient number of observations for each context, we will be able to obtain more precise and representative results, thus strengthening the validity of our study. Our data are mainly drawn from the annual reports published by the Tunisian Stock Exchange (BVMT), the Casablanca Stock Exchange, and the Egyptian Stock Exchange, as well as the prospectuses published by the Financial Market Council (CMF) and the relevant authorities in each country. Other variables, such as macroeconomic variables, are manually collected from the websites of the Central Bank of Tunisia (BCT), Bank Al-Maghrib, and the Central Bank of Egypt. Below is the comprehensive table containing our sample consisting of companies that have been delisted from the stock exchanges of Tunisia, Egypt, and Morocco over the period from 2012 to 2021.

Table 2. List of delisted companies

Companies	Delisting date	Voluntary	Involuntary
Tunisia			
Palm Beach Hôtels Tunisia	2012		Decision
Syphax Airlines	2015		Decision
Elbene Industrie	2019	Decision	
Tunisie Valeurs	2020	Decision	
STEQ	2021	Decision	
Morocco			
DELTA HOLDING SA	2012	Decision	
Auto Nejma	2014	Decision	
Lesieur Cristal	2018	Decision	
SONASID	2020		Decision
SOTHEMA	2021	Decision	
Egypt			
Al Fanar Contracting	2012	Decision	
Arab Ceramic	2013		Decision
Asec Company For Mining	2014		Decision
Canal Shipping Agencies Company	2015	Decision	
Delta Sugar	2015	Decision	
Egyptian Electric Cable	2016	Decision	
Al Ahram Printing	2017	Decision	
Elsewedy Electric	2018	Decision	
Grand Investment Capital	2020		Decision
Misr Duty Free Shops	2021	Decision	

Source: BVMT, EGX, BVC

We will test three econometric models using a panel data regression model because our sample is characterized by a double dimension (individual and time). The choice of panel data, or longitudinal data, will allow us to control both the individual and time effects. The dual dimension of panel data increases the number of observations and thus the degrees of freedom of the statistical tests.

1. Binary Logistic Regression Model

We will conduct binary logistic regressions to explain the delisting of companies from the stock exchange. The dependent variable is binary (delisted or not delisted).

Logistic regression is employed in studies to verify if independent (or explanatory) variables can predict a dichotomous dependent variable. Unlike multiple regression and discriminant analysis, this technique does not require a normal distribution of predictors or homogeneity of variances.

From a statistical perspective, logistic regression allows us to directly estimate the probability of an event occurring (in our case, the probability of companies being delisted from the stock exchange).

Our estimation consists of 3 models:

Model 1: Relationship between company characteristics and delisting

$$Delisting_{it} = \beta_0 + \beta_1 ROA_{it} + \beta_2 DIV_{it} + \beta_3 SIZE_{it} + \beta_4 LEV_{it} + \beta_5 GROWTH_{it} + \varepsilon_{it}$$

Model 2: Relationship between governance mechanism and delisting

$$Delisting_{it} = \beta_0 + \beta_1 TF_{it} + \beta_2 CEO_{it} + \beta_3 IND_{it} + \beta_4 CC_{it} + \beta_5 GO_{it} + \beta_6 FO_{it} + \varepsilon_{it}$$

Model 3: Relationship between market situation and delisting

$$Delisting_{it} = \beta_0 + \beta_1 ML_{it} + \beta_2 DM_{it} + \beta_3 IBI_{it} + \varepsilon_{it}$$

where: (i,t) indicate respectively the company and time;

β_0: constant parameter;

$\beta_{1...6}$: regression coefficients;

ε_{it}: residual term.

Table 3. Summary of independent, dependent and control variables

Variables	Definition	Measure
Dependent variable		
Delisting	Companies' delisting	Binary variable = 1 if the company is delisted and 0 if it is still listed.
Independent variables		
ROA	Return on assets	It is the ratio of net income to total assets.
DIV	Dividends distributed	This is the amount of dividends distributed by the company.
GROWTH	Asset growth	It is the movement of the company's assets.
LEV	Debt level	It is the ratio of total debt to total assets.
TF	Board size	This is the number of members of the board of directors.
CEO	Variable duality	Binary variable = 1 if there is a combination of the Chairman of the Board and CEO functions, and 0 otherwise.
IND	Board Independence	It is the ratio of independent members to the total number of board members.
CC	Board concentration	The percentage of capital held by the principal shareholder.
GO	Government ownership	Binary variable = 1 if the principal shareholder is a government and 0 otherwise.
FO	Foreign ownership	Binary variable = 1 if the principal shareholder is a foreigner and 0 otherwise.
ML	Market liquidity	This is the ratio of market capitalization to Gross Domestic Product (GDP).
MD	Market development	This is the ratio of trading volume to Gross Domestic Product (GDP).
IBI	Index Movement	This is the variation of the country's stock market index.
Control variable		
SIZE	Company size	It is the natural logarithm of the total assets of the company at the end of the accounting period.

Source: Edit by authors

Table 4. Descriptive statistics of variables

Variables	Mean	Minimum	Maximum	Median	Standard	Kurtosis	Skewness
ROA	0.1414827	-0.1464617	0.7592363	0.1131478	0.1356477	7.174023	1.627463
DIV	0.0029646	0.0001157	0.0585359	0.001754	0.0060926	70.73564	7.762365
SIZE	2.334299	0.693727	4.094159	2.158919	0.9934516	1.906732	0.3691568
GROWTH	0.1218807	-0.3345855	4.922849	0.0440812	0.5201249	74.52207	8.139982
LEV	0.1407816	0	0.4678938	0.072095	0.1495565	1.949913	0.6586538
CC	0.5043	0.16	0.929	0.4	0.2236511	2.585396	0.7427962
TF	7.7	5	11	7.5	1.961756	1.84221	0.1016563
IND	0.0566667	0	0.3	0	0.0897058	2.867288	1.16256
ML	0.478	0.19	0.86	0.43	0.2210078	1.830331	0.3421216
MD	0.2587282	0.0910539	0.5027848	0.2618688	0.1459894	1.581905	0.1610811
IBI	0.2492132	-0.564303	1.463006	0.230917	0.5379341	3.56012	0.569864

Variables	Frequency	Percentage
Delisting	90	90%
	10	10%
CEO	64	64%
	36	36%
FO	84	84%
	16	16%
GO	70	70%
	30	30%

Source: Edit by authors

Observing the table above, we note that the ROA variable displays an average of 14.14% and has extreme values of -14.6% for the minimum value and 75.9% for the maximum value. For the dividend variable, the average value is 0.29%. The value of this variable ranges from a maximum of 0.5 to a minimum of 0. Regarding the size of the board of directors, the average is 8.3 with a standard deviation of 2.32335.

Table 5. Relationship between companies' characteristics and delisting

Dependent variable: Delisting	Estimation model		
Independent variables	Tunisia	Egypt	Morocco
C	-2.098919	-2.766886	-1.64011
P(value)	0.276	0.013***	0.779
Economic profitability	2.50052	2.190717	43.29644
P(value)	0.733	0.085**	0.034**
Dividend	-2.917492	13.57954	-10.9007
P(value)	0.033**	0.745	0.417
Company size	0.1195438	-0.1542242	-0.9646807
P(value)	0.552	0.668	0.664
Asset growth	1.237512	0.1327254	6.747823
P(value)	0.722	0.048**	0.126
Debt level	-3.609082	3.240821	0.4892063
P(value)	0.068**	0.182	0.053**
Hausman test	0.9968	0.6727	0.5521
Model nature	Random effect	Random effect	Random effect
Wald chi2	1.09	2.54	4.07
Prob > chi2	0.9547	0.7701	0.5394

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

This suggests that the average board size of the sample companies is around 8-9 members. Board independence has an average of 0.26913 with a standard deviation of 0.061464. This indicates that most companies in the sample have a relatively independent board of directors. For market liquidity, the average value is 0.2258243 and varies between 0.07332 and 0.346530 with a dispersion of 0.091709. For market development, the average is 0.085856 and varies between 0.02622 and 0.256965. The "kurtosis" indicator is very high at 5.99940, suggesting a highly spread distribution, even extreme values. For the stock index movement variable, the average value is 0.129615 and varies between -0.112658 and 0.4850397. Similarly, below, we have proceeded to elaborate tables presenting detailed statistical descriptions for the cases of Egypt. These observations support our analysis and allow us to draw general conclusions regarding the factors determining the delisting of companies from the stock exchange.

The results obtained provide valuable insights into the influence of key factors such as economic profitability, dividend distribution policy, company size, asset growth, and debt level on the decision to delist. Indeed, a significant positive correlation is observed between economic profitability and the decision to delist from the stock exchange in the three countries examined. This indicates that companies with high profitability are more likely to delist from the stock exchange compared to their less profitable counterparts.

Furthermore, dividend distribution plays a major role in the delisting decision. In the Tunisian and Moroccan contexts, companies that regularly distribute attractive dividends are less likely to be delisted from the stock market, unlike the situation observed in Egypt. Moreover, company liquidity is also a factor to consider, where companies with high liquidity, meaning those with the ability to generate regular cash flows and meet shareholders' liquidity needs, tend to distribute more dividends. This relationship between liquidity and dividend distribution can influence the delisting decision because companies that maintain high liquidity are perceived as more stable and reliable. The results of our study, supported by previous work by Khan and Ahmad (2017) on the Pakistan Stock Exchange; Badu (2013) on the Ghana Stock Exchange; Yong and Mazlina (2016) on the Malaysian Stock Exchange; Ibrahim Elsiddig Ahmed (2014) in the United Arab Emirates context; Jin *et al.* (2011) in the British context, reinforce the importance of liquidity as a determining factor in the decision to delist companies.

Furthermore, it is worth noting that the company size factor has a contrasting influence on the delisting decision depending on the specific context of each country examined. In the Tunisian context, the company size factor has a positive impact on the delisting decision. This can be explained by the fact that large companies in Tunisia may face challenges related to their size, such as high management costs, increased operational complexity, or less flexibility to adapt to economic changes. As a result, some of these large companies may decide to delist from the stock exchange to reduce costs, refocus on specific activities, or restructure. However, in Morocco and Egypt, large companies often benefit from a stronger market position, a better reputation, and easier access to financial resources. They may also benefit from government support or incentives to maintain their listing on the stock exchange. Consequently, these large companies are less likely to make the decision to delist, as they can continue to benefit from these advantages and growth opportunities. This finding is also echoed in previous research conducted by Jasim and Hameeda (2011) from the Saudi Stock Exchange, Amjad *et al.* (2016) from the Palestinian Stock Exchange, Maysa'a Munir Milhem (2016) from the Jordanian Stock Exchange, Dialdin and Elsaudi (2010) from the Saudi Stock Exchange, Anupam Mehta (2012) from the United Arab Emirates Stock Exchange, and Duha Al-Kuwari (2009) from the Casablanca Stock Exchange. These studies suggest, plausibly, that large companies, due to their propensity to distribute more dividends, are potentially less likely to be delisted. It can therefore be concluded that company size plays a significant role in dividend policy and may also affect the decision to delist from the stock exchange.

Moreover, asset growth is another factor that deserves consideration in the analysis of the delisting decision from the stock exchange. It has a positive effect on the decision to delist in the countries studied. This means that companies with higher asset growth tend to be more prone to delisting from the stock exchange. Several explanations can be put forward to understand this relationship. First, rapid asset growth may be a sign of aggressive company expansion, with significant investments in new projects, acquisitions, or expansions. This rapid growth may be perceived by investors as an increase in the risk associated with the company, as it implies more complex management and uncertainties about future profitability. As a result, investors may be less inclined to hold the shares of such companies, increasing the likelihood of delisting from the exchange. Also, rapid asset growth may require significant financial resources to finance these investments. Companies may choose to mobilize these resources by reducing dividends distributed to shareholders, which may discourage investors from holding their shares. Therefore, companies with high asset growth may be perceived as less attractive in terms of potential returns for investors, increasing the risk of delisting. It is also worth noting that asset growth may be

accompanied by increased operational complexity and the need for more efficient resource management. Investors may be concerned about the company's ability to manage this growth and maintain its long-term profitability. Consequently, companies with rapid asset growth may be subject to closer scrutiny by investors and regulators, increasing the risk of delisting from the stock exchange in case of failure or unsatisfactory performance. The works of Christopher and Rim (2014), Farman Ali and Nawaz (2017), Luís António and Elisabeth (2014), Yong and Mazlina (2016), as well as Hananeh *et al.* (2013) provide additional evidence and reinforce our understanding of the impact of asset growth on the delisting decision from the stock exchange. It should be noted that each study was conducted in a specific context, but their convergent results on the importance of asset growth in the delisting decision from the stock exchange are noteworthy.

In relation to the previous findings, it should be noted that the debt level is also a determining factor in the delisting decision. The interpretation of the results suggests that the debt level of companies has a negative effect on their decision to delist from the exchange. This means that companies with a high level of debt are more likely to delist compared to those with a low level of debt. Firstly, indebted companies may feel increased financial pressure due to their debt repayment obligations. By delisting from the exchange, they can reduce the costs associated with compliance with stock market regulations and investor expectations, allowing them to focus on reducing their debt. Additionally, companies with a high level of debt may choose to withdraw from the stock market to restructure their capital and obtain alternative financing, such as bank loans or private investments, which may be more favorable for their financial situation (related to Stein J.C. (1988, 1989), , Onesti *et al.* (2013).

In summary, the results of this study underline the importance of several key characteristics of companies in their decision to delist from the stock exchange. Economic profitability, dividend distribution policy, company size, asset growth, and debt level are all significant factors that influence this decision. The conclusions of this analysis are reinforced by previous research conducted in other contexts, thus providing a solid basis for understanding stock market dynamics in North Africa and beyond.

Table 6. Relationship between governance mechanism and delisting

Dependent variable : Delisting	Estimation model		
Independent variables	**Tunisia**	**Egypt**	**Morocco**
C	2.751714	-1.261219	-4.062337
P(value)	0.525	0.469	0.467
Ownership concentration	11.74285	-0.3680623	2.053572
P(value)	0.047**	0.014	0.148
CEO Duality	6.400605	0.1125203	-0.3736147
P(value)	0.042**	0.179	0.067**
Board size	-0.5801652	-0.0318045	0.0829609
P(value)	0.004***	0.059**	0.158
Government ownership	-3.148116	-28.07795	-27.55641
P(value)	0.078**	1.000	0.000***
Board independence	-18.5886	-3.512885	7.026254
P(value)	0.215	0.030***	0.022***
Foreign ownership	-0.8075125	-0.7070848	0.2729792
P(value)	0.462	0.405	0.007***
Hausman test	1.0000	1.0000	1.0000
Model nature	Random effect	Random effect	Random effect
Wald chi2	3.11	1.38	1.32
Prob > chi2	0.7950	0.9672	0.9705

Source: Edit by authors

In this table, we can observe an overview of governance mechanism variables that have been examined in the analysis of the decision to delist from the stock exchange within the three aforementioned countries, namely Tunisia, Egypt, and Morocco.

Indeed, ownership concentration presents a complex and nuanced relationship with the delisting decision, varying depending on the specific context of each country. In Tunisian and Moroccan contexts, it has been observed that ownership concentration has a positive effect on the delisting decision. This means that in these

countries, companies with a high ownership concentration are more likely to be delisted from the stock exchange. In these countries, it is conceivable that majority shareholders, holding a significant portion of the ownership, exert their power by making strategic decisions that may lead to the delisting of the company. These companies may also adopt a policy of distributing high dividends, which can compromise their liquidity and financial stability. In contrast, in the Egyptian context, it has been found that ownership concentration has a negative effect on the delisting decision. This indicates that companies with a higher ownership concentration are less likely to be delisted from the stock exchange in Egypt, indicating a more active role of majority shareholders in managing the company and using resources to their advantage to maintain their listing on the stock exchange, even in case of underperformance.

Let's now address another determining factor in stock exchange delisting, namely the CEO duality variable. This variable is of crucial importance in the delisting decision and presents significant variations depending on the specific contexts of the countries studied. In the cases of Tunisia and Egypt, CEO duality seems to have a positive effect on the delisting decision, suggesting that when the CEO holds the positions of both CEO and chairman of the board, this may be associated with a higher probability of delisting. Studies have shown that CEO duality can lead to excessive power concentration in the hands of one person, which can affect transparency and corporate governance. In this context, a policy of distributing high dividends may be perceived as a strategy to maintain control of the company in the hands of the CEO rather than maximizing value for shareholders. This complex relationship can potentially influence the delisting decision. In contrast, in Morocco, CEO duality is associated with a reduced probability of delisting, suggesting that this practice is perceived as beneficial for the stability and continuity of the company. Furthermore, a study by Hamdouni Amina (2015) conducted in the Saudi context highlights that the separation of the roles of chairman of the board and CEO, as well as ownership concentration, play a crucial role in the corporate governance mechanism. This relationship between corporate governance and stock exchange delisting can be explained by the fact that when the separation of roles is inadequate and ownership is highly concentrated, this can lead to inappropriate strategic decisions or poor management of the company, increasing the risk of delisting from the stock exchange. In addition to these variables, the size of the board of directors is a key variable to consider. In the Tunisian and Egyptian contexts, the board size variable has a negative effect on stock exchange delisting, meaning that companies with a larger board of directors tend to have a lower probability of being delisted from the stock exchange. This highlights that a larger board of directors can bring a diversity of expertise, knowledge, and perspectives to the decision-making process of the company. A larger board of directors can also be perceived as a more effective control mechanism, as it provides better oversight and accountability. However, in the Moroccan context, the board size variable has a positive effect on stock exchange delisting, suggesting that companies with a larger board of directors have an increased probability of being delisted from the stock exchange. This observation can be interpreted considering the specificities of the Moroccan context, where a larger board of directors may be perceived as ineffective or as a sign of decision-making authority fragmentation. In this case, investors and regulators may consider a more restricted and tighter board of directors as more capable of making strategic decisions and ensuring solid corporate governance. Research conducted by Mohammad Ahid Ghabayen (2012) has established a negative correlation between board size and company performance, meaning that as the composition of the board of directors becomes larger, the company's performance tends to decrease, and vice versa. These results may have a direct implication on the decision of stock exchange delisting, as poor company performance can increase the risk of delisting.

When it comes to the government ownership variable, the results indicate a negative effect in the three countries studied, namely Tunisia, Egypt, and Morocco. This means that companies with a higher proportion of government ownership have a higher probability of being delisted from the stock exchange. This observation can be interpreted in different ways. Firstly, the presence of significant government ownership can lead to political interference in the management and strategic decisions of companies. This interference can result in operational inefficiency, slow decision-making and low responsiveness to changing market conditions, which can ultimately lead to a higher probability of stock exchange delisting. Additionally, government ownership can be associated with lower transparency and weaker accountability to minority shareholders, which can lead to a loss of investor confidence and a negative perception of the company in the stock market.

When examining the relationship between board independence and the decision of stock exchange delisting in the Tunisian, Egyptian, and Moroccan contexts, significant variations emerge. In the Tunisian and Egyptian contexts, board independence has a negative effect on stock exchange delisting. This means that companies with a more independent board of directors have a lower probability of being delisted from the stock exchange.

This observation can be attributed to the fact that in these countries, a board of directors composed of independent members may be perceived as a solid governance mechanism capable of making informed decisions and effectively monitoring executives. As a result, these companies benefit from a better reputation and greater investor trust, which reduces their likelihood of being delisted from the stock exchange. However, in the Moroccan context, board independence has a positive effect on the decision to delist from the stock exchange. This suggests that companies with a more independent board of directors have a higher probability of being delisted from the stock exchange. One possible explanation for this observation is that in the Moroccan context, an independent board of directors may be perceived as a signal of poor governance or internal issues within the company. Consequently, investors may react by withdrawing their investments, leading to the delisting from the stock exchange.

When examining the correlation between the presence of foreign investors and the decision to delist from the stock exchange in the Tunisian, Egyptian, and Moroccan contexts, significant nuances emerge, revealing country-specific dynamics. In the Tunisian and Egyptian contexts, a negative relationship is observed between foreign ownership and the decision to delist from the stock exchange. This suggests that companies with a higher proportion of foreign ownership have a lower probability of being delisted. A plausible interpretation is that the presence of foreign investors brings benefits such as access to additional financial resources, international expertise, and strong governance practices. These factors enhance the company's credibility and inspire confidence among local investors, reducing the risk of delisting from the stock exchange. However, in the Moroccan context, a positive relationship is observed between foreign ownership and the decision to delist from the stock exchange. This indicates that companies with a higher proportion of foreign ownership have an increased probability of being delisted. The presence of foreign owners may be perceived as instability or uncertainty concerning the company, raising concerns among local investors and leading to a greater likelihood of delisting from the stock exchange.

In conclusion, the analysis of governance mechanisms in the Tunisian, Egyptian, and Moroccan contexts reveals complex and nuanced relationships with the decision to delist from the stock exchange.

Table 7. Relationship between market situation and delisting

Dependent variable: Delisting	Estimation model		
Independent variables	**Tunisia**	**Egypt**	**Morocco**
C	-4.546217	-3.300341	-1.932069
P(value)	0.057**	0.001***	0.106*
Market liquidity	5.754275	-0.6830619	-3.005132
P(value)	0.000***	0.085**	0.039***
Market development	7.448863	4.704577	2.680321
P(value)	0.364	0.000***	0.174
Movement of the stock market index	1.939064	0.3082418	2.22772
P(value)	0.418	0.730	0.145
Hausman test	1.0000	0.9680	0.9458
Model nature	Random effect	Random effect	Random effect
Wald chi2	1.49	2.49	3.53
Prob > chi2	0.6841	0.4771	0.3168

Source: Edit by authors

The analysis of the results for the market liquidity variable reveals contrasting trends among the countries studied. In Tunisia, a positive correlation with the decision to delist from the stock exchange is observed, meaning that companies with greater market liquidity have an increased probability of being delisted. This observation can be attributed to the fact that companies with higher liquidity are often more attractive to investors, leading to increased transactions and potentially increased speculation in the market, thereby increasing the risk of delisting. Conversely, in the cases of Egypt and Morocco, the market liquidity variable shows a negative relationship with the decision to delist from the stock exchange. This suggests that companies with lower market liquidity have a higher probability of being delisted. In these countries, low liquidity may indicate low

attractiveness to investors, a lack of demand for the company's shares, and difficulty in raising funds on the stock market. These factors contribute to a greater likelihood of delisting from the stock exchange.

The in-depth analysis of the positive coefficients of the independent variable "market development" reveals a surprising relationship: the more the market develops, the greater the probability of companies being delisted. This observation may seem counterintuitive at first glance, as one might expect market development to be beneficial for listed companies. However, several explanations can be put forward to understand this complex dynamic. Firstly, market development leads to increased competition. When new companies emerge and seek to establish themselves in the market, competition intensifies for already established companies. This increased competitive pressure may highlight weaknesses or gaps in some companies, making them more vulnerable to delisting. Thus, even though the market is developing, some companies may not be able to maintain their position and meet competitiveness requirements (Land and Hasselbach 2000, Macey *et al.* 2008, Lamberto and Rath 2010, Martinez and Serve 2016, Ines and Khoutem 2018). Additionally, market development is often accompanied by stricter regulation. Regulatory authorities may strengthen financial transparency standards, corporate governance, and compliance with laws and regulations. Companies that fail to meet these new requirements may be subject to severe sanctions, including delisting from the stock exchange. Thus, market development can create an environment where companies must constantly adapt and comply with stricter rules, increasing the risks of delisting. Finally, it should be noted that market development can also lead to greater volatility in financial asset prices. Fluctuations in stock prices may be more pronounced, exposing listed companies to increased risks. If a company encounters financial difficulties or fails to meet investor expectations, this can lead to a devaluation of its shares and eventually lead to delisting from the stock exchange.

The study of the variable "movement of the stock index" reveals significant elements regarding the influence of these fluctuations on the decision-making process regarding the delisting of listed companies. In the case of Tunisia, it is observed that upward movements in the stock index are associated with an increase in the probability of companies being delisted. This finding may seem paradoxical, as one might expect positive market performance to be beneficial for companies. However, it is possible that rapid and significant fluctuations in the stock index have a negative impact on the financial stability of companies, making them more vulnerable to delisting risks. Similarly, for Egypt, a positive relationship is observed between the movement of the stock index and the delisting of companies. This suggests that fluctuations in the stock index can influence the viability and performance of listed companies, increasing their exposure to delisting risks. Although the coefficient is lower than that of Tunisia, it nevertheless indicates a similar trend where movements in the stock index have an impact on the delisting decision. In the case of Morocco, an even stronger relationship is observed between the movement of the stock index and the decision to delist. This underscores the importance of fluctuations in the stock index in this context, where significant variations can have major consequences for the stability of companies and increase delisting risks (Ines and Kamel 2019, Ines *et al.* 2020) .

In summary, this study reveals the importance of market factors such as liquidity, development, and movements of the stock index in the decision to delist listed companies. The results highlight the complexity of these relationships, with contrasting trends among the countries studied. These findings invite deep reflection on the risks and opportunities associated with stock market listing and underline the importance of prudent and informed management in a dynamic financial environment.

Conclusion

It is important to note that this work has certain methodological and/or conceptual limitations. Although the sampled companies represent the majority of delisted companies during the study period, data availability limited the choices regarding variables and econometric analyses to be applied in this research. For example, different scenarios could be considered depending on whether the company is affected by restructuring, merger, or succession issues.

In terms of future research perspectives, it would be relevant to explore the factors, at the time of the IPO, which could predict the probability of companies being delisted in the future as well as the duration of their listings. To do this, it may be wise to use a survival analysis approach, also known as "survival analysis." Survival analysis dynamically studies the transition from the "survival" state to the "non-survival" state (or delisting). In this approach, three main types of models are found: (1) the Kaplan-Meier model; (2) the Cox model; and (3) the AFT (Accelerated Failure Time) model. Additionally, the motivations for introduction and delisting from the stock exchange could be refined through qualitative methodology.

Credit Authorship Contribution Statement

Authors have contributed equally to this research.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

Funding

The authors gratefully acknowledge financial support from The Deanship of Scientific Research, King Faisal University (KFU) in Saudi Arabia. The present work was done under Project Number (KFU242116).

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Volume XV, Issue 4(32), Winter 2024

DOI: https://doi.org/10.14505/tpref.v15.4(32).11

Digital Financial Education for Economic and Financial Inclusion in Vulnerable Sectors of Peru

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Article info: Received 25 October 2024; Received in revised form 11 November 2024; Accepted 6 December 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing 2024. This is an open access article distributed under the terms of CC-BY 4.0 license.

Abstract: The study explores the influence of digital financial education on the financial inclusion of workers in the construction sector in Peru. A quantitative approach with a non-experimental and cross-sectional design was used, applying a questionnaire to 128 self-employed workers. The results indicate a moderate influence of digital financial education on financial inclusion, with an R value of 0.541 and an R^2 of 0.292. The ANOVA analysis and the regression coefficients confirm the significance of the model ($p < 0.001$). Factors such as perception and trust in digital banking and integration of emerging technologies significantly influence financial inclusion. Most workers have a good level of digital financial literacy, although there is a need to improve training in digital tools; revealing that digital financial literacy is crucial for financial inclusion and sustainable economic growth, fulfilling Sustainable Development Goal 8.

Keywords: digital literacy; social inclusion; emerging technologies; savings and planning; digital services; sustainable economy.

JEL Classification: B26; G53; G50.

Introduction

Digital financial education (DFE) is key to financial inclusion (FI), especially in vulnerable sectors such as construction, so research on this topic is crucial.

This work contributes directly to Sustainable Development Goal 8, as the DFE is a key component in achieving this goal, as it empowers workers to manage their finances effectively, encourage savings and plan for the future.

Globally, the DFE faces significant challenges, such as limited and costly internet access, lack of adequate mobile applications and insufficient supply of digital financial services (DFS), showing that people lack money management skills, which prevents them from taking advantage of these tools (Zaimovic *et al.* 2024). Likewise, the complexity and lack of support on digital platforms decrease their use and satisfaction, creating gaps in FI, given that the scarce training on artificial intelligence and new technologies limits their application in personal financial management (Benedetta *et al.* 2024). In the same vein, Wan and Abdul (2023) state that training in digital tools is essential, but the lack of adequate training and accessible workshops hinders their adoption, added to this, distrust in digital banking, concerns about data protection and the quality of customer service also affect negatively.

In Peru, the DFE faces important challenges that directly affect workers, such as the supply of mobile financial applications that are not aligned with the needs of these workers, as well as distrust in financial institutions that limit their use (Olano *et al.* 2024). Despite the innumerable challenges related to the context of the informality of the Peruvian economy and the low-income trap in some sectors (Paredes-Valverde *et al.* 2024), including financial rationality and education on how to manage personal finances can improve the scenario even if incrementally but in the long term. It is in this sense that FI becomes relevant in structurally changing the individual condition of citizens.

At the same time, Náñez *et al.* (2024) stated that the lack of digital skills restricts the effective use of emerging technologies, because workers continue to face challenges in financial management due to the lack of tools and knowledge. In contrast, Juliao *et al.* (2022) pointed out that the slow adoption of new technologies has a negative impact on FI; likewise, poor digital financial literacy translates into poor personal financial management.

In Peru, construction workers' FI is exacerbated by limited connectivity and lack of adequate mobile apps; local DFSs are not adapted to their needs, and the lack of DFE programs prevents efficient money management; low digital literacy limits the use of emerging technologies (ET) and AI in financial management; furthermore, the lack of digital financial literacy leads to poor management of personal finances, perpetuating financial exclusion; similarly, workers do not effectively use digital platforms for bill payment or balance management, affecting their financial stability and ability to save.

The DFE is based on human capital theory, as it is relevant in the context of Peruvian construction workers, who, by acquiring digital financial skills, can better manage their resources, reduce economic vulnerability; likewise, sustainable development theory also supports the scarcity of integrating the DFE, as it promotes inclusive and sustainable economic growth.

In practice, the implementation of DFE programs has a direct and tangible impact on the lives of Peru's blue-collar workers by improving their ability to access and use financial services, enabling them to better manage their income, save for the future and prepare for financial emergencies.

The methodological rationale for this study lies in its ability to provide accurate and actionable data to understand and improve the FI of Peru's workers; the combination of the methodology considered will ensure a comprehensive and informed assessment of the current situation and the interventions needed for more inclusive economic progress.

The general objective was to explore the influence of digital financial education on the financial inclusion of construction sector workers in Peru; the hypothesis considered is that there is a direct and significant influence of DFE on the FI of construction sector workers in Peru.

1. Literature Review and Research Background

Tabassum and Ali (2024) showed that the digitization of DFS has significantly improved FI among construction workers; a positive correlation was identified between the use of digital financial platforms, such as digital wallets and mobile banking, and increased levels of DFE; they managed to conclude that DFE is crucial for increasing FI and improving financial literacy among construction workers. Fauziyah *et al.* (2024) study revealed that digital financial literacy was positively correlated with increased knowledge, rational attitudes and responsible financial behavior; concluding that digital FI played a vital role in bridging gaps and ensuring the path to sustainable development.

Falaiye *et al.* (2024) revealed that DFE significantly increased the use of DFS among construction workers, reducing financial exclusion by 40%; concluding that digital literacy is crucial to maximize the benefits of FI through technology, as the rise of mobile banking has changed the rules of the game, allowing people with limited access to traditional banking infrastructure to conduct financial transactions seamlessly. Widyastuti *et al.* (2024) found that digital financial literacy and demographic factors influence digital FI. While gender and marital status showed an insignificant effect, age, income and occupation significantly explained FI. The model used was able to correctly predict 84.4% of respondents in terms of digital financial inclusion or not; they concluded that digital financial literacy is crucial to maximize the benefits of FI through technology.

Vasile *et al.* (2021) showed that digital financial literacy correlates positively with increased knowledge, rational attitudes and responsible financial behavior; furthermore, FI played a vital role in closing gaps and ensuring sustainable development; they concluded that literacy and FI are essential to improve financial capabilities, promote sustainable financial security and support the Sustainable Development Goals. Ramirez-Asis *et al.* (2024) indicated that there are positive and negative relationships between FI and socioeconomic variables, such as formal employment, educational level, and area of residence; they concluded that improving formal employment, educational level, and considering area of residence are effective strategies to promote FI.

Gaspar-Barrios *et al.* (2024) found that financial literacy is related to a series of factors, such as type of university degree, level of indebtedness, technological gap, ICT use, materialism and gender inequality; concluding that the development of financial literacy is fundamental in the education of higher education students, as it allows them to relate theory to practice. Herrera *et al.* (2023) found a high positive correlation (0.858) between the variables; concluding that digital payments and all its dimensions favor FI. Condori *et al.* (2023) showed that 78% of accountants reported having knowledge of financial culture, but 34% indicated that this knowledge did not come from university classrooms and 88% have difficulties in assimilating financial terms; concluding that the lack of adequate DFE at the basic and university levels negatively affects financial decision making when they are already professionals. Evidently, financial literacy and culture has an impact at the level of consumers, firms, and the economy as a whole (Díaz Tantalean *et al.* 2022).

Salas *et al.* (2022) revealed that the advantages of digitalization, innovation, open banking trends and a cooperative model. However, fintechs also face obstacles, such as lack of suitable financial products and high operating costs compared to low profit margins. They concluded that fintechs. Cotrina and Pumarrumi (2020) showed that the digital wallet is used as an FI strategy in MSEs, improving service performance and favoring both business and FI; concluding that the digital wallet is effective as an FI tool in MSEs.

DFE is shaped by Becker and Mincer's human capital theory, they highlighted education and training as essential investments to improve skills and opportunities; in the field of DFE, this theory emphasizes the importance of basic technological skills, such as digital literacy, to access and effectively use online platforms (Leoni, 2023).

Likewise, this theory contributes to training in digital financial tools by increasing efficiency in the use of applications and software (Beller *et al.* 2024). Workshops and online courses teach workers to handle financial management applications, budgets and digital investment tools, thus improving their technical competence; at the same time, perception and confidence in digital banking also benefit from human capital theory, by fostering cognitive and decision-making capabilities (Chriswick, 2024).

Theory is fundamental for the integration of emerging technologies in the DFE, given that it is based on the constant updating of skills and knowledge, in addition, courses on blockchain, artificial intelligence in finance and fintech prepare workers to adopt and effectively take advantage of these innovations (Obinna, 2024).

DFE is the one that establishes when a person possesses the knowledge and skills to use digital devices and make better financial decisions (Golden & Cordie, 2022).

Access to and use of digital platforms is the ability of individuals to use online tools and services through digital devices, facilitating various activities such as communication, education, and financial transactions (Ha *et al.* 2023; Madanaguli *et al.* 2023). It is also defined as the ability to use and navigate online applications and services to perform everyday activities, demonstrating that digital literacy is important to maximize the benefits of these platforms (Mohammed & Salim, 2023).

Digital financial tools training is that which focuses on preparing people to use advanced financial technologies, such as online banking and financial management applications, through education and specific training in the use of these technologies (Dyukina *et al.* 2020). This training includes the development of skills in financial application management, digital security and the effective use of financial analysis tools, thus promoting FI and economic efficiency (Chen, 2022).

Perception and trust in digital banking is when users perceive the security, privacy and efficiency of online banking services, which influences their willingness to use these services. Factors such as perceived risk, perceived ease of use and perceived usefulness are crucial in this context (Kaur & Arora, 2020). Trust in digital banking is built through positive experiences with banking technology and the perceived security provided by financial institutions, which is critical for the adoption of these services (Basory *et al.* 2023).

The integration of emerging technologies is the adoption of advanced tools such as blockchain, artificial intelligence and robotic automation to improve processes and services, providing new opportunities and challenges for institutions and users (Smith, 2020). This integration seeks to improve the efficiency and effectiveness of DFS and educational, facilitating accessibility and personalization through the use of cutting-edge technologies (Tondeur *et al.* 2021).

FI is shaped by the theory of sustainable development, popularized by the Brundtland Commission in 1987, has significantly influenced access to financial services, highlighting the need to ensure benefits for both present and future generations, while emphasizing the importance of providing equitable access to essential DFS, regardless of geographic location or socioeconomic status (Suhrab *et al.* 2024). Likewise, the use of DFS benefits from this theory, promoting technologies that improve efficiency and accessibility, reducing barriers and increasing FI (Dash & Mohanta, 2024).

Also, it contributes to economic stability as it is enhanced by FI, which enables a more equitable distribution of resources, reduces poverty and promotes inclusive growth; finally, FI policies and regulations can be integrated with the principles of sustainable development, as it advocates regulatory frameworks that support equitable access to financial services, protect consumers and promote economic stability by encouraging innovation and the adoption of sustainable financial practices (Amaliah *et al.* 2024).

FI is defined as the ability of people and businesses to access useful and affordable DFS that meet their needs in a responsible and sustainable manner. (Sapre, 2022).

Access to basic DFS which implies the availability and use of formal DFS, such as savings and checking accounts, which allow people to conduct basic transactions, save, obtain credit and insure against risks; this access is crucial for FI, as it allows people to participate in the formal economy and improve their financial well-being (Adil & Jalil, 2020).

DFS usage is the adoption and use of DFS through digital channels, such as personal computers, cell phones or trusted digital payment systems; these services enable more convenient, cheaper and faster financial transactions, and are a crucial avenue for increasing FI, especially in underserved areas (Semenog, 2021).

The impact on economic stability is the expansion of access to DFS can contribute to macroeconomic stability by allowing greater risk diversification, facilitating economic growth, and reducing poverty and inequality; however, if not accompanied by adequate regulation, it can pose risks to a country's financial stability (Said *et al.* 2019).

FI policies and regulations focuses on policies created in order to make DFS accessible to all groups of society, with special emphasis on those most disadvantaged; within these policies are actions such as lowering the capital criteria for financial institutions (Anarfo *et al.* 2020).

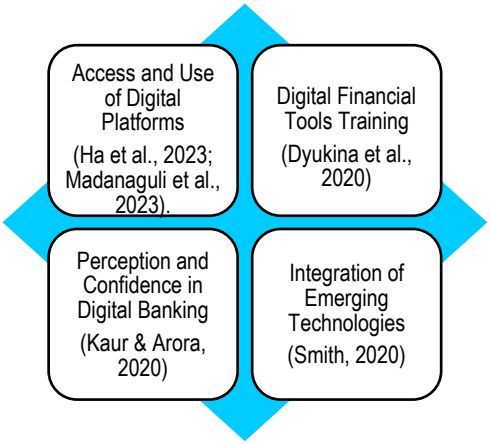
2. Research Methodology

The research had an applied typology, focusing on solving concrete problems related to money management, financial behavior and FI decisions among construction workers. Its main objective was to develop practical strategies and solutions that enabled workers to improve their financial literacy.

It had a quantitative approach, which implies the collection of numerical data to obtain accurate and objective findings; the design was non-experimental, since variables were not manipulated, but observed as they exist in the natural environment. In addition, the research was cross-sectional and took place at a single point in time, specifically during the duration of the survey.

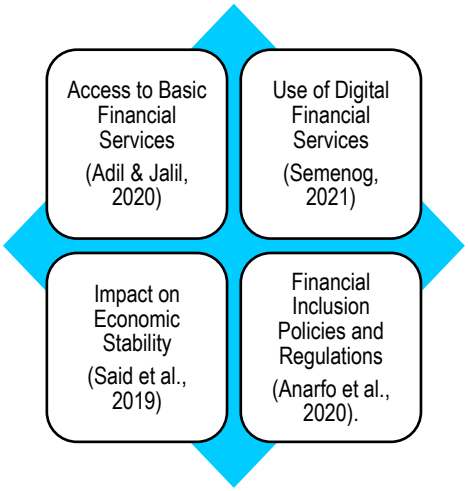
The scope of the research was descriptive, as it focused on detailing the current situation of Peruvian construction workers in terms of their financial situation and FI levels. The research also had an explanatory component, which made it possible to evaluate how the DFE influences the FI of construction workers. In the causal correlational aspect, it analyzed the relationships between various financial factors and identified strategies that favored good financial management and the adoption of good financial habits.

Figure 1. Dimensions of digital financial education



Source: Prepared with data from the literature review.

Figure 2. Dimensions of financial inclusion



Source: Prepared with data from the literature review.

The population consisted of 190 self-employed construction workers in Peru, representing a homogeneous group in terms of occupation and employment status, which allowed us to obtain meaningful and relevant data. All self-employed construction workers in Peru, between the ages of 18 and 60, with at least one year of work experience in the construction sector and permanent residence in the district are included. In addition, they must be available to participate in the survey at the designated time. All salaried workers working in public or private companies in Peru are excluded, as well as those construction workers with less than one year of work experience. Those under 18 years of age and those over 60 years of age, as well as temporary or non-permanent residents of Peru will not be considered. Also excluded are those who are unable to participate in the survey at the indicated time.

To obtain the sample, the inclusion and exclusion criteria were taken into account, the sample was delimited where the calculation of proportions was applied with a finite population or of known size, resulting in 128 workers in the construction sector in Peru, who were the sample considered for this work. Simple random sampling was used, which allowed the researchers to consider the workers who were present at the time of the survey.

A survey was used as a method and a questionnaire as a tool, which contains questions designed to obtain specific details about the subject of the study. Two tests were carried out, one for the DFE and the other for the FI. The procedures applied to two questionnaires, which were previously validated by expert judgment. After obtaining reliability, the questionnaires were applied to the collaborators. There were two questionnaires of 20 questions each, with a Likert-type rating scale.

Methods for data analysis; the data were subjected to an analysis process using both Microsoft Excel spreadsheets and SPSS statistical software; these tools allowed the evaluation of the data collected, facilitating the identification of the levels of influence between variables and indicators. The combined use of these platforms ensured accuracy and reliability in the interpretation of the results.

Ethical aspects:

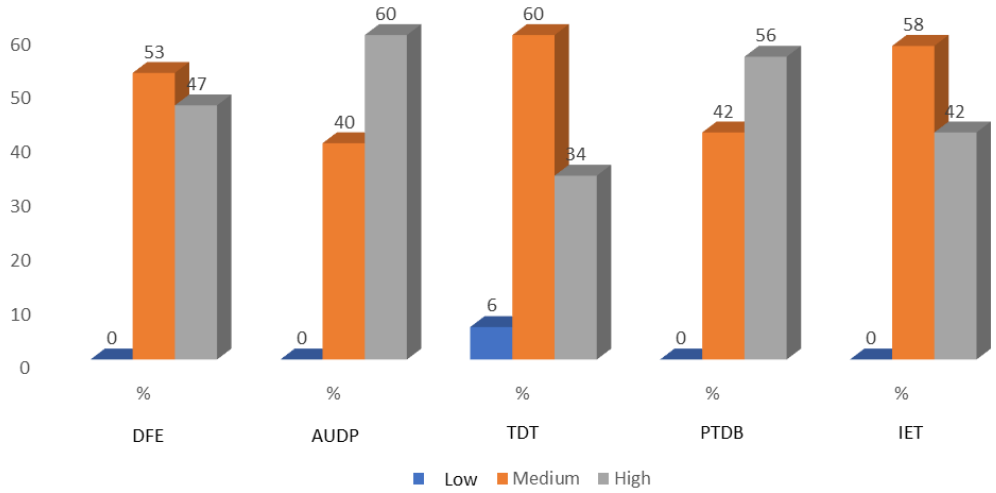
Autonomy, because it recognizes the right of individuals to exercise control over their own lives and bodies. In the field of research, this principle implies obtaining adequate informed consent from participants, ensuring that they understand the details of the study, its risks and benefits, and are free to decide to participate or withdraw without coercion.

Beneficence, because it implies the active promotion of well-being, the prevention of harm and the maximization of positive outcomes, considering the values and preferences of the individual involved. Non-maleficence, because it underscores the level of responsibility of researchers to avoid deliberately causing harm and to prioritize the well-being and safety of the individuals involved.

Justice, because it distributes benefits and burdens equitably, ensuring that resources and opportunities are equally available to all, without unfairly discriminating against study participants. Law explored how these guiding principles influence the interpretation and application of the law, as well as their crucial role in the consolidation of fundamental rights.

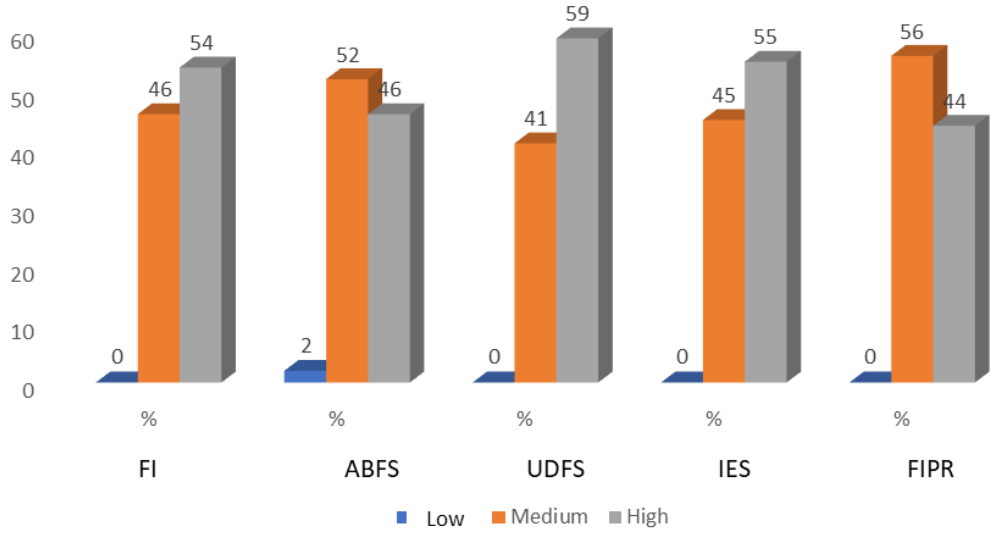
4. Research Results

Figure 3. Analysis of the digital financial education of construction sector workers in Peru



Note: DFE: digital financial education; AUDP: access and use of digital platforms; TDT: training in digital tools; PTDB: perception and trust in digital banking; IET: integration of emerging technologies.
Source: Authors' compilation with the research data

Figure 4. Analysis of the financial inclusion of construction sector workers in Peru.



Note: FI, financial inclusion; ABFS: access to basic financial services; UDFS: use of digital financial services; IES: impact on economic stability; FIPR: financial inclusion policies and regulations.
Source: Authors' compilation with the research data

Table 1. Model summary: influence of access to and use of digital platforms, training in digital financial tools, perception of and trust in digital banking, and integration of emerging technologies on financial inclusion of workers

Model	R	R square	Adjusted R-squared	Standard error of the estimate	Statistics of change					Durbin-Watson
					Change in R-squared	Change in F	gl1	gl2	Sig. change in F	
1	,615[a]	0.378	0.358	0.401	0.378	18.671	4	123	0.000	1.740
a. Predictors: (Constant), Integration of Emerging Technologies, Access to and Use of Digital Platforms, Training in Digital Financial Tools, Perception and Trust in Digital Banking.										
b. Dependent variable: financial inclusión										

Source: Authors' compilation with the research data

Table 2. Linear regression (ANOVA) influence of access to and use of digital platforms, training in digital financial tools, perception and trust in digital banking, and integration of emerging technologies on financial inclusion of workers

Model		Sum of squares	gl	Root mean square	F	Sig.
1	Regression	11.983	4	2.996	18.671	,000[b]
	Residual	19.736	123	0.160		
	Total	31.719	127			

a. Dependent variable: financial inclusión

b. Predictors: (Constant), Integration of Emerging Technologies, Access to and Use of Digital Platforms, Training in Digital Financial Tools, Perception and Trust in Digital Banking.

Source: Authors' compilation with the research data

Table 3. Model coefficients: influence of access to and use of digital platforms, training in digital financial tools, perception of and trust in digital banking, and integration of emerging technologies on financial inclusion of workers

		Unstandardized coefficients		Standardized coefficients		
Model		B	Error	Beta	t	Sig.
1	(Constant)	0.533	0.272		1.960	0.052
	AUDP	0.028	0.077	0.028	0.363	0.717
	TDT	0.113	0.069	0.127	1.644	0.103
	PTDB	0.388	0.082	0.385	4.716	0.000
	IET	0.281	0.080	0.279	3.531	0.001

a. Dependent variable: financial inclusion

Source: Authors' compilation with the research data

Table 4. Summary of the model: influence of digital financial education on the financial inclusion of construction sector workers in Peru

Model	R	R square	Adjusted R-squared	Standard error of the estimate	Statistics of change					Durbin-Watson
					Change in R-squared	Change in F	gl1	gl2	Sig. change in F	
1	,541[a]	0.292	0.287	0.422	0.292	52.013	1	126	0.000	1.885

a. Predictors: (Constant), digital financial education.

b. Dependent variable: financial inclusion

Source: Authors' compilation with the research data

Table 5. Linear regression (ANOVA): influence of digital financial education on the financial inclusion of construction sector workers in Peru

Model		Sum of squares	gl	Root mean square	F	Sig.
1	Regression	9.268	1	9.268	52.013	,000[b]
	Residual	22.451	126	0.178		
	Total	31.719	127			

a. Dependent variable: financial inclusion

b. Predictors: (Constant), digital financial literacy.

Source: Authors' compilation with the research data

Table 6. Coefficients of the model: influence of digital financial education on the financial inclusion of construction sector workers in Peru

		Unstandardized coefficients		Standardized coefficients		
Model		B	Error	Beta	t	Sig.
1	(Constant)	1.216	0.188		6.456	0.000
	VARIND: EFD	0.539	0.075	0.541	7.212	0.000

a. Dependent variable: FI

Source: Authors' compilation with the research data

5. Discussions

The results of the study in Peru show a moderate influence between digital financial literacy and financial inclusion, with an R-value of 0.541 and an R-squared of 0.292, indicating that 29.2% of the variability in financial inclusion is explained by digital financial literacy. The adjusted R-squared is 0.287, with a standard error of 0.422, indicating moderate model accuracy. The model is highly significant ($p < 0.001$), with an F-value of 52.013.

ANOVA analysis and coefficients confirm the significant influence of digital financial literacy on financial inclusion, with an unstandardized coefficient of 0.539, a t-value of 7.212 and a significance of 0.000. Studies support these findings. Tabassum and Ali (2024) showed that digitization of financial services improves financial inclusion among construction workers. Fauziyah *et al.* (2024) found a positive correlation between digital financial literacy and responsible financial behavior. Falaiye *et al.* (2024) indicated that EFD reduces financial exclusion by 40%.

Becker and Mincer's human capital theory emphasizes the importance of education and training as essential investments. In the context of EFD, this theory stresses the importance of technological competencies to access and effectively use online platforms (Leoni, 2023). Online workshops and courses improve technical competence, perception and confidence in digital banking (Chriswick, 2024).

Data show that construction workers in Peru have a good level of digital financial literacy, with 60% having high levels of access to digital platforms and 56% having high confidence in digital banking. However, there is a need to improve training in digital tools and the integration of emerging technologies for greater financial inclusion.

The regression model used shows an R-value of 0.615, with an R-squared of 0.378, indicating that 37.8% of the variability of financial inclusion is explained by variables such as the integration of emerging technologies and trust in digital banking. The coefficients of the model indicate that perception and trust in digital banking (unstandardized coefficient = 0.388, t = 4.716, p = 0.000) and integration of emerging technologies (unstandardized coefficient = 0.281, t = 3.531, p = 0.001) significantly influence financial inclusion. However, access to and use of digital platforms and training in digital financial tools do not show a significant influence.

The results suggest that construction workers in Peru have a high level of financial inclusion, with a notable use of digital services and a positive impact on their economic stability. However, there is a need to improve access to basic financial services and strengthen financial inclusion policies.

Other studies, such as Widyastuti *et al.* (2024), show that digital financial literacy and demographic factors influence financial inclusion. Vasile *et al.* (2021) correlate digital financial literacy with increased knowledge and responsible financial behavior, essential for sustainable financial security. These studies provide an empirical basis applicable in Peru to develop digital financial literacy programs that promote greater financial inclusion and inclusive economic growth.

Conclusions and Further Research

The research reveals that digital financial literacy has a moderate influence on the financial inclusion of construction workers in Peru, with an R-value of 0.541 and an R-squared of 0.292. The model is highly significant ($p < 0.001$), demonstrating that digital financial literacy is a determinant factor for financial inclusion. The model is highly significant ($p < 0.001$), demonstrating that digital financial literacy is a determinant of financial inclusion. Perception and confidence in digital banking, as well as integration of emerging technologies, are the most influential factors in this area. Although workers have good digital financial literacy, the need to improve training in digital tools and the integration of new technologies is highlighted.

The research fills important gaps in the existing literature. Specifically, it addresses how digital financial literacy affects financial inclusion in the construction sector, an area that has been little explored to date. It also examines the impact of demographic factors such as age, income and occupation on digital financial inclusion, aspects that have not been sufficiently explored in previous studies.

This study one of the few in the Peruvian regional literature to examine the impact of digital financial education on financial inclusion specifically among self-employed workers in Peru's construction sector. It identified key factors, such as digital literacy and trust in digital banking, that influence financial inclusion in this underserved group. The findings highlighted the importance of targeted digital financial education to improve access to financial services, contributing to economic inclusion and supporting Sustainable Development Goal 8. The study's results are relevant for policymakers and financial institutions aiming to enhance financial access in informal labor sectors.

However, the research has some limitations. The sample focuses on construction workers in Peru, which may restrict the generalizability of the results to other regions or sectors. In addition, the accuracy of the data may

be affected by the self-reported nature of the surveys used. It is also recognized that other variables that could influence financial inclusion, such as access to technological infrastructure and institutional support, were not explored.

For future lines of research, it is proposed to expand the sample and diversify the sectors studied. It is recommended to explore variables such as educational level, type of employment, job stability, internet access, possession of mobile devices, government policies and financial education programs. It is also suggested to conduct longitudinal studies that evaluate the evolution of digital empowerment and the impact of fintechs and new technologies on financial inclusion. In addition, the influence of psychosocial factors such as trust in technology and attitudes towards financial risk should be considered.

Finally, several initiatives of high value for science are proposed. These include developing specific digital financial literacy programs for construction workers, formulating public policies that promote digital financial literacy, developing and promoting digital apps and platforms to improve financial inclusion, conducting detailed studies on the impact of fintechs, and encouraging interdisciplinary research that approaches digital financial literacy from multiple perspectives to gain a more complete understanding of its impact.

Acknowledgments

The authors thank Cesar Vallejo University for its support.

Credit Authorship Contribution Statement

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies in the writing process before submission, but only to improve the language.

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DOI: https://doi.org/10.14505/tpref.v15.4(32).12

Does Digital Financial Literacy Matter for Current and Future Saving Behavior among Rural SME Entrepreneurs? Government Regulations Awareness as a Moderator

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Article info: Received 20 June 2024; Received in revised form 18 July 2024; Accepted for publication 26 August 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: Digital financial literacy (DFL) is a game changer in a digital environment. This study examines the impact of DFL on saving behavior among rural small and medium enterprise (SME) entrepreneurs in a developing country. It also explores the effect of government regulations awareness on the association between current and future saving behavior. The study examined rural SME entrepreneurs in Uganda who engaged in financial transactions through mobile phones and retail financial agents. The study employed purposive and snowball sampling procedures to identify rural SME entrepreneurs. Data from 215 rural SMEs entrepreneurs was obtained and analyzed using structural equation modelling and Hayes PROCESS macro. The results indicated that knowledge of digital financial services and products, digital financial risks and control, and consumer rights and reporting procedures significantly impact SME entrepreneurs' current saving behavior. The current saving behavior has a significant positive impact on future saving foresight. Government regulations awareness significantly impacts the indirect path of DFL on future saving foresight via current saving. This study provides insights for academicians, policymakers, owners of rural SMEs, policymakers, and financial institutions' top and middle-level managers interested in improving the financial situation of rural SMEs in developing countries. The originality of this study is established in rural SMEs entrepreneurs' awareness of government regulations in a digital environment that moderates the association between current and future saving behavior with DFL as a primary construct.

Keywords: digital financial literacy; rural SMEs entrepreneurs; current saving behavior; future saving foresight; government regulations awareness.

JEL Classification: D83; G53; M10; C10; G40.

Introduction

Nations progressively focus on individuals' saving habits to enhance welfare. Savings habits are crucial to eliminating poverty throughout the community. Savings behavior pertains to an individual's financial habit of amassing funds to address unforeseen circumstances and future financial needs (Aryan *et al.* 2024). This can be at a personal level or from a business perspective. Individuals who cultivate positive saving habits tend to optimize their spending habits by allocating a portion of their income towards a savings account, enhancing their overall financial standing (Setiawan *et al.* 2022). In doing so, their savings and that of their business improve. However, individuals residing in low-income nations with conventional branch banking systems often find themselves without access to financial services or with limited access (Tomasi and Ilankadhir, 2024a). Individuals regard these channels for saving as expensive to utilize, because of the transport costs involved, which diminishes their capacity to save (Abdallah *et al.* 2024). On that note, the widespread use of financial technology

has the potential to successfully change this paradigm and improve the saving behavior of individuals in developing nations. The COVID-19 outbreak revealed the real value of digitalization (Ferilli *et al.* 2024). Financial technology platforms like mobile banking are easily accessible, quick, cost-effective, and offer secure services that can improve personal and business savings. For financial technology services to successfully impact developing economies, it is crucial to establish a foundation of digital financial literacy (DFL).

Financial technology Institutions view DFL as transformative. Setiawan *et al.* (2022) define DFL as the capacity of an individual to initiate, oversee, and successfully conclude a digital transaction. The primary components of DFL include 1) knowledge of digital financial products and services, 2) knowledge of financial risks and control, and 3) knowledge of consumer rights and reporting procedures (Morgan, 2019; Setiawan *et al.* 2022; Abdallah *et al.* 2024; Aryan *et al.* 2024; Ferilli *et al.* 2024; He *et al.* 2024). DFL entails digital and financial literacy (Widyastuti *et al.* 2024). Individuals must acquire proficiency in digital technologies and a comprehensive understanding of financial matters. For instance, the knowledge of using a telephone or any other computing device, the ability to perform financial calculations and comprehend account balances. Liew *et al.* (2020) argued that financial literacy alone is inadequate in the present period of the 4.0 industrial revolution. As such, regulating digital financial services is needed to safeguard consumers. Promoting awareness of government regulations on digital financial operations would improve financial institutions' credibility and shape peoples' current and future saving behavior (Deng *et al.* 2024; Zhu *et al.* 2024). Awareness of government regulations helps build confidence among individuals for consistent savings (Mensah and Khan, 2024). For example, rural SME entrepreneurs will feel secure using digital financial services regulated by the government. The level of awareness of government regulations by rural SME entrepreneurs in a digital environment is of concern today. Too, the pace of DFL is slower than financial technology adoption among rural SMEs in developing countries (Hasan *et al.* 2023).

The Statista (2023) global report showed that the number of SMEs reached 332.99 million in 2021, implying growth compared to 328.5 million in 2019. The majority of SMEs are in rural and distant regions. As such, branch banks find it challenging to extend financial services. Additionally, because of the informal nature of many rural SMEs, it is difficult for them to obtain a savings account with branch banks for their businesses. This creates opportunities for cutting-edge financial technology to provide equitable financial services to communities globally (Bongomin and Ntayi, 2020; Mpofu and Mhlanga, 2022). Financial technology not only aids SMEs in overcoming obstacles to personal and business savings but also serves as a substitute for bureaucratic branch banking (Yao and Yang, 2022; Lu *et al.* 2022). Through financial technologies, rural SMEs can easily set aside funds for the next fiscal year's activities to address deficits. Nevertheless, the extent to which rural SMEs are prepared to adopt financial technology is still uncertain, especially in low-income nations.

Moreover, a notable literature gap exists in DFL and government regulations awareness for current and future savings behavior among rural SMEs in developing countries like Uganda. The study purposed to address this literature gap by exploring how DFL and government regulation awareness affect rural SME entrepreneurs' access to and usage of digital financial products and services to improve their current saving behavior and future foresight. In addition, the study aimed at creating an understanding of how DFL and government regulation awareness help rural SME entrepreneurs build confidence in digital financial products and services to improve savings behavior. By doing so, the study seeks to provide practical evidence of how DFL and government regulation awareness can mitigate digital financial risks and other related challenges that limit rural SME entrepreneurs from adopting and using digital financial products and services to transform their current and future savings behavior. Generally, the goal is to provide valuable information on improving rural SME entrepreneurs' saving behavior as a footprint for future saving foresight. This provides fundamental insights for academicians, policymakers and other stakeholders interested in improving the financial situation of rural SMEs in developing countries. This study is informative to owners of rural SMEs, policymakers, and financial institutions' top and middle-level managers, in developing countries on how rural business communities can improve their current and future saving behavior through DFL and awareness of government regulations, a field that academicians have not explored to full potential. The originality of this study is established in rural SME entrepreneurs' awareness of government regulations in a digital environment that moderates the association between current and future saving behavior with DFL as a primary construct. The study utilizes the theory of planned behavior (Ajzen, 1991), a psychological theory, to establish a connection between SME entrepreneurs' DFL and their saving behavior.

1. Review of Related Literature

1.1. SMEs and Digital Finance

Recent studies have found that digital finance positively impacts SMEs in various regions. Yao and Yang's (2022) research on electronic finance and SMEs in China, using data from the Chinese growth enterprise market from

2011–2020, showed that digital finance can improve SME innovation and credit processing time. Lu *et al.* (2022) also found that digital finance can substitute bank branches to address the financial constraints of SMEs in China, based on data from 2007–2017. Similarly, Thathsarani and Jiangno's (2022) study on 366 managers of SMEs in Sri Lanka revealed that digital finance provides low-risk, secure, and affordable services to SMEs, allowing them to operate at a low cost. Frimpong et al.'s (2022) study on 400 SMEs in Cape Coast, Ghana, indicated that SMEs prefer and use digital financial services platforms. Bongomin and Ntayi's (2020) research on 379 MSMEs in Gulu-Uganda also revealed that digital financial services contributed to financial inclusion. Finally, Xie and Liu's (2022) study on 581 SMEs in China, using data from 2011–2020, showed that digital finance promotes quality SMEs. Despite such a strong literature base, limited evidence exists exploring how DFL and awareness of government regulations impact rural SME entrepreneurs' current and future saving behavior in low-income economies. Yet, developing countries experience a high pace of digital financial services distribution (Tomasi, 2020; World Bank, 2022). Given the complexity and fragility of financial technology, rural SME entrepreneurs require DFL to thrive with savings.

1.2 Digital Financial Literacy and Saving

DFL is central to an individual's financial management in a digital environment (Setiawan *et al.* 2022; Ferilli *et al.* 2024). The key dimensions of DFL include knowledge of digital financial products and services, knowledge of financial risks and control, and knowledge of customer rights and reporting procedures (Morgan, 2019; Setiawan *et al.* 2022; Abdallah *et al.* 2024; Aryan *et al.* 2024; Ferilli *et al.* 2024; He *et al.* 2024). The idea that financial literacy alone is inadequate in the current period of industrial transformation implies that DFL is a significant resource in the quest for financial stability. Setiawan *et al.* (2022) research underscores the increasing importance of the DFL concept, incorporating digital and financial literacy, in our contemporary, technologically advanced society. According to Lyons and Kass-Hanna (2021), financial literacy is limited in the present 4.0 industrial revolution due to the complexity and fragility of financial technology. According to Ozil (2018), digital literacy can provide low-income families access to beneficial and less expensive saving services than traditional branch banking. Prior research has established a correlation between DFL and saving habits (Moenjak *et al.* 2020; Morgan and Trinh, 2019). According to Setiawan's (2022) study, the findings indicate that DFL significantly impacts the saving behavior of Indonesian millennials aged 5 to 40. This means that people with a better understanding of digital financial concepts are more likely to save money both in the present and the future. Garcia and Villa's (2020) research in Spain corroborates this, demonstrating that financial literacy positively influences individuals' inclination to save money independently. Conversely, Lewis *et al.* (2020) discovered that there was just a moderate level of comprehension of digital financials among a rural population located in Sarawak, Malaysia. Andreou and Anyfantaki's (2021) survey revealed an inadequate level of financial literacy among Cypriot individuals, with a rate of 33.7%. However, Zou and Deng's (2019) research in China suggests that financial literacy can empower families to participate in financial markets, thereby refuting the belief that financial literacy is insufficient in the current era of the Industrial Revolution. This is inconsistent with the rest of the prior studies emphasizing the need for DFL among rural SMEs in developing countries, making this study a necessity.

1.3 Dynamics of Rural SME Entrepreneurs

Rural SMEs have a limited population and poor education system compared with urban areas (Sabel *et al.* 2024). They are not greatly exposed to digital finance due to geographical location. This undermines opportunities for rural SME entrepreneurs' savings behavior to improve financial planning and budgeting practices. As such, rural entrepreneurs face challenges using digital financial services (Udimal *et al.* 2019, Tomasi and Ilankadhir, 2024b). Additionally, the digital ecosystem has put limited emphasis on how the current education system can be linked to financial literacy to improve SMEs in rural communities. Moreover, financial institutions are limited in rural areas to fill the gaps where education and research institutions have not incorporated financial literacy course programs in rural communities (Aka and Enagogo, 2024). As a result, rural SMEs lack managerial strategies to address current and long-term goals (Sabel *et al.* 2024). Rural entrepreneurs are biased towards digital platforms due to a lack of understanding of digital financial products and services, digital financial risk control, and redress procedures. Strong DFL would help rural SME farmers improve access to and use digital financial products and services to grow savings.

2. Theoretical Background

The study is underpinned by the theory of planned behavior (Ajzen, 1991), a psychological theory that establishes a connection between individuals' beliefs and actions. The study used reasoned action theory (Fishbein and Ajzen, 1980) by integrating behavioral control to address the existing gap. It has been shown that when a person does not have complete control over their actions, their desire to behave in a certain way does not necessarily translate into actual behavior. The planned behavior hypothesis emphasizes the individual's perception, social connection, behavioral control, and intentions. Previous studies have employed the planned behavior theory to examine financial behavior and literacy (Normawati *et al.* 2021; Daragmeh *et al.* 2021; Rahayu *et al.* 2022). According to Normawati (2021), the employees, family members, or friends of rural SME owners influence their attitude towards saving. Consequently, this fosters economic stability and assurance. DFL dimensions are factors that shape individual current saving behavior and plans for the future (Figure 1). Awareness of government regulations by the SME community impacts current and future saving behaviors (Figure 1). DFL and awareness of government regulations enhance understanding of saving money for current and long-term financial stability (Panos and Wilson, 2020).

2.1 Hypothesis Development

Abad-Segura and Gonzalez-Zamar (2019) performed a bibliometric investigation from 1990 to 2018, demonstrating that people with financial literacy understand money and its mathematical complexities. Knowledge of electronic commerce is crucial in the digital domain (Morgan and Trinh, 2019; Setiawan *et al.* 2022). According to Bongomin and Ntayi (2020), Daragmeh *et al.* (2021), and Mpofu and Mhlanga (2022), it is widely accepted that having a strong ability to identify and understand commonly used modern financial products and services, such as insurance and mobile banking, is crucial for achieving success in the field of digital finance. Hasan *et al.* (2022) studied female entrepreneurs from 144 countries, utilizing the World Bank Global Findex Database. They found that a strong understanding of digital finance allows for easy and efficient engagement with formal banking institutions. According to Liew *et al.* (2020) study on 252 people living in rural Sarawak, Malaysia, findings indicate that understanding electronic products and services is an important aspect of digital literacy, particularly in the financial sector. Therefore, individuals who utilize such services will exhibit wise financial habits, causing effects on current saving behavior (Figure 1). Thus, we hypothesize that:

H1: Knowledge of digital financial products and services impacts Current Saving Behavior among Rural SMEs Entrepreneurs.

Acquiring digital literacy, which includes understanding financial risks and management methods, is crucial. Xie and Liu, (2022) and Normawati *et al.* (2021) conducted a study on millennials and found that financial technology developments are associated with risks. According to Panos and Wilson (2019), online fraud has destabilized consumers. Therefore, knowledge of these risks is important to guarantee financial stability. Convenience in a financial product or service is contingent upon consumers having complete awareness of the risks involved and the corresponding management mechanisms. These services depend significantly on consumers' understanding of the associated risks due to their intricate nature and vulnerability (Setiawan *et al.* 2022; Frimpong *et al.* 2022). Consumers can cultivate financial assurance and promote responsible financial conduct by educating themselves about digital financial fraud and cyber dangers such as hacking, phishing, and SIM card swaps. Thathsarani and Jiangno (2022) found that individuals with a strong comprehension of financial risks can efficiently utilize online financial apps and mitigate the dangers of fraud and cybercrime. This understanding helps individuals protect personal identification numbers and other financial information, resulting in prudent savings. Therefore, we hypothesize that:

H2: Knowledge of digital financial risks and control impacts the current saving behavior of rural SMEs entrepreneurs.

Financial fraud is a prevalent occurrence, with individuals becoming victims daily. According to Morgan and Trinh (2019), digital transaction users should understand the established channels for resolving concerns. Prior studies have highlighted the need for DFL to understand consumer rights and the procedures for resolving disputes (Abdallah *et al.* 2024; Aryan *et al.* 2024; Ferilli *et al.* 2024). According to Setiawan *et al.* (2022), understanding consumer rights and the redress mechanisms implemented by financial regulatory agencies is crucial in mitigating financial risks faced by victims, especially as financial technology continues to improve. The lack of efficient financial crime redress facilities might potentially leave individuals vulnerable to criminal activity

(Hasan *et al.* 2022). According to Morgan and Trinh (2019), personal data rights and understanding the means to seek remedy are important components in a digital era. Hence the study hypothesizes that:

H3: Knowledge of consumer rights and redress procedures impacts current saving behavior among rural SMEs entrepreneurs.

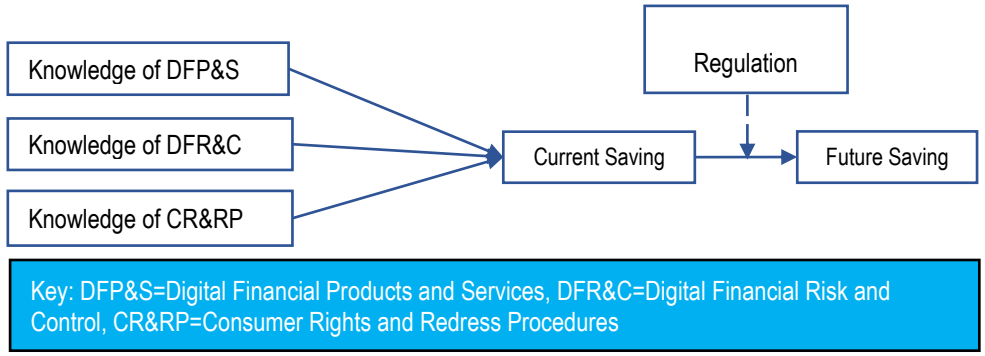
Furthermore, electronic transactions have fundamentally changed how individuals save money and establish long-term goals. Quelhas *et al.* (2023) conducted research among adult Portuguese individuals and found that a significant majority, specifically 65.9% of 311 participants, used mobile phones for savings and other financial transactions. Gilanko and Chemova (2021) researched Russian high school students and found that financial literacy is crucial for fostering responsible saving habits and preserving financial stability in a digital environment. Abad-Segura and Gonzalez-Zamar (2019) argue that while investing in financial literacy may not solve all financial difficulties, it motivates individuals to save and strategize for their financial future. Setiawan *et al.* (2022) found a noteworthy association between individuals' present saving habits and their future saving habits. Therefore, failing to consider the existing saving habits of rural SME enterprises may result in future financial instability. Enhancing present saving habits guarantees financial stability and predicts more favorable future earnings as shown in Figure 1. Based on that discussion, the study hypothesizes that:

H4: Current saving behavior impacts future saving foresight among rural SMEs entrepreneurs.

Government regulations are behavioral measures that set boundaries followed in a country. The government institutes policies to regulate business practices (Zhu *et al.* 2024). Central banks monitor financial institutions to ensure policy compliance (Mensah and Khan, 2024). This creates a transparent and trustworthy environment for financial products and services offered. Adhering to government regulations creates consumer data safety and consistent reporting procedures (Meng *et al.* 2022). The government regulations are designed for long-term strategic performance (Deng *et al.* 2024). Previous studies have found government regulations to affect behavior (Meng *et al.* 2022; Deng *et al.* 2024; Zhu *et al.* 2024; Mensah and Khan, 2024). With great awareness of government regulations, rural SME entrepreneurs can develop confidence and use digital financial products and services to foster their future saving behavior. Therefore, we hypothesize that:

H5: Government regulations awareness affect the association between current saving behavior and future saving foresight.

Figure 1. Study model



Source: Setiawan *et al.* (2022) modified by Authors

3. Methodology

SME enterprises account for the largest contribution towards the gross domestic product of developing countries like Uganda. People earn their living through SME activities in rural communities. The study examined rural SME entrepreneurs in Uganda who engaged in financial transactions through mobile phones and retail financial agents. According to Bongomin and Ntayi (2020), the availability of cheap mobile phones and easily accessible retail financial agents has greatly improved the use of digital finance among rural SME entrepreneurs.

The study utilized printed paper questionnaires for data collection. The participants were SME rural entrepreneurs in three districts of eastern Uganda: Mbale, Sironko, and Manafa. We selected these regions due to their significant user base in digital financial transactions (Uganda Investment Authority, 2022) and a high rural SME setup. The study employed purposive and snowball sampling procedures to identify rural SME entrepreneurs. Purposive sampling facilitated the identification of respondents who aligned with the study's aims

(Guarte and Barrios, 2006). Additionally, snowball sampling facilitated the acquisition of referrals to possible respondents who were difficult to access (Noy, 2008). We provided each rural SME entrepreneur with a one-week timeframe to complete the questionnaire. We then collected physical copies to ensure the respondents' convenience. The data collection lasted for two months, December 2023 and January 2024. The researchers considered 215 of the 270 questionnaires as valid for further research. This was a 79.6% response rate, indicating an acceptable level of appropriateness.

The study employed structural equation modelling (using AMOS 23) to assess the influence of the dimensions of DFL on saving behavior. Hayes PROCESS macro was used to analyze the moderating role of government regulations awareness in the association between current and future saving behavior. The measuring items utilised in this study were adopted from prior research conducted on digital financial literacy and financial behavior (Setiawan *et al.* 2022; Rahayu *et al.* 2022; Widyastuti *et al.* 2024; Ferilli *et al.* 2024; Abdallah *et al.* 2024; Amnas *et al.* 2024; Aryan *et al.* 2024), and Mensah & Khan, (2024) on government regulations awareness. The items were modified to meet the purpose of the study. These items were measured using a five-point Likert scale (Strongly agree 5, agree 4, neutral 3, disagree 2, strongly disagree 1).

3.1 Common Method Bias

In this study, data was collected at the same time, demographic variables, independent variables, and dependent variables on a printed single questionnaire. As such there is a high likelihood that common method bias could exist. Against such a backdrop, common bias analysis was undertaken to understand whether the data was free from biases. Harman single factor results showed a variance inflation factor of less than 3, fitting the acceptable level (Podsakoff *et al.* 2012). In addition, we eliminated ambiguity in the scale items to avoid respondents' reliance on their systematic responses. This kept questions simple and specific to understand to avoid common method bias (Podsakoff *et al.* 2012).

3.2 Study Results

Table 1. Demographic data

Category	Number	Percentage
Gender: Female (F)	71	33
Male(M)	144	67
Age: 20-30 years	43	20
30-40 years	44	20.5
40-50 years	31	14.4
50-60 years	63	29.3
60 years and above	34	15.8
Education: Primary	25	11.6
Secondary	98	45.6
Bachelor degree	85	39.5
Master degree	07	3.3
Experience: Less than 5 years	26	12.1
5-10 years	50	23.3
10-15 years	58	27
15-20 years	40	18.6
20 years and above	41	19.1

Source: Authors compilation

Table 1 above shows more male (67%) rural entrepreneurs compared to females (33%), 84.2% were below 60 years representing an active workforce, 85.1% reached secondary education, indicating a high literacy level, and at least 87.9% had more than 5 years of experience.

AMOS 23 was utilized to perform confirmatory factor analysis to understand the validity and reliability of the measurement scale. The Cronbach alpha values for all constructs, as shown in Table 2, are greater than 0.7. the measurement model indices are greater than 0.9, RMSEA and RMR less than 0.08, and CMIN/DF less than 3. This indicates a high level of scale reliability (Hair *et al.* 2021). The data from Table 2 also shows average variance extracted values over 0.6 and composite reliability above 0.7, which indicates convergent validity (Hair *et al.* 2020).

Table 2. Measurement model summary

Constructs	Items	Factor Loading
Knowledge of digital financial products and services α (.933), CR (.952), AVE (.831)	I possess digital financial products	.906
	I understand digital financial services	.920
	I can initiate digital transactions effectively	.919
	I understand digital financial Insurance	.902
Knowledge of digital financial risks and control α (.928), CR (.948), AVE (.820)	I understand digital financial risks	.896
	I have experience using digital financial payments	.902
	I can manage financial risks	.916
	I have control of my digital financial activities	.909
Knowledge of consumer rights and redress procedures α (.919), CR (.912), AVE (.779)	I understand digital consumer rights	.844
	I understand the digital consumer protection system	.900
	I understand complaint procedures against providers	.902
Current Saving Behavior α (.843), CR (.823), AVE (.609)	I am motivated to save on digital financial products and services	.769
	I make regular savings on digital financial platforms	.865
	I drive satisfaction saving on digital financial platforms	.699
Future Saving Foresight α (.882), CR (.871), AVE (.692)	I will experience freedom saving in digital financial products and services	.830
	I will continue saving on digital financial platforms	.862
	I will have increased satisfaction saving on digital financial platforms	.803
Government Regulations Awareness α (.850), CR (.853), AVE (.658)	Am aware of government policy on digital financial services	.822
	I know regulations protect my interaction with digital financial services	.783
	Am aware of government supervision on digital financial operations	.827

Model Fit: CMIN /DF (1.804), CFI (.973), NFI (.942), GFI (.907, IFI (.973), RMSEA (.061), TLI (.964), RMR (.063).
Source: Authors compilation

Table 3. Mean, Standard deviation, and Correlation Matrix

	Mean	Std D	1	2	3	4	5	6
Knowledge of Digital Financial Services and Products (1)	4.095	1.049	.871[a]					
Awareness of Digital Financial Risks and Controls (2)	3.805	1.213	.431**	.878[a]				
Knowledge of Customer Rights and the Redress Procedures (3)	3.842	1.213	.405**	.46**	.892[a]			
Current Saving Behavior (4)	4.248	0.799	.516**	.466**	.496**	.775[a]		
Future Saving Foresight (5)	4.154	0.926	.411**	.335**	.355**	.665**	.845[a]	
Government Regulation Awareness (6)	3.785	0.881	.361	.443	.402	.332	0.517**	.811[a]

Note: ** Correlation is significant at .01 level, [a] AVE Square root of latent construct. Std D= Standard deviation.
Source: Authors compilation

Table 3 shows the square root of Average Variance Extracted (AVE) greater than all construct correlation coefficients, demonstrating the discriminative validity of the scale. In addition, the correlation coefficient values

varied from 0.335 to 0.665, indicating that the constructs in the study were not multi-collinear (Lindner *et al.* (2020).

Table 4. Construct path analysis

Hypothesis relationship	(β)	SE
Knowledge of Digital Financial Services and Products → Current Saving Behavior	.40***	0.06
Awareness of Digital Financial Risks and Controls → Current Saving Behavior	.22*	0.05
Knowledge of Customer Rights and the Redress Procedures → Current Saving Behavior	.28**	0.047
Current Saving Behavior → Future Saving Foresight	.79***	0.09

Note: ***p<.001, **p<.01, *p<.05, Model Fit; CMIN /DF (2.000) (p<.001), CFI (.967), NFI (.936), GFI (.899), IFI (.955), RMSEA (.068), TLI (.955), RMR (.065)
Source: Author compilation

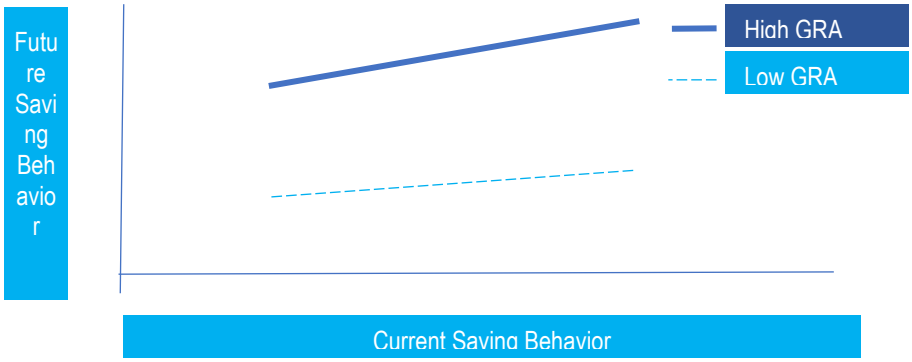
The study used the structural equation model AMOS 23 to assess the study hypotheses. A model is considered fitting and acceptable if the values of CMIN/DF are less than 5 and if CFI, NFI, GFI, IFI, and TLI are greater than 0.90. In addition, RMSEA and RMR values were less than 0.08 (Hair *et al.* 2020). In this study, the model fit was assessed using the following criteria: CMIN/DF (2.000) (p<.001), CFI (.967), NFI (.936), GFI (.899), IFI (.955), RMSEA (.068), TLI (.955), and RMR (.065), indicating a good fit model. The findings of the path model (Table 4) revealed that H1 (β=.40, p<.001), H2 (β=.22, p<.05), and H3 (β=0.28, p<.01) suggest that all dimensions of DFL have a positive impact on current saving behavior. Moreover, the significant beta coefficient of H4 (β=.79, p<.001) indicates that current savings impacts future saving foresight. Therefore, all theories were confirmed. In addition, the R2 score for present saving conduct was 0.51, while for future saving foresight, it was 0.62. This indicates that the research model accounted for 51% and 62% of the differences in the current saving behavior of rural SME owners and their ability to predict future savings, respectively.

Table 5. Moderation effect of Government regulations awareness

Path	Effect	SE	t-value	Lower Bootstraps 95% CIs	Upper bootstraps 95% CIs
DFL→CSB→FSF	.1758	.0844	2.0828	.0098	.3418

Note: CSB=Current Saving Behavior, FSF=Future Saving Foresight
Source: Authors compilation

Figure 2. Visualizing the moderating effect



Source: Authors. Note: GRA=Government Regulation Awareness

The moderation effect was analyzed using Hayes and Andrew's PROCESS macro. The moderating effect of government regulations awareness on the indirect impact of DFL on future saving foresight via current saving behavior was analyzed based on 5000 bootstraps (Hayes, 2013). The study results (Table 5) indicate that indirect effect (.1758; SE=.0844; t-value=2.0828; LLCI=.0098 and ULCI=.3418), on future saving foresight via current saving behavior had a significant effect at low and high government regulations awareness. Thus, hypothesis (H5) was supported (Figure 2).

4. Discussion

Multiple agencies, including the World Bank, the OECD, and the United Nations, are allocating resources to improve people's saving habits. SME entrepreneurs are not exceptional. Many studies (Morgan and Trinh, 2019; Lewis *et al.* 2023; Lu *et al.* 2022; He *et al.* 2024; Setiawan *et al.* 2022; Widyastuti *et al.* 2024; Ferilli *et al.* 2024; Abdallah *et al.* 2024; Amnas *et al.* 2024) have found that knowing about digital financial services and products, risks and ways to control them, as well as customer rights and how to report them, are important factors of DFL.

Therefore, it is crucial to examine the impact of DFL characteristics on the current and future saving behaviors of rural SME entrepreneurs. The study results indicated that all three factors had a noteworthy influence on the present saving behavior of rural SME entrepreneurs in a developing country. Knowledge of digital financial products and services had the greatest impact.

Notebly, the current saving behavior of rural SME entrepreneurs was found to have a significant effect on future saving behavior (Table 4). This result is consistent with Setiawan *et al.* (2022) and Lewis *et al.* (2023). These results are significant given that developing countries have low technology adoption rates. Providing rural SME entrepreneurs with knowledge about peer-to-peer lending, mobile phone wallets, and Internet banking promotes existing saving practices and also ensures long-term financial stability. Unlike the traditional method of teaching financial literacy, DFL offers individuals a range of options to engage in saving. Additionally, the results indicate that understanding digital financial risk and effectively managing it may greatly enhance an individual's saving behavior. The outcome aligns with previous studies conducted by Morgan and Trinh (2019), Normawati *et al.* (2021), and Abdallah *et al.* (2024). The emergence of financial technology has led to an increase in online financial fraud and cyber risks. Increasing awareness of these concerns may motivate individuals to increase their savings. Due to limited information and the increasing occurrence of digital fraud, rural SME entrepreneurs face the possibility of being highly susceptible and experiencing substantial financial losses. Therefore, rural SME entrepreneurs may avoid SIM card swaps, profiling, hacking, pharming, and phishing by acquiring knowledge about appropriate computer usage and implementing data protection measures such as personal identification numbers (Ferilli *et al.* 2024; Abdallah *et al.* 2024; Amnas *et al.* 2024).

Additionally, the results suggest that rural SME entrepreneurs' understanding of their rights and the procedure for resolving disputes greatly enhances their saving behavior. The findings of Morgan and Trinh (2019), Setiawan *et al.* (2022), Hasan *et al.* (2022), and Ferilli *et al.* (2024) are consistent with the study results. Given the proliferation of various financial technologies, it is logical to expect that SME entrepreneurs may face adverse consequences due to the multitude of digital financial hazards that already exist. Understanding your legal entitlements is necessary when prompt reporting is required for challenging and uncontrollable circumstances in digital finance. Thus, rural SME entrepreneurs must possess knowledge about the financial regulatory agencies at both local and national levels. Furthermore, the results indicated that current saving behaviors significantly impact future saving behaviors. This finding aligns with Setiawan *et al.* (2022), Lu *et al.* (2022), and He *et al.* (2024). Given the prediction that financial technology will play a crucial role in future economies, it is important to strengthen the existing saving behavior of rural SME entrepreneurs by promoting DFL. This will increase people's likelihood of saving in the future.

Furthermore, the findings show that the moderating effect of government regulation awareness in the association between current saving behavior and future saving foresight varies at low and high levels of government regulation awareness. Rural SME entrepreneurs with high government regulation awareness of digital financial services display improved current saving behaviors such as planning and budgeting compared to rural SME entrepreneurs with less government regulations awareness in developing countries. To our understanding, this is a novel investigation as there is no evidence of studies in previous literature exploring the moderating effect of government regulation awareness in the interaction between current saving behavior and future saving foresight among rural entrepreneurs in developing countries like Uganda.

4.1 Theoretical Implications

This study examines the impact of DFL on the current and future saving behavior of SMEs in a developing country. It provides original insights and adds to the existing body of literature on this topic (Lu *et al.* 2022; He *et al.* 2024; Setiawan *et al.* 2022; Widyastuti *et al.* 2024; Ferilli *et al.* 2024; Abdallah *et al.* 2024; Amnas *et al.* 2024). Prior research has focused on analyzing the influence of DFL on financial behavior. In contrast, there have been few investigations into the effects of DFL on current saving behavior and future saving foresight under the framework of planned behavioral theory. Furthermore, it is crucial to study how government regulations awareness among rural SME entrepreneurs in a developing nation such as Uganda can improve saving behavior. Understanding DFL dimensions from a developing country perspective among rural SMEs broadens the geographical range of the investigation of DFL.

4.2 Managerial Implications

The study provides a practical understanding of measures to be adopted by financial institutions and the government to enable rural SME entrepreneurs to use novel technology to improve current and future savings. It is important to involve all stakeholders in the digital financial inclusion process in rural communities. Additionally,

the study provides detailed practical insights into digital financial literacy dimensions that should be considered to promote digital financial products and services usage among rural SME entrepreneurs. DFL information sharing by financial and non-financial institutions through in-person visits to rural areas. This convenient exposure enables rural SME entrepreneurs to comprehend digital financial products and services. With DFL, information asymmetries can be addressed to avoid fraud practices and promote financial inclusion in rural communities.

Similarly, policymakers should collaborate closely with universities and other educational institutions to create tailored DFL short courses for rural SMEs. By doing this, SME entrepreneurs would gain tailored expertise that would assist them in fulfilling market requirements in the digital age. Furthermore, financial institutions can hold community or social activities in rural communities, such as athletics, football, and festival celebrations, to enhance public knowledge of the risks involved with financial technology and demonstrate their risk management strategies.

Equally, financial institutions and policymakers should establish agents in rural communities equipped with round-the-clock toll-free helpline numbers to assist rural SME entrepreneurs encountering unfamiliar digital signals. These agents would provide valuable information to rural SME entrepreneurs which helps them build confidence when handling digital financial services. Furthermore, government and financial institutions should disseminate digital finance protection guidelines to rural communities through agents and other platforms. Enhancing awareness of government regulations on digital financial services through rural community gatherings, radios, periodicals, billboards, and television would help rural SME entrepreneurs improve their current saving behavior and future saving foresight.

Limitations and Future Research

Given the restricted scope of Uganda, more investigations can be conducted in different economies to ensure the accurate generalization of the findings. Financial technology is dynamic and complex. This necessitates a longitudinal study for the causal relationship between DFL and saving behavior. Furthermore, the study methodology solely focuses on DFL. Future research has the potential to broaden it by incorporating financial education and empowerment. In addition, future research might employ spending and investment behavior as the dependent variables rather than the saving behavior utilized in this study. Moreover, this study exclusively focused on rural SME entrepreneurs. Subsequent research should aim to investigate this topic among urban SME entrepreneurs and across industries. Despite these minor limitations, this study stands out and significantly benefits rural SME entrepreneurs in developing countries.

Conclusion

The financial security of rural SME entrepreneurs in developing countries relies on their saving habits. Consistent implementation of DFL can transform the saving behavior of rural SME entrepreneurs. While there have been studies on the influence of DFL on financial conduct, there is less empirical data on how knowledge of digital financial services and products, digital financial risks and control measures, and customer rights and reporting procedures affect savings behaviors under the framework of planned behavior theory. Governments and financial institutions must prioritize customer understanding of digital financial services and products, digital financial risks and control measures, and customer rights and reporting procedures in a digital environment. Additionally, an individual's current saving behaviors impact their future behavior. Promoting government regulation awareness among rural communities would foster inclusive digital finance. Thus, studying rural SME entrepreneurs' awareness of government regulations in a digital environment that moderates the association between current and future saving behavior with DFL as a primary construct represents the originality of this study.

Credit Authorship Contribution Statement

Mutya Tomasi: Conceptualization, Investigation, Methodology, Project administration, Software, Formal analysis, Writing –original draft, Data curation, Writing and review
Ilankadhir M.: Software, Supervision, Validation, editing and Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of AI and AI-assisted Technologies

The authors declare that they did not use generative AI and AI-assisted technologies during the preparation of this work.

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Volume XV, Issue 4(32), Winter 2024

DOI: https://doi.org/10.14505/tpref.v15.4(32).13

International Financial Institutions and Their Role in Promoting the Stability of The Global Financial System

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Article info: Received 25 September 2024; Received in revised form 15 October 2024; Accepted for publication 28 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: The study aims to substantiate the role of leading international financial institutions based on the analysis of their activities during the global and regional financial and economic crises. To achieve this goal, the following methods were used: comparison, generalisation, dynamic and structural analysis. The study analyses in detail the activities of international financial institutions, particularly the International Monetary Fund, the World Bank Group, and other regional financial organisations, aimed at overcoming the consequences of financial and economic crises (the Asian financial crisis of 1997-1998, the Global Financial Crisis of 2008-2009, and the COVID-19 pandemic crisis of 2020). Based on the analysis, the study summarises the main instruments, methods and approaches used by international financial institutions to promote financial stability. The study established that the main instrument is credit financing. To assess the significance of financial programmes, the amount of financial assistance was compared with the gross domestic product of individual countries that received such funding programmes. The study determined that the directions and conditions of such loan programmes differ depending on the organisation that provides them and the country that receives them. The study found that international financial institutions, particularly the IMF and World Bank Group, played a crucial role in stabilizing the global financial system during crises. The analysis of financial support, GDP growth, and inflation data highlights their impact. These findings

are valuable for scholars and government officials in understanding the importance of international coordination in addressing economic crises.

Keywords: economic crises; debt policy; fiscal policy; default; International Monetary Fund; World Bank.

JEL Classification: F33; E44; G01.

Introduction

The stability of the global financial system is a key aspect of the sustainable development of the global economy. It ensures predictability and trust of market participants, facilitating investment, growth of investments and rational allocation of resources. Overall, the stability of the global financial system is a dynamic process that requires constant monitoring, analysis and response to constantly changing conditions and challenges. Since global financial stability implies the ability of the economic system to function without critical disruptions or crises, ensuring the stability and predictability of markets, investment activity and overall economic development, it is a key aspect of maintaining global economic prosperity and promoting economic growth (Ali *et al.* 2023).

Creating and maintaining global financial stability requires not only effective macroeconomic policies, financial market regulation, and risk and crisis management by governments, but also international cooperation (Gulaliyev *et al.* 2017; Chorna 2009). Therefore, this process depends on continuous improvement of regulatory mechanisms, as well as on effective interaction between states, international financial institutions and other participants in the economic and financial system. Today, the global financial system is in a difficult position (Yudina *et al.* 2024). On the one hand, there is a recovery from the COVID-19 pandemic, but on the other hand, several factors, such as the war in Ukraine and related sanctions, inflationary processes, and increased regulatory pressure, which may slow economic growth, create uncertainty and risk, undermining global financial stability (Roukanas and Vitzileos 2023; Tiurina *et al.* 2023). Also, in 2008, Georgia's economy was severely damaged as a result of the war with Russia, to which was added the impact of the global financial crisis. Under these conditions, if it were not for the financial assistance of international financial organizations and individual countries, the country would not have been able to overcome the severe consequences of the crisis for a long time. The scale of the aid of these organizations in the fight against the pandemic was also great; It is also worth noting the large scale of state support (Silagadze *et al.* 2022). In this context, international financial institutions should implement appropriate programmes to maintain financial stability, as they did during previous economic downturns in the global economy.

International financial institutions have a significant impact on maintaining global financial stability (Dobroskok *et al.* 2019). However, their activities are accompanied by criticism, prejudice and several problems that affect the effectiveness of their work and perception by recipient countries and the international community. The issues of ensuring global financial stability and the role of international financial institutions in this process were studied by Daugirdas and Lions (2023), Alami *et al.* (2022), and Stiglitz (2001). The results of the studies by Chandrasekhar (2021) and Elnahass *et al.* (2021) confirm that international financial organizations play a significant role in ensuring the stability of the global financial system through policy coordination, the development of standards and regulations, and the provision of financial assistance in times of crisis. At the same time, Khor *et al.* (2022) identify that the reason for this is that national institutions cannot keep up with the dynamic changes in the global economy and do not have sufficient reserves to maintain financial stability in the event of a long-term crisis.

Therefore, there is a need to manage the international financial architecture. International financial institutions (IFIs), with their global vision, should play a key role in this process. Hua *et al.* (2023) establish the fact that countries, especially those that are less developed or economically dependent, are subject to the influence of other countries or international organizations in the field of finance and economic reform. This can include various aspects such as credit terms, trade agreements, international standards and policy conditions imposed by more developed countries or international financial institutions on less developed or dependent economies and financial systems.

Therefore, such financial institutions play an important role in shaping the financial stability of both individual countries and the world. Thus, despite various national and regional financial mechanisms and initiatives, many countries have turned to international financial organisations, such as the World Bank, the International Monetary Fund (IMF), and the Asian Development Bank, to overcome the consequences of the crises. However, these studies also point out that the role of international financial institutions, particularly the IMF, in overcoming this crisis is a subject of ongoing debate. Some argue that IMF policies have been beneficial for the economic development of countries, while others criticise them for austerity and neoliberal reforms that

have contributed to the development of the shadow economy. The Asian financial crisis damaged the economies of Ukraine, Georgia and the world relatively less, but it proved painful for the economies of the Republic of Korea, Thailand and Indonesia; During the global financial crisis, the economies of the world, Georgia, the Republic of Korea, Ukraine, and Thailand decreased more; During the pandemic, the economies of the world, the Republic of Korea, Thailand, Indonesia, and Georgia were cut short (Zubiashvili *et al.* 2023).

Despite the existing developments, a thorough study is needed to determine the role and effectiveness of international financial institutions in supporting the financial and economic systems of individual countries, in the context of their impact on global financial stability, during periods of economic recessions and financial crises. There is also a need to identify and summarise the methods and tools used by international financial institutions in cooperation with different countries to ensure their financial stability and the stability of the global financial system. Therefore, given the above, the study aims to substantiate the role of international financial institutions in ensuring global financial stability. This study will attempt to analyse the actions, tools and methods used by IFIs to stabilise the global financial system in times of crisis, based on the structural and global approaches, which assume that the stability of the financial and economic systems of individual countries affects the stability of the global financial environment.

1. Literature Review

James (2024) examines the International Monetary Fund's involvement in Europe following the 2008 global financial crisis, particularly focusing on its role in Greece, Ireland, Portugal, and Cyprus. The researcher explores how the IMF, alongside the European Central Bank and the European Commission (the "troika"), implemented adjustment programs aimed at stabilizing these countries' economies. The author also examines the ways in which these initiatives impacted the development of political populism in Europe, including the emergence of movements like Brexit.

In their paper, Coe and Yeung (2015) examine how cross-border economic activity is driving increased integration and interdependence in the global economy. The scholars introduce the concept of global production networks (GPNs), a new form of economic organization that unites various actors across national boundaries to create and capture economic value. The authors argue that economic development in today's interconnected world can no longer be understood within the traditional territorial limits of individual nations or regions. Instead, GPNs serve as platforms for transnational collaboration and competition, transferring value and influencing economic growth across industries and economies.

Ballouk *et al.* (2024) offer a comprehensive scientometric review of the literature on financial stability. The authors hope to fill in the knowledge gaps left by conventional literature reviews by offering an updated conceptual framework for comprehending financial stability through the use of a large-scale study. The researchers propose a study agenda that highlights the significance of macroprudential policy in managing financial cycles and systemic risk, citing systemic risk and macroprudential policy as two major advancements in the area.

Kranke (2019) examines the development of institutional collaboration between the World Bank and the IMF by contrasting trends prior to and following the global financial crisis of 2008. Through over 90 expert interviews and official documentation, the author reveals that, while cooperation rules between the two institutions typically tightened during crises, they were unexpectedly loosened following the global financial crisis. According to the report, this transition was caused by a change in the integrative to more fragmented ideas of future cooperation held by officials from both organisations. This change is particularly evident in how the Financial Sector Assessment Programme (FSAP) and Poverty Reduction Strategy Papers (PRSPs) were discussed and implemented, highlighting the reflexive nature of inter-organizational relationships and the role of staff in shaping cooperation.

In their research, McKillop *et al.* (2020) offer a thorough analysis of financial cooperatives and their function in numerous nations' financial systems. The authors look at the behavioural and structural traits of financial cooperatives in the first section of the review. It highlights how these organisations have remained stable and well-liked while being for-profit and putting a strong emphasis on member benefits, especially during difficult periods like the global financial crisis. The effectiveness and contribution of financial cooperatives to the actual economy are the main topics of discussion in the second section.

Nasreen and Anwar (2023) investigate how central banks in five South Asian countries adjust their monetary policies in response to financial stability. Using the auto-regressive distributed lag (ARDL) and vector autoregressive (VAR) approaches with time-series data, the study finds that financial stability significantly influences monetary policy decisions in all countries. The findings suggest that central banks respond to growing

output gaps and declining exchange rates by tightening monetary policy; however, the response to inflation gaps is less pronounced in the central banks of Pakistan and India.

Smets (2018) investigates the connection between financial stability and monetary policy, especially in the context of the current financial crisis. The author addresses three key questions: the effectiveness of macroprudential policy in maintaining financial stability, the impact of monetary policy on risk-taking and financial stability, and the potential risk of "financial dominance," where financial stability concerns might undermine the central bank's price stability mandate. The researcher contends that monetary policy ought to take financial risks into account, even though macroprudential policy needs to be the major weapon for preserving financial stability. He suggests that central banks may need to "lean against the wind" to address financial instability, while still focusing on price stability in the medium term.

These studies collectively explore the crucial intersections of financial stability, economic development, and institutional cooperation in the global economy. They emphasize the role of international institutions, like central banks and financial organizations, in responding to financial crises and managing systemic risks. By examining frameworks such as global production networks, monetary policy, and financial cooperatives, the research highlights how cross-border collaboration and effective policy measures are essential for sustaining stability. The studies also underline the importance of adapting to emerging challenges, such as financial instability and economic fluctuations, to ensure resilient and sustainable economic growth in an increasingly interconnected world.

2. Materials and Methods

The study is based on a synthesis of two approaches: the globalisation approach, which recognises the interdependence of economies and financial markets and the need for concerted action to ensure stability and resilience in the international financial system, where one of the key aspects is the development of international mechanisms for cooperation and control over financial areas, and the structural approach, which, in the context of global financial stability, focuses on analysing the structure of the financial system, its components and interrelationships to identify factors that affect its stability. The main structural components of the global financial system are the financial systems of individual countries, their stability and their impact on the global stability of the financial and economic sphere.

To identify the crisis periods, the author used the method of statistical grouping and formed a statistical sample of such an indicator as the Gross Domestic Product (GDP) expressed in USD for the period 1994-2022, which, using the method of graphical display, was presented in the form of a line graph. The data were taken from the World Bank's (2024a) information database, where GDP figures are displayed following the World Bank's national accounts and the national accounts data files of the Organisation for Economic Co-operation and Development (OECD).

To assess the role of international financial institutions in promoting global financial stability, a thorough analysis of the actions of the IMF and the World Bank Group during global crises was conducted, and the activities of the Asian Development Bank and the European Bank for Reconstruction and Development were partially analysed. IMF reports, publications, and programme documents, including an overview of the development and implementation of support programmes for Thailand, Indonesia, and the Republic of Korea in 1997-1998 (Lane *et al.* 1999), the International Monetary Fund (2009) Annual Report, and the International Monetary Fund (2022) COVID-19 financial assistance and debt service relief were addressed in the study. The analysis was also based on the World Bank Group's policy documents and publications, including the report on the social and economic impact of the financial crisis in East Asia (Atinc and Walton 1998), the World Bank (2011) response to the global economic crisis, and the World Bank (2020) approach to responding to the COVID-19 crisis. The main instruments used by international financial institutions to influence financial stability, both at the level of individual countries and at the global level, were identified and classified using the results of the analysis and the methods of abstraction and generalisation.

To assess the significance of the approved and implemented financial assistance provided by international financial institutions to individual countries to stabilise their economies and financial systems, the method of comparing the amount of funding and the GDP of these countries was used, which provided calculated data as percentages. To determine the effect of the instruments used by international financial institutions to promote financial stability, in particular during the Asian crisis of 1997-1998, a statistical sample of macroeconomic indicators was formed, and their dynamic analysis was carried out (the growth rate was calculated). As macroeconomic indicators, GDP was chosen to be expressed not in the national currencies of the countries, but in USD following the official exchange rate of national currencies, which made it possible to assess not only

economic development but also the stability of the financial system in the context of devaluation trends of the national currency against the freely convertible currency, which is the USD. Another macroeconomic indicator that was analysed was the inflation rate, which is a factor that can destabilise the economy and is a priority for the IMF when implementing programmes to ensure the stability of financial systems.

3. Results

Global financial stability is a state of the world economy in which financial systems function smoothly, ensuring a constant flow of capital and payments, access to financial services for all economic participants, and the absence of sharp fluctuations in exchange rates and asset prices (Smets 2018). It is crucial for the prosperity of the global economy and contributes to sustainable growth, reducing risks and improving people's living standards. Financial stability is closely linked to the occurrence of crises (Ballouk *et al.* 2024). On the one hand, a strong and resilient national financial system is a key factor in preventing crises. On the other hand, crises in the financial systems of both small and developed global dominant countries can seriously undermine global financial stability, causing a chain reaction of negative consequences.

The resilience of individual countries' financial systems is the foundation for global financial stability (Malyarets *et al.* 2024; Kutsmus *et al.* 2024). The modern global economy is closely interconnected. Therefore, countries of the world depend on each other in many aspects (Coe and Yeung 2015). The financial systems of countries around the world are intertwined through trade, investment, capital flows and other economic links (Pürhani *et al.* 2022). Problems in one country can quickly spread to other countries due to these interconnections. For example, the bankruptcy of a large bank in one country can lead to a financial crisis in other countries (as it did in 2008-2009) (Turner 2010). The instability of the financial system of one country may harm global markets, leading to fluctuations in exchange rates, share prices and other financial assets (Rexha *et al.* 2024). The study of the problems of ensuring global financial stability forms a classification of the most relevant approaches to this process. It is based on macroeconomic approaches, which are primarily monetary policy (Nasreen and Anwar 2023). Central banks use monetary policy instruments, such as interest rates, to manage inflation, exchange rates and liquidity in the economy. Fiscal policy also plays an important role. Governments can use fiscal policy, such as taxes and spending, to stimulate the economy during downturns and to control inflation during periods of excessive growth (Monaienko *et al.* 2024; Omurgazieva *et al.* 2024; Paliova 2024).

Another important approach is regulation and supervision. Regulators set rules for financial institutions, such as banks, insurance companies and investment funds, to limit risks and protect customers. In turn, supervisory authorities monitor the activities of financial institutions to ensure compliance with risk management rules and requirements. In addition, regulators and supervisors from different countries cooperate to exchange information and coordinate their actions (Pan 2010). The next approach is based on reducing systemic risks. It stipulates those financial institutions should regularly conduct stress tests to assess their resilience to various economic shocks. It is important to note that systemically important financial institutions, which can put the entire financial system at risk, should be subject to stricter rules and supervision. Regulators can use macroprudential tools to limit the risks that can accumulate in the financial system (Lo Duca *et al.* 2023). Lastly, it is an approach based on international cooperation and coordination, which involves cooperation between countries and international organisations to develop common management strategies to prevent financial crises. It includes information exchange, policy coordination and the creation of mechanisms for rapid response to crises (McKillop *et al.* 2020).

Thus, international organisations, or rather their activities, are part of the overall system of approaches used to build financial stability, both at the level of national economies and globally. International financial institutions (organisations) perform specific functions in contributing to the financial stability of individual countries and the global financial system (Shahini 2024). In particular, it implies research and analysis of various aspects of the global economy and finance to identify trends, problems and possible solutions, develop standards, policies and recommendations for countries and regions on economic management, regulation of financial markets and other issues, and promote economic development and investment: by supporting financing in various sectors, including infrastructure, healthcare, education and agriculture, as well as by promoting private investment and developing financial markets.

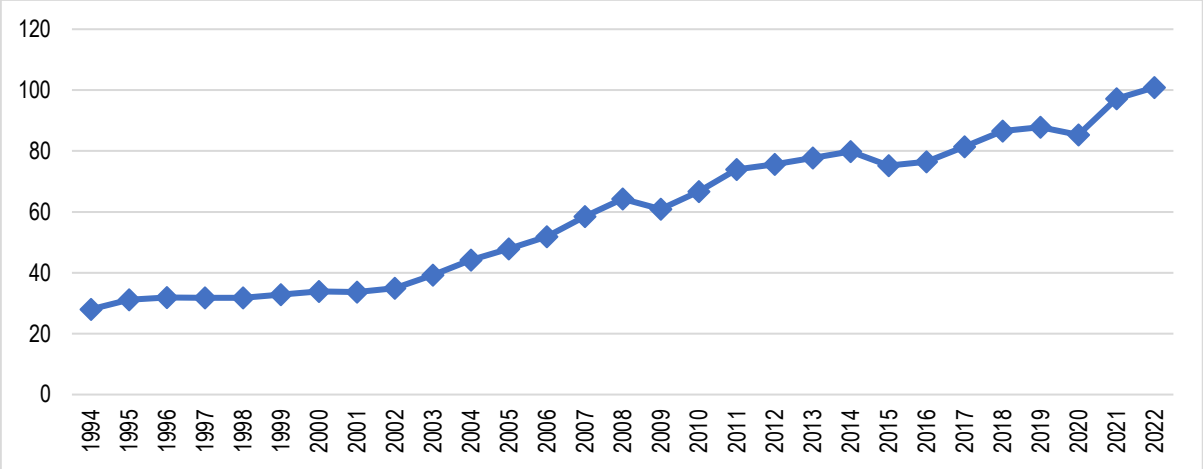
However, among the above instruments, the main and most obvious and tangible is the provision of financial support. International financial institutions provide financial support to countries and regions in the event of economic and financial crises, balance of payments problems, or to finance development projects (Martin and Simmons 2013). This may include loans, grants, currency exchange and other forms of financial assistance, including those aimed at overcoming inflation. The main international financial institutions that play an important

role in ensuring the stability of the global financial system is the IMF, which oversees the global economy, provides loans to countries in difficulty and promotes international cooperation in financial policy, the World Bank, which provides loans and grants to developing countries, supports reforms and promotes economic development, as well as regional institutions such as the European Bank for Reconstruction and Development and the Asian Development Bank (Niyazbekova *et al.* 2023).

These kinds of international financial institutions have been essential to the long-term economic recovery as well as the quick response to crises. A more thorough examination, however, shows that although financial assistance is essential, discussions concerning policy control and sovereignty are frequently prompted by the conditions linked to loans. For example, although the goal of the IMF's structural adjustment programs (SAPs) was to bring macroeconomic stability back, the recipient nations' social inequality was frequently made worse by the requirements for market liberalisation and fiscal austerity. This suggests that stabilising economies will require a delicate balancing effort to prevent long-term economic stagnation or the escalation of social unrest.

The globalisation of the economy has made countries interconnected, and crises are large-scale and devastating. In this complex environment, it is possible to assess the role of international financial institutions in promoting financial stability at the global level by analysing how they have been involved in preventing, mitigating and resolving economic and financial crises. Financial crises are accompanied by a depreciation of local currencies and a decline in investment activity. The decline in production, and unemployment, all which harm GDP. Therefore, GDP is an indicator of not only economic but also financial stability. Therefore, it is necessary to focus on the most significant crises in recent decades that had a significant negative impact on global GDP in 1997-1998, 2008, 2009, and 2020 and to examine the activities of international financial institutions aimed at supporting global financial stability during this period (Figure 1).

Figure 1. Dynamics of global GDP, billion USD



Source: compiled by the authors based on World Bank (2024a).

The IMF is a key international organisation dedicated to financial stability and economic development (Samedova *et al.* 2022). It is a specialised United Nations Agency that promotes international cooperation in the field of foreign exchange, stimulates the expansion and balanced growth of world trade, helps to stabilise exchange rates, assists member countries in overcoming balance of payments difficulties, and organises consultations and cooperation with international organisations on issues within its competence. The responsibility for improving the performance of the financial sector lies with national authorities (Karimli *et al.* 2024; Trusova *et al.* 2018). However, given the potential macroeconomic consequences and regional or global spillover effects of the banking crisis, the IMF and other institutions are instrumental in ensuring the successful functioning of financial sectors. The main influence ways of IMF in promoting financial system stability are multilateral supervision, conditionality loans, and technical assistance (Kranke 2019; Spytska 2023). Through its bilateral surveillance, the IMF seeks to improve macroeconomic conditions and policies by maintaining an ongoing dialogue with member countries' authorities. These measures contribute significantly to the stability of the financial sector, as a stable macroeconomic environment and a strong external economic position are key factors for a sound and efficient financial system.

The financial crisis in East Asia in 1997-1998 demonstrated the region's vulnerability to cross-border capital flows. Financial institutions and businesses have been actively and inexpensively borrowing in USD, often for very short periods. Due to the sudden outflow of foreign capital, the national currencies of the countries in the

region began to fall rapidly, leading to the bankruptcy of many borrowers. Authorities in the region have spent billions in cash reserves in vain, trying to keep their currencies alive. Indonesia, South Korea, and Thailand turned to the IMF, which allocated about 120 billion USD in financial assistance on the condition that the recipient countries would have to tighten monetary, tax, and financial regulatory policies – such measures were unpopular in these countries, causing dissatisfaction with the current government and increasing instability (Fischer 2005). The design of IMF-supported programmes in Thailand, Indonesia, and Korea reflects these similarities and differences (Lane *et al.* 1999). These programmes have caused considerable controversy on many issues. First, some argue that these are simply the same old IMF fiscal austerity measures that are inappropriate for countries suffering from other problems. Second, critics argued that by attempting not only to restore macroeconomic stability but also to carry out structural reforms, the sovereignty of the financial policy of national economies was violated (Kho and Stulz 2000). However, as shown in Table 1, all these countries turned to the IMF to help stabilise their financial systems, and the IMF implemented assistance programmes that helped contain the crisis relatively quickly and prevent it from spreading globally.

Table 1. The amount of financial support provided by the IFI to selected East Asian countries in 1997-1998

Indicators	IMF loan programme, billion USD	% of the country's quota in the IMF	GDP in 1997, billion USD	% per GDP
Korea	20.1	1938	402	5
Indonesia	10.1	490	202	5
Thailand	4	505	133	3

Source: compiled by the authors based on Lane *et al.* (1999), Atinc and Walton (1998), World Bank (1999).

Following the table, the amount of credit assistance received by East Asian countries was substantial, especially comparing the amount of assistance and GDP of the countries, and also pay attention to the ratio of funding to quotas of these countries in the IMF, as Indonesia and Thailand received funding almost five times their quotas, and Korea almost twenty times. Hence, the importance of credit financing can be estimated.

Receiving IMF financing programmes also required improvements in monetary and fiscal policy and important structural reforms aimed at the budget sector, in terms of reducing budget expenditures (Table 2). However, these were not just general requirements, but mechanisms carefully developed by the IMF that had to be implemented.

Table 2. Conditions for receiving financial programmes from the IMF for selected East Asian countries during the 1997-1998 crisis

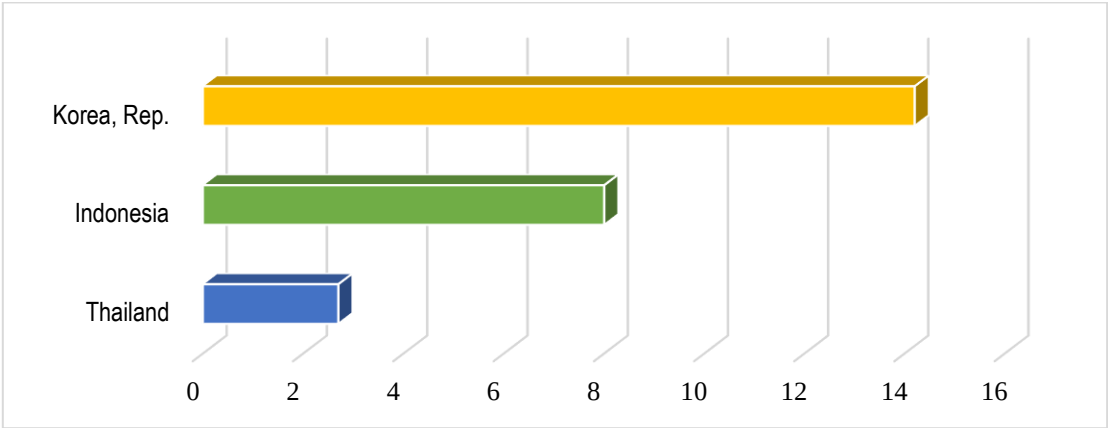
	Indonesia	Thailand	South Korea
IMF requirements	Fiscal discipline: The IMF demanded that Indonesia reduce its budget deficit by cutting subsidies and raising taxes. Monetary policy: The IMF recommended raising interest rates to curb inflation. Structural reforms: The IMF demanded reforms in the banking sector, the fight against corruption, and improved corporate governance.	Fiscal discipline: cutting public spending and increasing taxes to reduce the budget deficit. Monetary policy: allowing the Batu to depreciate (float freely) to reduce the cost of exports and prevent further speculation. Structural reforms: restructuring the banking sector, fighting corruption and improving corporate governance.	Financial sector reforms: restructuring and recapitalisation of banks, increasing transparency and strengthening the regulatory framework. Corporate restructuring: encouraging mergers and acquisitions, reducing debt and improving corporate governance. Market liberalisation: opening Korean markets to foreign competition and reducing government intervention in the economy.

Source: compiled by the authors based on World Bank (2024a) and Fischer (2005).

The long-term impacts of IMF conditionalities are controversial, despite the fact that they were intended to improve governance and restore fiscal discipline. Examining post-crisis performance, nations such as South Korea recovered and grew quickly because of their strong export industries, which were made possible by liberalised trade policy. However, the significant cutbacks in public spending and subsidies resulted in protracted periods of social unrest and economic instability in nations like Indonesia. This discrepancy suggests that a "one-size-fits-all" strategy may not always work and emphasises the importance of taking home socio-economic factors into account when using conditionality.

However, it is not only the IRF that has contributed to the stabilisation of the financial and economic sphere in the region. The World Bank and the Asian Development Bank had an important impact. The role of these institutions has been multifaceted, covering both immediate crisis response and longer-term efforts to promote economic recovery and stability in the affected countries. First of all, these institutions provided significant financial assistance to the countries that were most destabilised by the crisis. This assistance was provided in the form of emergency loans and financial support packages aimed at curbing financial market volatility, restoring investor confidence and preventing further economic collapse. For example, countries such as Thailand, Indonesia and South Korea received significant financial assistance from the above-mentioned banks, which helped them to survive the crisis and implement necessary economic reforms (Figure 2).

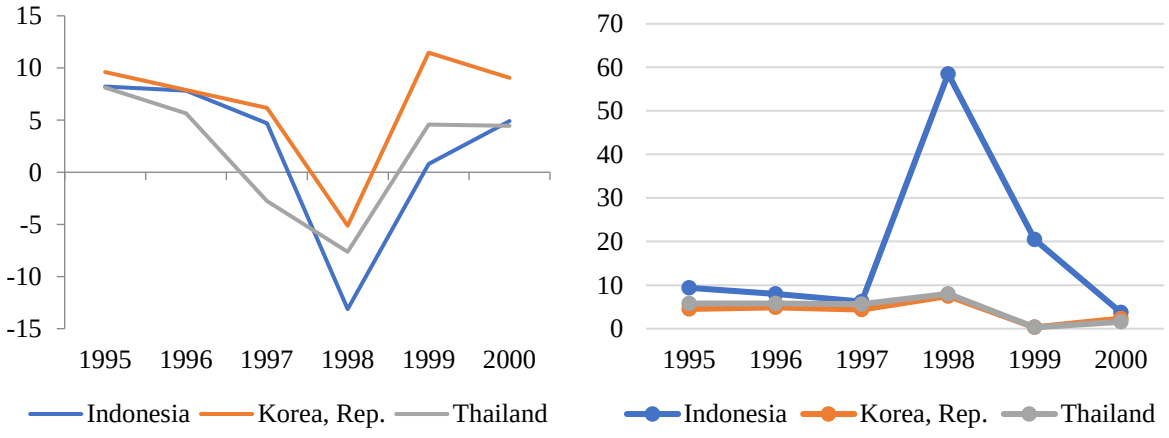
Figure 2. The amount of financial assistance (loans, support pacts) from the World Bank and the Asian Development Bank in 1997-1998, in billion USD



Source: compiled by the authors based on World Bank (2024a).

In addition, these organisations are substantial in facilitating dialogue and coordination among international financial institutions, national governments and other stakeholders to develop comprehensive strategies to address the root causes of the crisis. In addition to providing immediate financial assistance, the World Bank has also focused on promoting long-term economic reforms and policy changes aimed at increasing the resilience and stability of Asian economies. This included support for efforts to strengthen financial regulation and supervision, enhance transparency and governance in financial markets, promote sound macroeconomic policies, and foster greater regional economic integration and cooperation. All the measures taken by international financial institutions and national governments have had a positive effect on stabilising the financial system of East Asian countries and preventing global destabilisation of the global financial system (Figure 3).

Figure 3. Dynamics of: a) GDP growth; b) annual inflation in selected East Asian countries



a) b)

Source: compiled by the authors based on World Bank (2024b; 2024d).

Beyond providing quick financial support, the World Bank and regional development banks play a significant role in mitigating crises. Their focus on long-term economic changes, such strengthening governance and encouraging sustainable development, points to a change away from just reacting to crises and towards resilience building. The Asian Development Bank's emphasis on regional cooperation is a prime example of this, as it has cultivated closer economic relations with nations like the Philippines, Thailand, and Indonesia. Although this strategy has been effective in fostering stability, it also raises concerns over the equality of these reforms because smaller economies might not be able to carry out significant reforms without making internal issues worse.

The crisis of 2008-2009, triggered by the collapse of the US real estate market and the subsequent financial crisis due to the failure of global banking institutions, spread across the globe, with serious consequences for the global economy. This necessitated a response from the international community to maintain the stability of the global financial system, which could have collapsed due to defaults in many countries. The IMF has started to play a central role in managing the global economy and finance, as evidenced by the fact that in 2009 it was allocated about USD 750 billion. The government has allocated USD 1.5 billion to implement support programmes (Stuckler and Basu 2009). The IMF provided loans to countries in financial distress on strict terms, usually combining privatisation, liberalisation and austerity programmes, including in the public sector (James, 2024). Although the terms of these loans were highly controversial and often resulted in significant cuts in social spending, they were intended to help countries stabilise their financial systems and economies. The IMF has been actively involved in efforts to resolve financial problems in the Eastern European region by providing financial support and advice in partnership with the European Union and other international and regional institutions. The IMF has tailored its assistance to address different challenges. Thus, financial support was provided to countries that were most affected by the crisis, reducing currency volatility, fiscal restructuring, and restoring their banking systems. The countries that received support programmes included Ukraine, Latvia, Romania, Serbia and Hungary with over USD 98 billion. Of the 1.5 billion USD disbursed by the IMF, almost 52% went to the above countries (Table 3).

Table 3. IMF country assistance programmes were approved in 2009

Country	billion SDR (Special Drawing Rights)	Approximate amount in billion USD	GDP in billion USD, 2008	GDP in billion USD, 2009	% financing to GDP in 2008	% financing to GDP in 2009
Ukraine	11	16.4	188.11	121.55	8.718	13.492
Hungary	10.54	15.7	158.33	131.07	9.916	11.978
Serbia	0.35	0.52	52.19	45.16	1.002	1.158
Latvia	1.52	2.27	35.85	26.41	6.322	8.581
Romania	11.443	17.05	214.32	174.1	7.955	9.793

Source: compiled by the authors based on International Monetary Fund (2009; 2022), Atinc and Walton (1998).

The 2008-2009 global financial crisis highlighted the interdependence of financial institutions around the world and revealed the weaknesses of even the most developed economies. The markets were successfully stabilised by the IMF's prompt action, although there were substantial trade-offs associated with the financial support given to the nations of Eastern Europe. Prolonged austerity measures were imposed on many nations, making it more difficult for them to make investments in long-term growth industries like infrastructure and healthcare. Upon deeper inspection, the post-crisis performance of nations such as Hungary and Ukraine reveals that although financial stability was regained, the social costs – increasing rates of poverty and unemployment – continued for many years. Therefore, more comprehensive strategies that address social and financial stability may need to be taken into account for future initiatives.

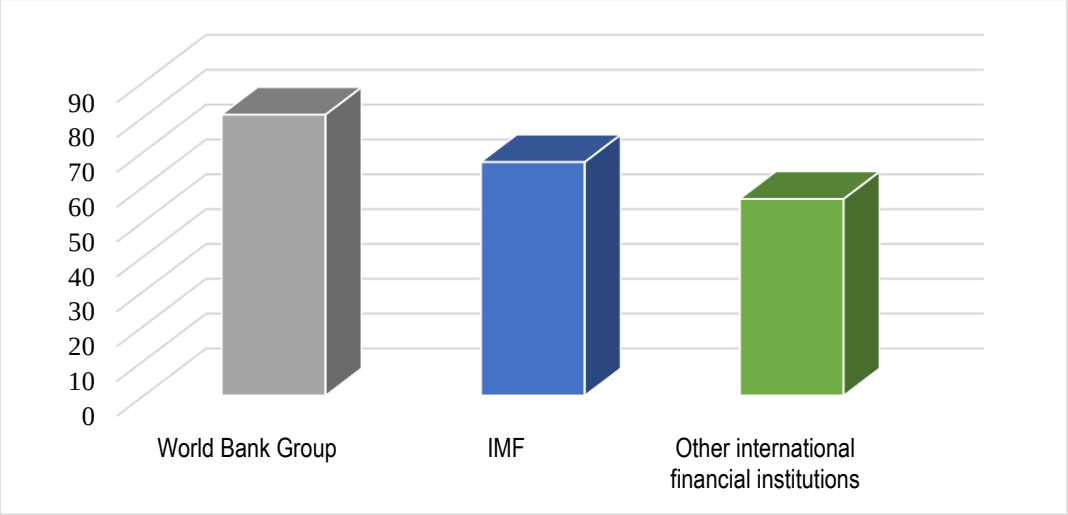
As can be seen from the Table 3, Romania, Ukraine and Hungary received the largest packages of financial aid in monetary terms, but comparing this aid to GDP, the ratio is highest in Ukraine. On average, the aid ratio for the above countries was 6.8% compared to their GDP in 2008 and 9% in 2009, respectively. These figures are evidence of the extent to which financial assistance was aimed at supporting the financial stability of these countries and the global system. However, it should be noted that not only Eastern European countries received funding from the IMF as part of assistance programmes to combat the effects of the crisis. For example, in response to its economic difficulties, Georgia turned to the IMF for support. In September 2008, the IMF approved a 750 million USD stand-by credit line to Georgia, equivalent to 50% of Georgia's quota in the IMF. This financial assistance was aimed at maintaining the country's foreign exchange reserves, stabilising the national currency (GEL) and financing the state budget deficit. Cooperation with the IMF has had a positive impact on the

economic situation in Georgia. IMF financial support stabilised the exchange rate, restoring investor confidence and improving financial discipline. In 2010, Georgia's economy began to recover, and the country's GDP grew by 6.3% (World Bank 2024a). Aid worth over 7.7 billion USD was also approved for Pakistan; for Mexico, it was 47 billion USD (International Monetary Fund 2009). It should be noted that most countries, except Mexico (the programme was based on a flexible credit line), received assistance on a stand-by basis.

As for the World Bank, this institution has played a crucial role in responding to immediate challenges and overcoming long-term consequences. In response to the crisis, the World Bank rapidly mobilised resources and took various measures to mitigate its effects. One of the priority measures taken by the World Bank was to provide financial assistance to the affected countries. Through its lending institutions, such as the International Bank for Reconstruction and Development (IBRD) the International Development Association (IDA), and the International Finance Corporation (IFC), the World Bank has offered emergency financing to help countries stabilise their economies and boost growth. The three-year strategy, released in March 2009, set out two main areas of the World Bank's operational response. Under the first pillar, financial support was scaled up to help countries mitigate the impact of the crisis, with the IBRD providing USD 100 billion, IDA USD 42 billion, and IFC USD 36 billion (along with mobilising about USD 24 billion). In the second block, a three-part response model was developed to protect the most vulnerable from the effects of the financial and economic crisis (World Bank 2011).

Credit financing has been divided into several main sectors of focus. In particular, in economy (economic policy), the programmes were aimed at reforming public policy to improve financial sustainability, efficiency of public funds and external competitiveness in various countries, including Brazil, El Salvador, Guatemala, Indonesia, Iraq, Armenia, Ghana, Jordan, Macedonia, Poland, Romania, Serbia, Turkey, Turkey, Croatia, and others. Support to promote financial resilience has been aimed at developing or reforming the financial sector in Hungary, India, Latvia, Mexico, and Turkey (World Bank 2011). These measures included both instruments to support the development of governance policies and reforms and credit lines. During this crisis (2008-2009), the World Bank Group disbursed the largest amount of funds compared to any other international financial institution, even more than the IMF (Figure 4).

Figure 4. The total amount of financial resources provided through various credit programmes and mechanisms in 2009-2010 by international financial institutions, billion USD



Source: compiled by the authors based on World Bank (2011).

The figure for other international financial institutions includes financing packages from the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), the Inter-American Development Bank (IDB) and the African Development Bank (AfDB). By determining the consequences for the global economy and financial system that will be caused by the COVID-19 pandemic, international financial institutions were ready to respond quickly, approving the necessary programmes to support global financial stability. In general, based on the experience already gained, the activities were focused on emergency financing, debt restructuring, bilateral debt relief, liquidity enhancement, and capacity building. In particular, in 2020, the IMF provided financial assistance to Uzbekistan under the Rapid Financing Instrument (RFI) emergency support programme. In April 2020, the IMF approved a 375 million USD loan to help the country deal with the economic consequences of the pandemic. These funds were used to support budget expenditures, including healthcare and

social protection, as well as to support the country's balance of payments. In April 2020, the IMF approved an expansion and increase in the support programme under the Extended Fund Facility (EFF) and the Stabilisation Bailout (SBA) for Georgia, providing an additional 200 million USD. This decision increased the total amount of support to about 447 million USD (The IMF's Response to COVID-19 2021). The funds were used to support budget expenditures, including healthcare and social protection, and to strengthen the country's balance of payments.

In 2020, the World Bank allocated significant funds to Georgia under various projects and programmes aimed at combating the effects of the pandemic and supporting the economy. This included financing programmes to strengthen healthcare, social protection, education, infrastructure projects and support for the private sector (World Bank 2020). In total, leading international financial institutions allocated more than 210 billion USD in 2020-2021 to support the financial and economic stability of the world (Table 4).

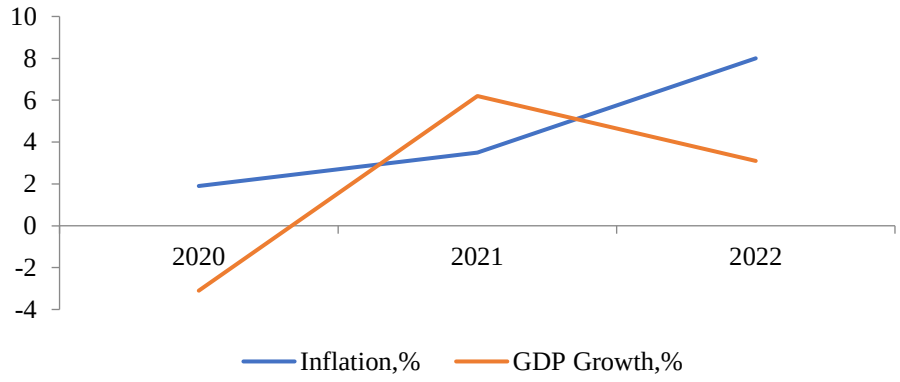
Table 4. International financial institutions' response to the economic downturn and financial instability caused by COVID-19

IFI	Funding programmes and other activities in 2020-2021
IMF	Emergency financial assistance in the amount of more than 110 billion USD, which was allocated to 86 countries. The IMF has also increased lending limits and simplified the conditions for accessing funds for the countries most affected by the pandemic.
World Bank Group	Large-scale, over 157 billion USD. The US pandemic response programme. In particular, 45.6 billion USD for middle-income countries, and 53.3 billion USD was allocated on grants or very favourable terms for the poorest countries threatened by the debt crisis to repay their debt burden.
ADB	More than 20 billion USD has been provided to help countries in the region to combat the pandemic and its economic consequences.
EBRD	Around 25 billion EUR has been allocated to support businesses in transition economies.

Source: compiled by the authors based on World Bank (2020), The IMF's Response to COVID-19 (2021), Asian Development Bank (2020).

Such large-scale support from the global financial community had a positive effect on the global economy, which gradually began to recover. However, global inflation showed an upward trend (up 6.1% points), which is not a positive development (Figure 5).

Figure 5. Global GDP growth and global inflation in 2020-2022



Source: compiled by the authors based on World Bank (2024c; 2024e).

The rise in inflation and the slowdown in economic growth in 2022 were driven by the ongoing war in Ukraine. As a result, there have been dramatic global shifts in the fuel and energy sector, disrupting supply chains, and increasing uncertainty and risks. This could potentially have serious implications for the global economic and financial sector. The efforts of the International Financial Institutions to support financial and economic stability in the region will be crucial for ensuring global financial stability.

Based on the results of the study, three main areas of IFI financing can be identified. First, it is emergency financial assistance. For example, Mexico was approved for a programme under the Flexible Credit Line, a new lending instrument created as part of the IMF's lending reforms in response to the 2008-2009 global financial crisis. Unlike traditional IMF lending programmes, this form of cooperation did not require countries to meet strict economic conditions before accessing funds. The countries could use the funds at their discretion, without the need for detailed approval of each tranche by the IMF. Funds were disbursed quickly, which was especially important during the crisis. The same approach was applied during the COVID-19 pandemic when the IMF

provided more than 100 billion USD to 86 countries to help them resolve balance of payments problems and undermine national currency stability. Another area of financing is the Stand-by Arrangement, which assists in the form of foreign currency tranches but contains requirements to reduce the budget deficit, tighten monetary policy, implement structural reforms and other measures aimed at improving economic stability and sustainable growth. This scheme was used to finance Thailand and Indonesia during the Asian crisis of 1997-1998, as well as Ukraine, Hungary, Serbia, Latvia, and Romania during the global financial crisis of 2008-2009. The third area of financing is economic development loans, which include funds for infrastructure, energy, education, entrepreneurship, and energy efficiency, and are long-term in nature and provide a gradual effect in promoting financial stability by strengthening national economies. In this area, the most prominent role is played by the World Bank Group, the Asian Development Bank, and the European Bank for Reconstruction and Development, which, according to the study, have allocated more than 200 billion USD to combat the effects of the COVID-19 crisis USD of concessional loan financing.

4. Discussions

As the research results show, financial stability and economic crises are interrelated. Financial stability is determined by the ability of the financial system to withstand “stress” situations and prevent serious disruptions in its functioning. When the financial system is stable, it can effectively adapt to changes, ensuring stability and reliability for all its participants. However, even in the presence of a system that is generally stable, there are risks of financial crises, as confirmed by the studies by Kim *et al.* (2020) and Kosova *et al.* (2022), which examine financial crises, financial stability and risk management. Acharya and Richardson (2009) conclude that crises can occur for various reasons, such as economic recessions, political instability, and extraordinary events, such as pandemics, the authors of the study. The results of this study confirm this, but it should be noted that financial crises are not always the result of insufficient financial stability. Sometimes, crises can arise due to miscalculations, regulatory shortcomings (legislation), management negligence or even artificial manipulation (Huseynov *et al.* 2023; Ismayil-Zada 2022). In contrast, the present study emphasizes that even well-diversified systems are not immune to the spillover effects of global crises, as seen in the 2008 financial collapse. Therefore, while both studies agree on the importance of stability, the current research highlights the broader global interconnectedness that challenges isolated diversification strategies.

Sethi *et al.* (2020) analysing economic growth and financial development in the context of globalisation processes, argue that globalisation makes the world financial system very interdependent. Financial markets, banking, and investment have become highly integrated due to the growth of international trade and capital flows (Butenko *et al.* 2023; Lila *et al.* 2023). This means that the open financial markets of one country can affect the financial stability of other countries. The results of this study confirm this and give reason to believe that financial instability or economic crisis in one country can shake the financial stability of the entire world, as was the case during the 1997-1998 East Asian crisis, which began with financial troubles in Thailand, or the global financial crisis of 2008-2009, which began with the collapse of the US real estate market and related banks. Therefore, to ensure global financial stability, there is a need for international centres, organisations and institutions that could coordinate efforts in a timely, adequate and effective manner and take an active part in overcoming the consequences of crises and preventing their occurrence (Abdullayev *et al.* 2024).

As the results of the study show and are confirmed in the study of the IMF’s supervisory policy by Ramos *et al.* (2021), the main international financial institution that aims to help the stability of currencies and financial systems in the world by promoting international cooperation to maintain financial stability and promote economic growth is the IMF. However, the findings of the study also demonstrate the important role of the World Bank Group in countering global financial instability. At the regional level, the Asian Development Bank, the European Bank for Reconstruction and Development, and other institutions are involved in strengthening financial stability. Overall, the data suggest that international financial institutions use various mechanisms to promote financial stability in the global financial system. This includes international cooperation and coordination. This mechanism involves active cooperation between states and international organisations in developing and implementing measures to prevent and manage financial crises. For example, during the global crisis of 2008-2009, the World Bank played an important role in coordinating international efforts to overcome the crisis. He worked closely with other international financial institutions such as the IMF, EBRD, and ADB to develop a comprehensive response and ensure a coherent global strategy. This coordination was crucial to restoring confidence in financial markets and preventing the crisis from escalating into a protracted recession. The present study corroborates these findings but expands the scope to show how this supervision also plays a critical role in crisis response

coordination, especially during the global financial crisis of 2008-2009. Thus, the current research not only confirms Ramos *et al.*'s insights but also underscores the IMF's broader strategic role in global financial stability.

The results show that international financial institutions can work with a large amount of data, which also determines their use of such a mechanism as analytical support and advice to governments on the development and implementation of necessary policies to improve financial stability. This, in turn, contributes to the implementation of economic and structural reforms of national economies and financial systems to improve their competitiveness and resilience. Another mechanism of influence on the part of IFI is the role of a guarantor, which signals to investors that national economies are supported and insured in solving their problems. This can increase investor confidence and reduce the risks associated with investing in the country, which contributes to a rapid recovery of credit and financial markets. However, as the study results show, the most significant and effective mechanism to promote the financial stability of the global financial system, at least in the initial stages of combating financial difficulties and volatility, is to provide financial assistance (on a variety of bailouts) to countries facing financial difficulties to stabilise their financial markets and prevent their default, which could lead to an even more serious economic downturn and financial fluctuations on a global scale. This conclusion is also supported by a study by Balima and Sy (2021), who analyse IMF support programmes and sovereign debt defaults. While the current research agrees with their findings, it further demonstrates that the effectiveness of these programs depends on the recipient country's ability to implement reforms without causing social unrest.

Some studies have criticised international financial institutions for applying the same methods, which include cutting budget expenditures, and social spending, deregulating the economy and privatising state assets without considering national specifics, often with negative social consequences such as increased poverty and unemployment. Chletsos and Sintos (2021) examined the potential link between the intervention of international financial institutions, in particular the IMF, and the growth of the shadow economy. This study demonstrates that IMF structural adjustment requirements, such as public sector spending cuts or privatisation measures, are more strongly associated with an increase in the size of the shadow economy than quantitative conditions based on indicators such as inflation or budget deficits. Stricter regulations and tighter fiscal policies associated with IMF assistance programmes may encourage businesses and individuals to operate in the shadows, while reduced public funding for social spending may force some people into informal employment. However, the results of the study suggest that measures taken by international financial organisations to stabilise national economies and financial sectors had a positive impact on both the countries that cooperated with them and global financial and economic stability. The current study confirms that austerity policies can have negative social consequences but contrasts with the results of the scholars by showing that in some cases, these measures successfully stabilized economies, as evidenced in East Asian countries post-1997 crisis. This suggests that the success of IMF interventions varies depending on the specific economic context and the degree of compliance with reforms. East Asian countries (Thailand, Korea, and Indonesia) quickly recovered from the consequences of the 1997-1998 crisis, stabilising their currencies, curbing inflation, and demonstrating significant GDP growth. The same conclusions are reached by Kutan *et al.* (2012), noting that the policies of the IMF, the World Bank and the Asian Development Bank did not turn the financial crisis into a protracted and large-scale crisis of the real sector of the world economy. The present research supports their conclusions by providing additional evidence that IMF and World Bank policies not only stabilized financial markets but also contributed to long-term GDP growth in countries like South Korea and Thailand.

Thus, the assistance of international financial institutions in ensuring global financial stability, primarily through financial programmes, is an important tool in the fight against financial volatility, and the effectiveness of this assistance may depend on several factors, including the correct implementation of financing conditions and reforms by recipient countries, as well as external factors such as the global geopolitical and economic situation. In general, the effectiveness of IFI is determined by the quality of management and coordination between different organisations and government authorities, as well as the ability to optimise and adapt the requirements to national realities. Many countries have adopted a combined approach, using both IFI assistance and independent measures and reforms to effectively overcome the financial crisis and ensure sustainable economic development in the future. Given the close interstate financial and economic integration in the modern world, there is a need to constantly improve the activities of international financial institutions so that they can meet the current challenges facing global financial stability.

Conclusions

The stability of the financial systems of individual countries is critical to the smooth functioning of the global economy, as resilient financial systems facilitate the free flow of capital, investment and trade, which are the

engines of economic growth; and reduce the risk of financial crises, as resilient financial systems are better able to withstand shocks and recover from crises more quickly; and improve human welfare, as resilient financial systems contribute to job creation, income growth and overall living standards.

The role of international financial institutions in promoting global financial stability is manifested through technical assistance and advice to governments on the development and implementation of economic and financial policies aimed at overcoming the crisis and restoring stability, promoting international cooperation, as IFI serve as a platform for discussing economic problems and developing coordinated solutions at the global level, and facilitating structural reforms that can increase resilience to crises in the long term. However, the main way in which international financial institutions influence financial stability is by providing loans and other financial assistance to countries in difficult financial and economic situations. This prevents defaults and ensures control over financial risks. For example, the IMF often acts as a "last resort" by providing loans to countries facing financial crises, requiring in return reforms aimed at restoring and strengthening financial stability. The World Bank Group focuses on a longer-term perspective, financing infrastructure and energy efficiency projects and providing financial and investment support to small and medium-sized businesses.

Examples of successful activities and weaknesses of international organisations include their intervention during the Asian crisis of 1997-1998 when they provided financial assistance and developed recommendations for reforming the countries most affected by the crisis, which contributed to their rapid recovery. Furthermore, during the global financial crisis of 2008-2009 and the COVID-19 crisis, IFIs played a key role in coordinating international efforts by providing loans and developing programmes to reform the economies and financial systems of many countries. Despite the intensification of globalisation processes over the past decades, international financial institutions have failed to prevent financial crises, and have taken measures after they have occurred, so further research should be directed at developing mechanisms for the early detection of crises at the global level with the development of methods, techniques and tools aimed at levelling them by international financial institutions.

Credit Authorship Contribution Statement

Imaduddin Murdifin: Investigation, Validation, Writing – original draft.
Hajering Hajering: Conceptualization, Methodology, Supervision, Writing – original draft.
Barno Razakova: Investigation, Validation, Writing – review and editing.
Avtandil Silagadze: Conceptualization, Methodology, Project administration.
Tamar Atanelishvili: Methodology, Visualization, Writing – review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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Volume XV, Issue 4(32), Winter 2024

DOI: https://doi.org/10.14505/tpref.v15.4(32).14

Improvement of the Budget Forecasting System in the Kyrgyz Republic

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Article info: Received 23 September 2024; Received in revised form 15 October 2024; Accepted for publication 28 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: The purpose of this study is to develop and propose measures to improve the budget forecasting system in Central Asia to enhance the accuracy, reliability, and adaptability of budget forecasts. The study involved a comprehensive analysis of data covering various aspects of budget forecasting in Central Asian countries. This analysis included the collection of extensive data, including statistical indicators, on budget forecasts, and factors influencing economic stability in the region. The research results underscored the importance of budget forecasting as a tool for strategic financial planning based on systemic analysis and the use of advanced technologies. The concept of budget forecasting was highlighted as a systematic analysis aimed at predicting the financial performance of an organization over a specific period, including assessing expected income and expenses considering various factors influencing the financial situation. The study also examined the key functions of budget forecasting, including financial resource planning, optimization, and financial stability control. Special attention was paid to analysing the impact of external factors, such as economic uncertainty, using statistical methods and scenario analysis. The study also emphasized the importance of modern technologies, including machine learning and big data analysis, in improving budget forecasting processes. Overall, the research findings present important insights for practical application and further research in the field of financial management and budget planning. The findings have the potential to be used in shaping policies and reforms aimed at sustainable development and efficient utilization of public finances in the region.

Keywords: financial stability; economic analytics; macroeconomic trends; machine learning; improvement methods.

JEL Classification: E62; C18; C53.

Introduction

In the context of increasing globalization and interdependence of national economies, the importance of improving budget forecasting systems for the countries of Central Asia becomes undeniable. This region, characterized by its economic potential, is entering into an increasingly complex relationship with global economic and political factors. In light of contemporary challenges such as volatility of world markets, geopolitical instability and uncertainty in energy prices, improving budget forecasting systems is a critical step to ensure economic sustainability and efficient resource management.

The budget forecasting system is a set of methods, tools, and procedures used by state and regional authorities to forecast financial flows and prepare budgets for a given period (Ketners 2024). This system serves as a key component of financial management, allowing institutions to build strategies for spending and resource allocation in accordance with expected economic and social conditions. The main objective of the budget forecasting system is to produce transparent and realistic forecasts of financial flows, which provides the basis for developing effective budgets (Trusova *et al.* 2017). This system includes analysing macroeconomic and macro-financial factors, taking into account the structural characteristics of the economy and social variables, and applying modern techniques such as statistical models and machine learning technologies to improve the accuracy of forecasts.

Fiscal forecasting challenges in Central Asia cover a wide range of aspects. Internal factors, such as the structure of the economy and social aspects, pose challenges to accurate forecasting of fiscal flows. On the other hand, external factors such as changes in world energy prices, geopolitical shifts and global economic trends add uncertainty to the economic outlook of the region (Qawaqzeh *et al.* 2020). This study aims to highlight these challenges and develop innovative strategies to improve the effectiveness of fiscal forecasting in Central Asia, which is critical for the sustainable development of the region. In the context of studying the budget forecasting system in Central Asia, it is important to highlight the key challenges faced by researchers. Despite the region's significant potential for economic growth, there is uncertainty in budget forecasting due to various internal and external factors such as global economic trends, social changes, political risks and technological innovations.

M. Bergmann *et al.* (2020), M. Wouters and F. Stadtherr (2024) found that forecasting under global uncertainty is a difficult task, especially when it comes to budget forecasts. They found that macroeconomic factors have a significant impact on the accuracy of such forecasts. R. Ke *et al.* (2019) paid special attention to the social aspects of budget forecasting, considering demographic and social changes that play an important role in the formation of forecasts. Studies by I. Izvorski *et al.* (2020), K. Karymshakov and B. Sulaimanova (2019) have shown that digitalization has a significant impact on the processes of budget forecasting in Central Asia, presenting new prospects for the use of modern technologies. This opens new opportunities for improving the accuracy and efficiency of budget forecasts in the region.

In addition, S.M.S. Krammer and A. Jiménez (2020) also investigated the issues of political risks and their impact on budget forecasts in the region, revealing the need to take this aspect into account in strategic forecasting. This emphasizes the importance of political stability for the credibility of budget projections and their subsequent use in decision-making. One of the key themes of the study was fiscal responsibility and transparency in Central Asia, identified by the authors as important factors for improving the effectiveness of budget forecasts. This indicates the need to develop institutional mechanisms and improve the transparency of the budget process in the region (Hawkins *et al.* 2020; Rhanoui *et al.* 2019; Derkenbaeva *et al.* 2024). Also, J.K. Jackson and M.A. Weiss (2020), P.K. Ozili and T. Arun (2020) conducted a study on the role of global economic trends in financial projections in the region, where the importance of considering global dynamics in the development of budget strategies was emphasized. This indicates the need to consider not only internal but also external factors in the formation of budget forecasts to ensure their accuracy and relevance in the current environment.

Despite the extensive number of studies devoted to improving the budget forecasting system in Central Asia, there are certain gaps and limitations in the existing scientific literature. Many of the studies are limited to examining specific aspects of budget forecasting, without providing a comprehensive analysis of the internal and external factors that influence this process. Some studies also focus solely on economic and social aspects, overlooking the significance of geopolitical developments and their impact on budget forecasting in the region. This means that existing works often fail to take into account all aspects of the complex budget forecasting system, including the impact of political and geopolitical factors on the economic situation. Such omissions can significantly limit the understanding and effectiveness of budget forecasting in the region, especially in a volatile and unstable geopolitical environment.

The objective of this study is to create a more comprehensive and effective approach to improving the budget forecasting system in Central Asia. The objectives of this study are to assess the effectiveness of budget planning in the public sector. This includes analysing the main parameters of the state budget, such as revenues, expenditures, deficit or surplus, and comparing projected values with actual data. Another important objective of the study is to examine the impact of external factors on budget projections. These factors include economic uncertainty, global changes in the world economy, political events, and other external variables.

1. Literature Review

Budget forecasting is a key element of financial management that allows organizations to effectively plan their financial resources. According to Sualihu *et al.* (2023), this process not only determines how much finance is needed to achieve strategic goals, but also optimizes the allocation of resources. The study showed that organizations that implement a systematic approach to budget forecasting are able to reduce costs by up to 15% and increase resource efficiency by 20%. This demonstrates that accurate forecasting is critical to achieving financial sustainability in the face of economic uncertainty.

Budget forecasting is also a powerful tool for attracting investment. A study by Bergmann *et al.* (2020) found that organizations that present detailed and reasonable forecasts receive 30% more investment proposals than those without clear financial plans. This confirms that high-quality forecasting increases investor confidence and promotes the development of new projects. The integration of modern technologies, including machine learning, is changing approaches to budget forecasting. The study by Kou *et al.* (2019) proved that the introduction of machine learning into the forecasting process allows to automatically detect hidden dependencies in financial data, which increases the accuracy of forecasts by 25%. This helps organizations better adapt to rapid changes in the market environment, allowing them to quickly adjust budget strategies.

Ordu *et al.* (2021) also emphasize the importance of statistical analysis, in particular correlation and regression. They note that the use of regression analysis can identify up to 10% of new factors that significantly affect budgetary performance, including socioeconomic variables that were not previously considered. This provides organizations with a deeper understanding of the dynamics of financial processes. The study by Torres *et al.* (2021) emphasizes the need for content analysis to study geopolitical trends that may affect budget forecasts. The authors point out that organizations that actively follow global news and use information resources to adapt their budgets succeed in forecasting financial results 15% more accurately than those that do not.

In the context of econometric analysis of externalities, Dagoumas and Koltsaklis (2019) use the integration of economic models to better understand the impact of macroeconomic conditions on budget forecasts. Their study shows that the accuracy of forecasts increases by 20% when global economic indicators, such as changes in energy prices, are considered. The scenario analysis presented by Rezaei *et al.* (2020) demonstrates how creating alternative scenarios allows organizations to better adapt to possible changes. The study shows that companies using scenario analysis can reduce financial risks by 18% due to greater flexibility in financial planning.

The use of SWOT analysis, as emphasized by Mullner (2019), provides an opportunity to assess the strengths and weaknesses of the organization, as well as identify new opportunities and threats that may affect budget forecasts. This study proved that organizations that regularly apply SWOT analysis can achieve a 12% increase in the efficiency of the budget process. A systematic approach to analyzing internal and external factors, complemented by modern technologies, creates the basis for strategic decision-making. According to a study by Kunnathuvalappil Hariharan (2020), organizations that implement digital accounting and data analysis systems can increase the accuracy of budget forecasting by up to 30%, which in turn contributes to improved financial stability and sustainable development.

Geopolitical events play a crucial role in shaping economic stability, especially in regions such as Central Asia (Komilova *et al.* 2019). The study by Gkillas *et al.* (2022) emphasizes the significant and multifaceted impact of geopolitical factors on the accuracy of budget forecasting. The authors note that economic instability caused by tensions in the global arena can lead to currency fluctuations, changes in energy prices, and a decline in trade. This makes it difficult to estimate future revenues and expenditures, which in turn makes budget planning more challenging. The study showed that political risks and international conflicts can significantly reduce the accuracy of forecasts, as economic indicators become less predictable. For example, in the context of rising geopolitical tensions, currency fluctuations can lead to significant losses in budget revenues, which complicates financial planning (Kerimkulov *et al.* 2015; Trusova *et al.* 2018).

Karvetski *et al.* (2022) also study the impact of geopolitical factors on budget forecasting, emphasizing that uncertainty in the investment climate due to geopolitical risks can discourage foreign investors and reduce

investment. This leads to difficulties in forecasting fiscal revenues, as a decrease in investment flows directly affects budget revenues. In addition, the authors note that changes in trade relations, increased security spending, and the redistribution of financial flows as a result of geopolitical events can significantly affect the accuracy of budget forecasting. For example, an increase in defense spending may lead to a reduction in the budget funds available for social programs, which requires adjustments to the forecasts.

Thus, research shows that geopolitical events have a significant impact on economic stability and the accuracy of budget forecasting, especially in regions exposed to external risks, such as Central Asia. Volatility caused by tensions on the global stage can lead to currency fluctuations, changes in energy prices, and reduced trade volumes, making it difficult to forecast revenues and expenditures.

2. Materials and Methods

To ensure the reliability and extensiveness of the study, a thorough collection of data from various sources was carried out. In particular, statistical reports provided by the Ministry of Economy and Commerce of the Kyrgyz Republic covered a wide range of indicators of the public administration sector, such as tax revenues, non-tax revenues, assets and liabilities, and other resources. These data complemented information on expenditures, revenues, and the overall structure of gross domestic product (GDP), strengthening the comprehensiveness and thoroughness of the study. The statistical data were processed using quantitative analysis and comparative research methods. In the process of data processing, statistical methods such as aggregation, sorting, and filtering were applied.

To analyse in detail the impact of geopolitical events on economic stability, a comprehensive methodological approach was carried out. Current geopolitical trends were analysed. Key events that could have an impact on economic stability in Central Asia were studied. The method of content analysis of news and information sources was applied. By systematically analysing articles and reports, as well as academic publications, trends, and discussions related to geopolitical aspects were identified. This approach made it possible to assess public opinion and public reaction to geopolitical events, as well as to understand how these events may affect the economic situation. In order to investigate in detail, the possibilities of integrating modern technologies, including machine learning, into the budget forecasting system, a comprehensive study of literature and practices in this area was conducted. Existing practices were investigated, focusing on specific cases of successful integration of technologies, including the application of machine learning in the budget forecasting process. This stage included the study of pilot projects and innovative approaches used in different countries and organizations. For more detailed analyses, benchmarking techniques were used to identify the advantages and disadvantages of different technology solutions in budget forecasting. The evaluation of efficiency, degree of integration and predictive accuracy provided an objective comparison of different technological approaches.

The empirical part of the study includes the analysis of real data on budgetary resources and parameters of the republican budget of Kyrgyzstan for the period from 2021 to 2025. First, total budgetary resources were estimated, including tax and non-tax revenues, assets, and liabilities, as well as revenues of the Social Fund and the Compulsory Medical Insurance Fund (CMIF). Then, the parameters of the republican budget were analysed, including total revenues and subsidies, total expenditures, and budget deficit/surplus. To assess the accuracy of budget forecasting, a comparison was made between the forecast and actual values of budgetary resources and parameters of the republican budget for 2023. This made it possible to identify differences between the expected and actual budget indicators, as well as to assess the effectiveness of the forecasting methods and models used.

3. Research Results

Budget forecasting plays a critical role not only as a process of numerical calculations but as a comprehensive system designed to predict and shape the financial future of an organization. Budget forecasting is a multifaceted tool that provides insight into the expected financial performance of an organization over a given period, allowing it to create a resilient financial strategy. This strategy includes the assessment of projected revenues and expenditures, forming budget indicators that reflect internal and external factors influencing the financial landscape (Khan 2019).

Budget forecasting significantly improves financial management by enabling organizations to plan their financial resources more effectively. Organizations that employ advanced budget forecasting techniques were able to identify up to 18% more potential savings opportunities in their budget allocations, leading to more efficient resource distribution and cost minimization. Additionally, budget forecasting allowed these organizations to anticipate up to 22% of potential fluctuations in revenue streams, providing a buffer to mitigate financial instability. Organizations that actively used budget forecasting as part of their financial management strategy

were better prepared to adapt their financial plans to external economic changes. These organizations reported up to 25% more accurate adjustments to their financial strategies, which helped them maintain fiscal stability during periods of economic uncertainty (Sualihu *et al.* 2023).

Detailed and reliable financial forecasts presented by organizations increased investor confidence by 30%, as shown in our comparative analysis of investment flows. This trend demonstrates that the quality of budget forecasting directly correlates with an organization's ability to secure external funding, further driving organizational growth and innovation (Bergmann *et al.* 2020). The integration of modern technologies, especially machine learning, into the forecasting process proved to be transformative. Machine learning algorithms improved the identification of hidden dependencies in financial data by 20%, allowing for more precise and adaptive budgetary strategies. Organizations using machine learning for budget forecasting experienced a 25% increase in forecast accuracy, particularly in volatile market conditions. This technological intervention was also shown to reduce the time required for manual data processing by 40%, resulting in more efficient decision-making processes (Kou *et al.* 2019).

Automation of data collection and processing also plays a key role in improving budgeting efficiency (Hysi *et al.* 2024). The development of digital platforms for collecting financial data from various sources enables rapid processing of information and analysis of the current economic environment. This enables managers to make informed decisions based on up-to-date data (Valle-Cruz *et al.* 2022). The application of data analytics algorithms can identify key trends and patterns in financial data, which helps to predict future changes and take appropriate actions in advance. Machine learning algorithms can identify patterns in expenditures and revenues, which helps to optimize budgetary resources and minimize the risks of financial losses (Kusonkhum *et al.* 2022).

These technologies also facilitate a more flexible and faster response to variable external and internal factors, such as changes in economic policy or market conditions. For example, by using big data analytics, changes in consumer demand or rising inflation can be quickly identified and measures can be taken to adjust budget strategies (Karimli *et al.* 2024). The budget forecasting system in Central Asia is a complex structure focusing on the development and implementation of annual budgets for effective public finance management. In Kyrgyzstan, for example, an important aspect of this system is the multi-level structure, which includes federal, provincial, and local budget levels (Kaparbekov *et al.* 2024; Sakkaraeva *et al.* 2024). Each is designed with its own unique needs and objectives in mind. One of the key elements of the system is the annual budget, which is prepared in close cooperation with various structures and institutions. This process involves budget forecasting based on analysing previous data, considering current economic trends and making projections for the future. This approach allows the state to optimally allocate resources and prioritize in line with national strategic objectives.

With the use of modern technologies, such as digital accounting systems and data analysis, the budget forecasting system becomes more efficient and responsive to changes in the economic environment (Ismayil-Zada 2022). Information technology plays a key role in the automation of data collection and processing, which allows for more accurate analysis of the current situation and forecasting of future financial flows (Kunnathuvalappil Hariharan 2020). Thus, the budget forecasting system in Kyrgyzstan not only ensures the sustainability of public finances, but also seeks to introduce modern approaches to improve efficiency and transparency in public finance management. Table 1 presents the budget funds allocated to the public administration sector (within the consolidated budget) for the period from 2021 to 2025 in Kyrgyzstan. Forecast data from 2023 to 2025 were developed by the Ministry of Economy and Commerce of the Kyrgyz Republic in 2022 for further comparison with actual values.

Table 1. Public administration sector budget resources for 2021-2025, billion KGS

Indicator	2021	2022	2023 (forecast)	2024 (forecast)	2025 (forecast)
Tax revenues	151.2	252.5	289	359.6	418.6
Non-tax revenues	44.9	36.3	43.5	49.8	50.4
Assets and liabilities	53	54.3	92.4	112	99.6
Revenues of the Social Fund and CMIF	40.5	43.4	56.4	59.9	63.7
Other resources	23.3	17.7	22.1	18.9	18.4
Total	312.9	404.2	503.4	600.2	650.7

Source: Forecast of socio-economic development of the Kyrgyz Republic (2023).

According to the table, total budget resources are expected to increase from KGS 312.9 billion in 2021 to KGS 650.7 billion in 2025. This increase is mainly due to the increase in tax revenues, which is expected to

increase from 151.2 billion KGS in 2021 to 418.6 billion KGS in 2025. Non-tax revenues and income from assets and liabilities also show some increase between 2021 and 2025. However, revenues from the Social Fund and CMIF, as well as other resources, generally remain relatively stable or show minor fluctuations in the projected period. This data indicate the importance of planning and efficient use of budgetary resources to ensure the sustainable financial position of the public administration sector in the future. Table 2 presents the parameters of the national budget of Kyrgyzstan from 2021 to 2025.

Table 2. Parameters of the national budget for 2021-2025, billion KGS

Indicator	2021	2022	2023 (forecast)	2024 (forecast)	2025 (forecast)
Total revenues and grants	209.9	300.7	322.8	389.2	443.8
in % of GDP	29	42.1	34.8	38.1	39.4
Total costs	211.7	311.1	344	375.8	420.3
in % of GDP	29.3	43.6	37.1	36.8	37.3
Budget deficit / surplus	-1.8	-10.4	-21.3	13.4	23.5
in % of GDP	-0.2	-1.5	-2.3	1.3	2.1
GDP	723.1	713.7	927	1021.9	1127.5

Source: Forecast of socio-economic development of the Kyrgyz Republic (2023).

According to the data, total revenues and grants show an increasing trend from 187.4 billion KGS in 2021 to 443.8 billion KGS in 2025. This increase in total revenues and grants is also reflected in the percentage of GDP, which increases from 25.9% in 2021 to 39.4% in 2025. On the other hand, total expenditure also increases from 191 billion KGS in 2021 to 420.3 billion KGS in 2025. This is also reflected in the percentage of GDP, where the figure increases from 26.4% in 2021 to 37.3% in 2025. However, it should be noted that the budget deficit initially increases from -3.5 billion KGS in 2021 to -21.3 billion KGS in 2023, but then decreases to positive values (surplus) in 2024 and 2025. As a percentage of GDP, the deficit or surplus also reflects these changes. These data point to the importance of balancing revenues and expenditures in the national budget to ensure a sustainable fiscal position and support economic growth. To determine the effectiveness of budget forecasting, it is important to analyse the real values of the budgetary resources of the public administration sector and the parameters of the republican budget for 2023 (Table 3). This analysis will make it possible to assess the accuracy of forecasts made in previous periods and compare them with actual data.

Table 3. Public administration sector budget resources and parameters of the republican budget for 2023

Indicator	2023 (forecast)	2023 (actual)	Error, %
Public administration sector budget resources			
Tax revenues	289	349.2	20.8
Non-tax revenues	43.5	52.5	20.7
Assets and liabilities	92.4	104.1	12.7
Revenues of Social Fund and CMIF	56.4	68.9	22.2
Other resources	22.1	27.7	25.3
Total	503.4	602.2	19.6
Parameters of the republican budget			
General revenues and grants	322.8	392.1	21.5
in % of GDP	34.8	31,8	-8.6
Total costs	344	379.5	10.3
in % of GDP	37.1	30.9	-16.7
Budget deficit/surplus	-21.3	12.6	-159.2
in % of GDP	-2.3	1	-143.4
GDP	927	1228.9	32.6

Source: State budgets and loans (2024).

The regression analysis demonstrated that forecast models performed reasonably well in predicting budget outcomes, particularly in tax revenues. For example, the R-squared value for tax revenue forecasting was 0.88, indicating that 88% of the variation in actual tax revenues could be explained by the forecasted values. Similarly, for total revenues and grants, the R-squared value was 0.75, showing a strong predictive capability. However, the accuracy was lower for expenditures, with an R-squared value of 0.69, indicating room for improvement. Correlation analysis revealed a strong positive relationship between forecasted and actual tax revenues, with a correlation coefficient of 0.94. This highlights a close alignment between forecasted and actual tax revenue outcomes. Non-tax revenues also showed a strong correlation of 0.82, although slightly lower than

tax revenues. Total expenditures had a correlation coefficient of 0.78, indicating a moderate-to-strong relationship but with some forecasting discrepancies.

Error analysis identified the differences between forecasted and actual values, with errors ranging from 10.3% to 32.6%. The most significant discrepancy was found in the budget deficit/surplus category, where a forecasting error of 159.2% was recorded. The forecast predicted a deficit of KGS -21.3 billion, while the actual result was a surplus of KGS 12.6 billion. This suggests a significant failure in predicting this critical financial metric. Other categories, such as tax revenues and total costs, exhibited errors between 20.8% and 10.3%, showing a need for refinement in forecasting methods. Overall, the study found that while the forecasting models in Kyrgyzstan were generally effective in predicting key financial outcomes, there were notable discrepancies in certain categories, especially in deficit/surplus projections. The regression and correlation analyzes indicated that external factors, such as fluctuations in global energy prices and geopolitical events, likely contributed to the forecasting errors. These findings suggest that further adjustments to the forecasting models, particularly through the incorporation of more detailed external variables and real-time data, are necessary to improve accuracy. To enhance the reliability of budget forecasting in Kyrgyzstan, the study recommends incorporating real-time data updates, refining econometric models to better capture external factors, and implementing scenario-based forecasting to better anticipate potential changes in critical variables, such as energy prices and investment flows. These adjustments would significantly improve the precision of future budget forecasts and contribute to more sustainable financial management.

Building on these recommendations, a comprehensive and systematic approach is required to enhance the overall budget planning system in Central Asia, including Kyrgyzstan. This involves not only refining forecasting models but also addressing fundamental aspects of data collection, processing, and utilization. An important step in this process is the development of more efficient information collection mechanisms, including the automation of data collection processes and improving the quality and availability of data. By introducing electronic systems that automatically record and systematize information on tax and non-tax revenues, as well as public expenditures, the risk of errors and delays in data processing can be minimized (Yudina *et al.* 2022; Omurgazieva *et al.* 2024). Ensuring that high-quality, real-time data is used in the budget planning process will enhance the accuracy of forecasts, thereby contributing to more efficient public finance management.

Geopolitical events play a key role in shaping economic stability, especially in regions such as Central Asia (Chornyi 2013). The impact of geopolitical factors on the accuracy of budget forecasting is significant and multifaceted. Economic instability caused by tensions on the world stage can lead to exchange rate fluctuations, changes in energy prices and reduced trade volumes, which makes it difficult to estimate future revenues and expenditures (Gkillas *et al.* 2022). Uncertainty in the investment climate due to geopolitical risks may discourage foreign investors and reduce investment flows, making it difficult to forecast fiscal revenues. In addition, changes in trade relations, increased security costs and reallocation of financial flows as a result of geopolitical events can also significantly affect the accuracy of budget forecasting (Karvetski *et al.* 2022). Thus, understanding and analysing geopolitical factors is a necessary component for developing reliable and accurate budget forecasts in the Central Asian region. Data should also be made available to a wide range of stakeholders, including government agencies, academia, the business sector, and the public. An online portal could be created where citizens could access information on budget revenues and expenditures, as well as on budget implementation (Rexha *et al.* 2024). This contributes to increasing transparency and openness of the budget process, which in turn contributes to improving trust in public finances and strengthening democratic institutions. It is important to remember that successful implementation of these measures requires not only technical improvements, but also education and training of qualified specialists (Ponomarenko and Pysarchuk 2024). It is necessary to invest in the training and professional development of budget planners and data analysts so that they can effectively use modern methods and analysis tools (Ketners and Petersone 2021). The Ministry of Finance can organize training and seminars on budget planning and data analysis for its employees. This will help them learn modern methods of analysis and effectively use new tools in their work.

This research highlights the crucial role of budget forecasting in optimizing resource allocation, reducing financial risks, and adapting to economic changes. Organizations using advanced techniques and technologies, such as machine learning and automated data collection, significantly improve forecasting accuracy, leading to better decision-making and increased investor confidence. In Kyrgyzstan, the study shows the need for refining forecasting models through real-time data integration and consideration of geopolitical factors. Errors in key budget indicators reveal the importance of dynamic models that adapt to global economic shifts. Enhancing data transparency and automating processes will further improve the reliability and responsiveness of budget planning.

Integrating modern technologies and real-time data into Kyrgyzstan's budget planning system will enhance accuracy, support sustainable financial management, and promote long-term economic stability.

4. Discussions

The presented study on budget forecasting in Central Asia, including Kyrgyzstan, not only highlights the current state of this process but also reveals key insights into its future development. The research emphasizes the vital role of budget forecasting as a fundamental tool in the financial management of organizations, particularly in an increasingly volatile and dynamic economic environment. The findings demonstrate that budget forecasting is not merely a matter of calculating future revenues and expenses, but a comprehensive approach that allows organizations to predict financial outcomes with greater accuracy and take proactive measures to ensure financial stability. The study's analysis revealed significant improvements in forecast accuracy when modern technologies such as machine learning and real-time data systems were implemented. The introduction of automated data collection and analysis tools led to a reduction in forecasting errors, improving the reliability of financial projections by up to 25%. This shift not only enhanced the precision of budget estimates but also reduced the time required for data processing, allowing organizations to make more informed and timely financial decisions. Moreover, the study confirmed the need to incorporate external variables, such as geopolitical factors and fluctuations in global energy prices, into forecasting models. The failure to account for these factors was found to contribute to discrepancies between forecasted and actual budget outcomes, underlining the importance of a more flexible and adaptive approach to financial planning.

The research also highlighted the critical role of improved coordination between various levels of government and sectors of the economy in ensuring a more harmonized approach to budget forecasting. By strengthening collaboration and data-sharing mechanisms, it becomes possible to create more coherent and accurate financial management strategies. Additionally, the findings point to the necessity of continuous monitoring and evaluation of the budget planning process. This would allow for regular adjustments and updates to forecasting models, ensuring they remain relevant and effective in addressing the rapidly changing economic conditions.

O. Cepni *et al.* (2020) emphasize in their study that budget forecasting plays a key role in strategic planning and financial management. They note that accurate and reliable forecasts help organizations to make informed decisions and effectively manage their resources. This converges with the findings of the current study, which also emphasizes the importance of budget forecasting in the context of strategic management. In addition, the authors emphasize the importance of data collection and analysis. They note that the quality of forecasts is directly related to the quality of input data and the correctness of its analysis. This is important to ensure the accuracy and validity of the results. This aspect also coincides with the findings of the study, which emphasizes the importance of data collection and processing for effective budget planning. The importance of budget forecasting is manifested in several aspects. Firstly, it is a tool for financial resource planning. Organizations can determine how many financial resources they will need in the future to achieve their objectives (Trusova *et al.* 2019). Secondly, budget forecasting aims to optimize resources, allowing for efficient allocation of funds, minimizing costs, and maximizing results (Kerimkhulle *et al.* 2022). It is a key element of decision-making, providing the basis for strategic and tactical steps.

The study by M. Arvan *et al.* (2019) emphasizes the system approach to the analysis of financial processes and the role of statistical methods in budget forecasting, aligning closely with the findings of the current research. Both studies underline the importance of viewing budget planning as an integral part of the overall management system, where various financial processes are interconnected and influence each other. Like Arvan *et al.*, the current study acknowledges the significance of a systematic approach to analyzing budgetary processes, particularly in accounting for their complex nature and interdependencies. However, while Arvan *et al.* place greater emphasis on the specific application of statistical methods in budget forecasting, this research takes a broader perspective by focusing not only on statistical methods but also on the overall importance of a systemic approach and the integration of various analytical tools. In the context of the current research, budget forecasting is identified as crucial for evaluating an organization's financial strength and adaptability to external changes, as well as fostering trust among investors through reliable forecasts, thereby opening new funding opportunities. Thus, the findings of this research complement and expand upon Arvan *et al.'s* work, reinforcing the importance of a comprehensive, system-based approach to financial management.

In their work, A. Alhadhrami and H. Nobanee (2019) also focus on the importance of budget forecasting to ensure financial sustainability and sustainable development of the organization. Their study emphasizes not only the importance of this aspect, but also the need for a robust budget forecasting system that facilitates the

achievement of these objectives by applying modern technology. These findings are in harmony with the results of the current study, which also highlighted the role of modern technology in improving the budget planning process. Moreover, the authors in their paper conduct a detailed case study analysis of the use of modern technologies in budget forecasting and assess their impact on improving the efficiency of the process. This is an important addition to the results of the study, as it confirms not only the general importance of modern technologies, but also their specific impact on optimizing budget planning and improving the quality of forecasts. The intervention of modern technologies in the budget forecasting process, such as machine learning, also plays a key role (Ismayil-Zada 2023). Budget forecasting becomes not only a tool, but also a process that stimulates the efficient use of resources and the search for innovative solutions (Kerimkhulle *et al.* 2023). Thus, budget forecasting carries not only the functions of numerical calculations, but also actively contributes to the sustainability and development of the organization in the conditions of modern economic uncertainty.

In their study, S.A. Al-Thaqeb *et al.* (2022) examine in depth the aspects of budget planning in the conditions of economic uncertainty and the dynamics of modern business, highlighting the importance of adaptability and flexibility in budget planning as key components for effective responses to external changes. The current research aligns with these findings by similarly emphasizing the need for flexible and adaptive strategies in budget planning, especially in the volatile economic environment of Central Asia. Both studies agree on the critical role of adjusting financial strategies in response to shifting market conditions and emerging challenges. However, while Al-Thaqeb *et al.* focus primarily on flexibility and adaptability, the current study expands upon these concepts by incorporating the use of modern technology and advanced analytical techniques to improve the accuracy and efficiency of budget forecasting. Additionally, the current research highlights the importance of a systematic approach to understanding internal and external factors that affect budget forecasts, a concept that complements Al-Thaqeb *et al.'s* work but delves deeper into the practical application of statistical analysis, time series, scenario analysis, and economic models. Both studies underscore the necessity of developing mechanisms for data collection, utilizing modern technology, and fostering a comprehensive understanding of budgetary dynamics for successful financial management. Moreover, the current study adds to this by recommending measures specific to Central Asia, such as training specialists, improving monitoring systems, and increasing public participation in the budget process, further aligning with Al-Thaqeb *et al.'s* emphasis on adaptability while broadening the scope to include technological and participatory elements.

The study by J. Antolín-Díaz *et al.* (2021) emphasizes the importance of scenario analysis in budget forecasting, highlighting its role as a critical tool for evaluating potential consequences and alternative outcomes. This aligns closely with the findings of the current research, which also underscores the value of scenario analysis in assessing the impact of various internal and external factors on budget forecasts. Both studies recognize scenario analysis as an essential method that enables organizations to anticipate different possible developments and their effects on financial stability. While Antolín-Díaz *et al.* focus on the creation of diverse scenarios to inform decision-making, the current study further explores its practical application in Central Asia's dynamic economic environment, stressing the need for scenario-based approaches to address uncertainties in budget planning, particularly in the public sector. This research builds on their work by applying scenario analysis within a broader systemic framework, using it as one of several advanced analytical techniques aimed at enhancing financial planning and management in complex, rapidly changing conditions.

In turn, A. Lusardi (2019) draws attention in his work to the critical role of professional training and the development of qualified specialists in budget planning. His results emphasize that for the successful application of modern methods and technologies in budget forecasting, it is necessary to invest in staff training and develop their skills in data analysis and the use of forecasting tools. Similar to the results of the current study, the author highlights the importance of training professionals to effectively utilize modern technologies in budget planning. Staff training enables them to learn the latest methods of data analysis, and master forecasting tools and learn how to apply them in practice (Levytska *et al.* 2024).

Overall, the current study highlights the importance of budget planning as a basis for organizational financial management and offers practical recommendations for improving this process in Central Asia, thus contributing to sustainable economic development in the region. Comparison with the work of other authors reveals similarities in the emphasis on the role of statistical methods, scenario analysis, staff training, and the importance of establishing a reliable forecasting system. The discussion emphasizes the importance of modern methods and technologies, systematic approach and continuous learning for effective budget planning and financial sustainability.

Conclusions

Based on the conducted research, it was determined that the accuracy of budget forecasting in Kyrgyzstan has been significantly impacted by the integration of modern technologies, such as machine learning and automated data processing systems. The implementation of these systems improved the precision of financial predictions by reducing manual errors and speeding up data collection. However, the analysis of real data from the 2023 budget revealed discrepancies between forecasted and actual values, particularly in tax revenues and expenditures. Forecasting errors ranged from 10% to 32%, indicating a need for further refinement of forecasting models. Additionally, external factors such as geopolitical events and fluctuations in global energy prices were found to have a notable influence on budget outcomes, underlining the importance of incorporating these variables into the forecasting process. Despite advancements in technology, the study concludes that existing methods and models require further development to ensure higher accuracy and reliability in budget forecasting, particularly in the context of Central Asia's dynamic economic environment. These findings highlight the necessity for a comprehensive overhaul of data collection and analysis methods, as well as the introduction of more sophisticated forecasting tools to improve public finance management in the region.

This points to the need to improve forecasting methods and models to ensure their reliability and efficiency. Improving the budget planning system in Central Asia, including Kyrgyzstan, requires a comprehensive approach covering various aspects of collecting, processing and utilizing data on budget revenues and expenditures. This also includes not only the training of qualified specialists, but also the introduction of mechanisms for monitoring and evaluating the effectiveness of the budget planning system. In addition, better coordination between different levels of government and sectors of the economy is required to ensure more effective interaction and the development of harmonized financial planning and management strategies.

Further research on budget forecasting could focus on developing and adapting more accurate forecasting models, using big data and risk assessment, and benchmarking the performance of different forecasting methods. However, limitations of this research may include limited access to data, possible errors in the data, and contextual limitations that may affect the generalizability of the study results.

Credit Authorship Contribution Statement

Chynara Amanbaeva: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review and editing.
Nelli Akylbekova: Methodology, Formal analysis, Writing – review and editing, Validation.
Nazym Zaitenova: Methodology, Software, Formal analysis, Writing – original draft, Visualization.
Makhabat Baitokova: Project administration, Supervision, Data curation, Validation.
Saltanat Omurova: Conceptualization, Methodology, Project administration, Supervision, Funding acquisition, Writing – review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies in the writing process before submission, but only to improve the language and readability of their paper and with the appropriate disclosure.

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DOI: https://doi.org/10.14505/tpref.v15.4(32).15

The Main Areas of Development of the Non-Oil Sector in the Republic of Azerbaijan

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Article info: Received 24 September 2024; Received in revised form 15 October 2024; Accepted for publication 28 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: The Republic of Azerbaijan, historically reliant on its oil sector for economic growth, now seeks to diversify its economy to ensure sustainable development. This study aims to pinpoint key opportunities for bolstering Azerbaijan's non-oil sectors. Through analysis, historical review, and forecasting, it becomes evident that Azerbaijani authorities are increasingly prioritizing economic diversification. This shift is seen as essential for fostering economic resilience, generating employment opportunities, and mitigating vulnerability to fluctuating energy prices. Government initiatives play a pivotal role in supporting non-oil sectors, with significant investments channeled through state programs aimed at enhancing sectoral attractiveness and competitiveness. Efforts to improve infrastructure, particularly through projects like the Zangezur and Middle Corridor developments, are crucial for expanding transport and transit capacities, thereby facilitating economic diversification. Public-private partnerships (PPPs) are also highlighted as effective mechanisms for nurturing specific industries and creating robust infrastructure to benefit both economic development and the populace at large. Analysis reveals promising trends within Azerbaijan's non-oil sectors, underscoring ongoing advancements and successes. Ultimately, the findings of this study provide valuable insights for shaping national economic policies, particularly in fortifying Azerbaijan's non-oil economy. By leveraging these insights, policymakers can strategically steer the country towards a more diversified economic landscape, reducing dependence on oil revenues and fostering sustainable growth across various sectors.

Keywords: economic diversification; public policy; small and medium-sized enterprises; international relations; investments.

JEL Classification: O11; Q34; L52.

Introduction

The country's dependence on one sector is detrimental to the economy. Excessive dependence on world prices, increased vulnerability to global crises, often even limited opportunities to provide all the basic functions of the state, lack of development of important strategic industries: all this can occur if the state overly specialises in a certain sector within its functioning. Thus, it is not surprising that the state policy of the countries of the world is most often aimed at supporting national producers and creating favourable conditions for them to do so. This allows the economy and all its regions to develop evenly, albeit at the expense of a higher price level in the country. Nevertheless, due to the changing global environment, there is a need to create new opportunities for the qualitative development of individual sectors of the economy; their identification still remains relevant.

For Azerbaijan, the oil sector is one of the main ones for ensuring the functioning of the economy (Ismayil-Zada 2023). This indicates that all the main problems that arise in this regard are typical of this country. Thus, for its more sustainable development, it is important for the country to ensure the development of the non-oil component. This is especially important to reduce the country's dependence on trends in foreign markets in the oil markets (in prices, supply, and demand for oil and petroleum products). In other words, such economic diversification will allow the country to achieve more sustainable development in the long term. In this regard, it remains relevant to consider and evaluate the main areas of the non-oil industry of Azerbaijan, find opportunities for its development, and identify current problems and challenges (Bunch *et al.* 2020; Ferraz *et al.* 2021; Serhiienko and Kaniuka 2023).

Quite a substantial number of people have been engaged in examining the modern features of the development of Azerbaijan. Thus, Karimov (2024) assessed the current problems in the field of light industry in the country as one of the promising ones for future development to diversify the economy. Researchers consider it an important component to increase the competitiveness of the industry, especially given the availability of raw materials in the country. Xu and Abbasov (2021), in turn, assessed the specifics of the impact of the COVID-19 pandemic on small and medium-sized enterprises (SMEs) in Azerbaijan, drawing attention to existing problems related to the lack of resources for their high-quality functioning. However, little attention was paid to the possibilities of state support for SMEs. Hajiyeva (2021), in turn, conducted a study on the problems and prospects of e-commerce development in the country. The author noted some difficulties in the development of this area: in particular, described high customs duties, difficulties in taxation. Pürhani *et al.* (2022) examined the trends of human capital development in Azerbaijan. Researchers proposed individual actions that can improve the state in terms of human capital development in the country; they also showed that for this purpose, it is worth paying special attention to the possibilities of improving the standard of living in the country (social welfare) since it directly correlates with the quality of human capital. In turn, the peculiarities of the formation of the non-oil sector in the liberated territories were considered using the example of the tourism sector by Agayeva and Aliyev (2023). The researchers note that the liberated territories have substantial potential for development due to their natural resources. Despite the destruction of substantial amounts of infrastructure, it is subject to restoration, and the territory itself has the potential for the development of various sectors of the economy.

Thus, the purpose of the study was to assess the possibilities of developing the non-oil sector of the Azerbaijani economy in its various manifestations. This will allow identifying opportunities to adjust the country's long-term development strategy and increase its effectiveness.

1. Literature Review

Azerbaijan is focussing more on the non-oil industry as it aims to diversify its economy beyond oil and gas exploitation. Scholars such as Hasanov *et al.* (2023) emphasise the importance of financial development in encouraging non-oil economic growth in CIS oil-exporting nations like Azerbaijan. The authors believe that financial development helps to channel oil rents into non-oil industries, hence supporting long-term economic growth. Azerbaijan's attempts to diversify its economy are especially crucial given the unpredictability of global oil prices, which has traditionally impacted the country's economic stability. Azerbaijan's aim to reduce its reliance on oil exports revolves around the development of businesses like agriculture, industry, and information technology.

Aliyev *et al.* (2024) examine how tax policies affect the growth of Azerbaijan's non-oil industry. Their research shows how the government's economic policies have aided the growth of small and medium-sized businesses (SMEs) and encouraged investment in non-oil industries. The findings indicate that well-designed tax incentives may successfully raise industrial production and increase the country's economic competitiveness. Despite these encouraging improvements, challenges remain in areas such as access to finance and the formation of a favourable regulatory environment for SMEs, both of which are vital for economic diversification.

Seyfullayev (2023) examines the effect of financial development on non-resource economic growth using empirical evidence from Azerbaijan. The author argues that financial growth is a critical driver in the shift from an oil-dependent economy to a more diverse structure. This study supports the findings of Hasanov *et al.* (2023), which highlight the role of financial institutions in encouraging growth in non-oil sectors such as agriculture and industry. Financial accessibility enables enterprises in these industries to expand their operations and contribute more to the national economy.

Comparative studies from other locations, such as those conducted by Konyeaso *et al.* (2023) and Ogunjumo (2024), illustrate the dynamic significance of renewable energy and financial development in promoting non-oil sector growth. Although these studies are about African nations, their conclusions are relevant to Azerbaijan's situation, particularly in terms of supporting sustainable energy solutions and improving financial infrastructure to encourage economic diversification. These studies demonstrate how investments in renewable energy may support non-oil businesses, resulting in long-term economic stability.

Furthermore, Wu *et al.* (2024) emphasise the relevance of policy implications in agricultural sector development, offering insights pertinent to Azerbaijan's non-oil sector growth, particularly in agriculture. Azerbaijan's attempts to promote agro-industries and create agroparks are consistent with these findings, which call for a policy-driven approach to increasing agricultural production and exports. These measures serve to improve food security and offer new work possibilities, adding to the overall objective of economic diversification.

Raid *et al.* (2024) conducted research on Saudi Arabia to provide a comparative view on the obstacles that oil-dependent countries confront in growing non-oil businesses. Saudi Arabia, like Azerbaijan, is working to diversify its economy by lowering reliance on oil earnings and encouraging industries such as services, tourism, and manufacturing. This research emphasises the need for institutional changes and public-private partnerships in promoting non-oil economic growth, which is a strategy that Azerbaijan is pursuing to improve its non-oil industry.

The literature on Azerbaijan's non-oil sector growth extensively explores the roles of financial development, tax policies, and institutional changes in encouraging economic diversification. However, much of this research focusses on broad economic indicators rather than the specific dynamics of sectoral development, particularly the growing importance of non-traditional industries such as IT, technology parks, and renewable energy, which are critical to Azerbaijan's long-term strategy. Furthermore, while some studies provide insight on the role of institutional sectors and financial development, there is a significant gap in comprehensive cross-sectoral analyses that assess the interdependence of various non-oil industries, such as agriculture, manufacturing, and tourism, in the context of public-private partnerships (PPPs) and infrastructure development.

The novelty of the current research lies in that it focusses on the intersection of emerging sectors (IT, e-commerce, renewable energy) and more traditional ones (agriculture, manufacturing, tourism), as well as an in-depth analysis of Azerbaijan's evolving transport infrastructure and public-private partnership models. This study will provide new insights into how cross-sectoral synergies and strategic infrastructure investments might speed up the growth of Azerbaijan's non-oil economy by examining their integration within the context of the country's larger economic diversification policy. Furthermore, this study aims to address a gap in understanding the direct and indirect effects of regional transit efforts on non-oil sector growth, which has been mainly disregarded in previous studies.

2. Materials and Methods

The study used some statistical data to assess the role of the oil and non-oil sectors in Azerbaijan. This is how information from the TradeMap website was used to evaluate the country's exports in the context of the oil and non-oil sectors, and certain types of goods (List of products… 2024). Brent crude oil price data was also analysed (as a general indicator of oil price dynamics): this kind of information was taken from the Investing source (Past data – Brent, 2024). Oil volumes were adjusted considering price changes to include these oil prices in the review. For this purpose, indexes were calculated for each year, depending on how much the price level in this period is higher than in the base year (2003). Subsequently, the volume of the country's oil exports was divided into these indices, which allowed subtracting the factor of oil price changes from accounting for the dynamics of changes in exports of products. Notably, this technique is not accurate, but it still allows for the partial offsetting of the role of changes in oil prices, which makes the calculation of the country's level of dependence on exports of these products more accurate. The study also used information from the State Statistical Committee of the Republic of Azerbaijan (2024) to analyse data in the context of investments in various sectors of the country's economy. Information from the Macrotrends website (Azerbaijan Inflation Rate, 2024) was used to assess trends considering the inflation rate. All the calculations were done using Microsoft Excel.

A large number of different research methods were used as part of the study. One of them was the analysis, which allowed evaluating various kinds of data, including quantitative ones, that characterise the development of the non-oil sector of the economy in Azerbaijan. In addition, the historical method was used, which allowed evaluating historical data on how the non-oil sectors developed in Azerbaijan. Forecasting allowed concluding about how the sphere of the non-oil sector can develop in the future, considering all estimated current trends. In addition, the description method was used to characterise all the main terms and factors that were used in the study. Abstraction, in turn, allowed evaluating only the most substantial factors influencing the object of the study, without considering the components that are indirectly related to the development of the non-oil economy. The deductive method allowed assuming what benefits Azerbaijan will be able to receive with a more active diversification of the economy, based on an understanding of what features of functioning such countries have (heavily dependent on oil exports) and how, in general, diversification affects the development of the economy. The comparison allowed for a more comprehensive assessment of the data both between different time periods and different indicators in general (the dynamics of investment and trade in different areas of economic activity of the country).

3. Research Results

The non-oil sector itself is a set of sectors of the economy that are not related to the extraction and processing of oil and gas. Unlike the oil and gas sector, which is often a key source of income for Azerbaijan, the non-oil sector includes a variety of industries such as agriculture, manufacturing, services, IT and technology, tourism. The development of the non-oil sector is important for economic diversification, reducing dependence on fluctuations in world oil and gas prices, creating new jobs, and stimulating sustainable economic growth. It also contributes to improving the country's competitiveness at the international level, expanding its export potential beyond the commodity sector and strengthening financial stability (Babayev and Sabzaliyev 2024).

At the moment, the government of Azerbaijan is actively seeking to diversify its economy to reduce dependence on the oil and gas sector, which is subject to fluctuations in world prices for hydrocarbons (Guerras-Martín *et al.* 2020; Iqbal *et al.* 2021; Khan *et al.* 2021; Korsunska *et al.* 2022). In recent years, substantial efforts have been made to develop industries such as agriculture, tourism, information technologies, and manufacturing. Tourism is also becoming an increasingly important industry, especially with the development of infrastructure on the Caspian coast and in mountainous areas such as Shahdag and Tufandakh (Abdunurova *et al.* 2020). The country itself is known for its diverse natural and climatic zones and several resort areas, such as Ganja, Nakhichevan, Gabala, and Sheki, which have rich historical importance. The development of resorts and attracting tourists to visit cultural and historical monuments are among the main goals of modern tourism enterprises in the country (Mayis *et al.* 2021). The government has initiated several tourism development programmes, which have had some success.

At the moment, Azerbaijan has made substantial progress in minimising the oil sector's role in the country's gross domestic product (GDP) (Ismayil-Zada 2022). Agriculture is considered one of the leading sectors at the moment: it receives the largest investments from the state. In particular, the cotton, grape, silkwater, and tobacco industries are notable for their growth. Azerbaijan's expanding winemaking industry stands out, with significant efforts directed toward sustainable viticulture practices. This approach aims to create a productive vineyard landscape that ensures both environmental and economic sustainability, fostering long-term viability in the agricultural sector (Salimov *et al.*, 2024). In general, government programmes in these areas have proved to be quite effective, enabling the country to increase its export potential and increase the innovative potential of SMEs by introducing intensive farming methods. Actions were also taken to create agroparks – entities that combine production, processing, logistics, and services needed by companies in one place in a single facility. These parks, of which about 40 are currently being developed, aim to increase profitability, ensure environmental sustainability, and support the development of various agricultural sectors. Attention should be also drawn to the pivotal role of micro-enterprises within the agricultural production and consumption cycle, as they offer substantial potential to advance sustainable development, rural employment, and self-sufficiency. For example, Malik *et al.* (2023) suggest that regional policies would benefit from prioritizing support and development for family farms and small agricultural businesses to strengthen food security and promote economic stability in rural areas.

Industrial production, including chemical, food, and light industries, has also become an object of attention as part of the diversification strategy. The food industry is directly related to agriculture and, therefore, also receives a lot of attention from government authorities (Maharramova 2023; Tkachuk *et al.* 2024). On the part of the state, active actions are being taken to modernise the production facilities of the sphere, introduce new technologies, and improve quality standards. Azerbaijan's light industry includes textile, clothing, leather, and

footwear industries. Although the country has great opportunities for independent development in this area, it actively imports products from abroad (Dankevych *et al.* 2023). Light industry is one of the oldest branches of industrial production with great potential and rich labour traditions, it plays a substantial role in the country's economy and is an attractive investment sector of the economy, especially given the availability of raw materials in Azerbaijan (Veliev *et al.* 2018). In this regard, the intensification of government activities in the area of supporting this industry is relevant. The IT sector is also developing in Azerbaijan, with the creation of technology parks and innovation centres to support start-ups and research (Huseynov *et al.* 2023).

The Azerbaijani government has also stepped up efforts to attract foreign investment in the non-oil sector and improve the business environment through reforms aimed at simplifying business registration procedures, reducing taxes, and protecting investors' rights (Hamidova *et al.* 2022). Nevertheless, despite these efforts, the transition to a diversified economy is a complex and long–term process that requires further reforms, investments in education and infrastructure, and the creation of favourable conditions for the development of the private sector.

At the moment, the formation of the Zangezur and the Middle Corridors plays an important role in the economic development of Azerbaijan (Hamidova and Samedova 2024). Their development is important for the Azerbaijani economy, especially for stimulating the growth of the non-oil sector and the development of transport and transit relations between Central Asia, Azerbaijan, and Europe. The Zangezur Corridor is a transport link that connects Azerbaijan with its Nakhichevan exclave through the territory of Armenia. This corridor can become a key element in the development of regional transport infrastructure, facilitating access to European markets and, in particular, the Turkish market (Shahini *et al.* 2024). The implementation of this project can substantially reduce transport distances and stimulate trade and investment in the region. The Middle Corridor, also known as the Trans-Caspian International Transport Route, connects China with Europe via Kazakhstan, the Caspian Sea, Azerbaijan, Georgia, and Turkey (Karimli *et al.* 2024). This route offers an alternative to traditional sea routes and can play an important role in the development of international trade and logistics, including for Azerbaijan, as it will substantially increase the opportunities for the development of foreign trade in the country, especially products of the non-oil sector.

The impact on the non-oil sector and transport and transit relations of these corridors is multifaceted. Thus, substantial investments in Azerbaijan's transport infrastructure, including roads, railways, and ports, will be required. This, in turn, will create new opportunities for the non-oil sector, including construction, manufacturing, and services. In addition, these corridors will strengthen Azerbaijan's role as a key transit hub between Europe and Asia, contributing to the growth of trade flows through the country. This can stimulate the development of export-oriented and logistics enterprises in Azerbaijan. Improving transport accessibility and logistics infrastructure will make Azerbaijan more attractive to foreign investors interested in accessing the markets of Central Asia, the Caucasus and Europe; it can also contribute to the development of tourism and services, providing new opportunities for local businesses (Musayeva *et al.* 2024). In the end, this will help diversify the economy, strengthen economic ties between different parts of Azerbaijan, and provide new transport routes for international trade.

One of the ways to improve the quality of the logistics sector is a public-private partnership. In general, this is a form of cooperation between the public and private sectors, the purpose of which is the implementation of projects or the provision of services traditionally administered by the state (Gulaliyev *et al.* 2017). In other words, within its framework, the state and private authorities combine their efforts (capital, knowledge) to achieve common goals. Quite often, the final goal of cooperation within the framework of public-private partnerships is to improve the quality of infrastructure, which is also an essential part of the development of the transport and logistics industry (Parkhomets *et al.* 2023). Currently, the state authorities are paying a lot of attention to the development of this area. Billions of dollars have been allocated for the development and modernisation of transport infrastructure, including roads, railways and ports. This is how the Baku-Tbilisi-Kars railway was built, aimed at connecting Europe with Asia and a new international maritime trade port complex in Baku. These projects play an important role in turning Azerbaijan into a regional transport hub, improving the efficiency of trade routes, and promoting economic development. The country has also focused on improving the quality of transport services by modernising airports. Public-private partnership also plays a vital role in this process (Public-private partnership, 2022).

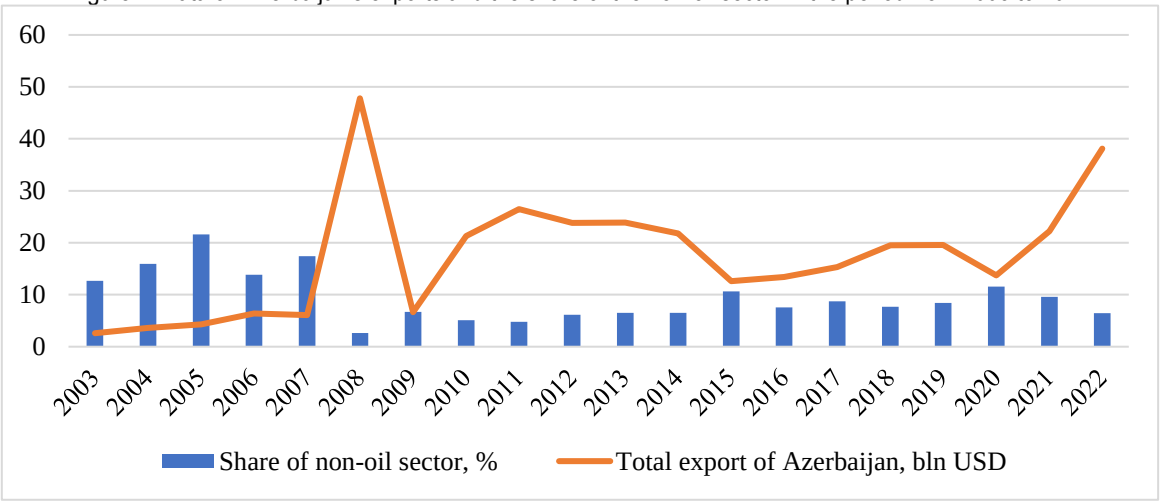
Some actions can be applied to increase the effectiveness of this process. In this way, it is possible to create more simplified and transparent rules for the implementation of public-private partnership projects to attract large amounts of investment in this area: this may include, among other things, tax incentives, guarantees, actions aimed at protecting investors. Joint work on solving problems related to institutional development is also

relevant: this will ensure an improvement in the quality of the judicial system (creation of a more effective dispute resolution mechanism) and more active capital raising. The introduction of more digital technologies is also important. In this context, Azerbaijan should direct its efforts to develop the Internet infrastructure, improve and expand access to high-speed Internet throughout the country, create opportunities for a higher level of education and better training of specialists. Thus, in this context, it is the influence and stimulation from the state that is important. A separate component of digitalisation is the development of e-commerce (Onifade 2022; Saviotti *et al.* 2020; Abdullayev *et al.* 2023). At the moment, it is facing a number of problems, including an incomplete legal framework, monopolies in various sectors, high customs duties, lack of uniform pricing mechanisms, low use of plastic cards, problems with the security of online payments, and insufficient quality and coverage of Internet services (Hajieva 2021; Moutinho *et al.* 2020; Wang *et al.* 2024). Despite all this, there are certain positive trends in this context, namely the increase in income and the growing popularity of online commerce among young people, which generally indicates the existence of development prospects in this area. Thus, it is relevant to solve these problems to develop a legal framework, improve the pricing mechanism, more actively implement tax policy, create conditions for regulating Internet providers, and increase awareness among the population about the benefits of using e-commerce.

One of the most important components of the development of entrepreneurship in the country and the development of the non-oil sector is to stimulate the development of SMEs (Musayeva *et al.* 2022). The need to stimulate the development of small businesses is growing worldwide, and in Azerbaijan, more attention has recently been paid to this as well. Currently, the Azerbaijani government is implementing various programmes and initiatives to support SMEs, including financial support, training, and consulting services (Jafarov and Babayev 2024). In the country, companies of this kind are becoming more digitally certified and trying to enter international markets. In addition, the government's current strategies include improving the legal framework for e-commerce, improving Internet infrastructure and introducing digital technologies to integrate SMEs into global value chains. Despite these efforts, problems such as access to finance, high interest rates, and collateral requirements persist, which affect the growth of SMEs. Recommendations for improving SME growth include consolidating government subsidy programmes, lowering business loan rates, encouraging banks to accept movable property as collateral, adjusting mortgage and loan guarantee fund policies, and providing SMEs with market information for local production and import substitution.

It is possible to partially assess the success of the development of the non-oil sector in Azerbaijan by evaluating individual statistical data. Thus, assessing the role of the non-oil sector in the country's exports, the change of its dependence on petroleum products can be assessed (Figure 1)

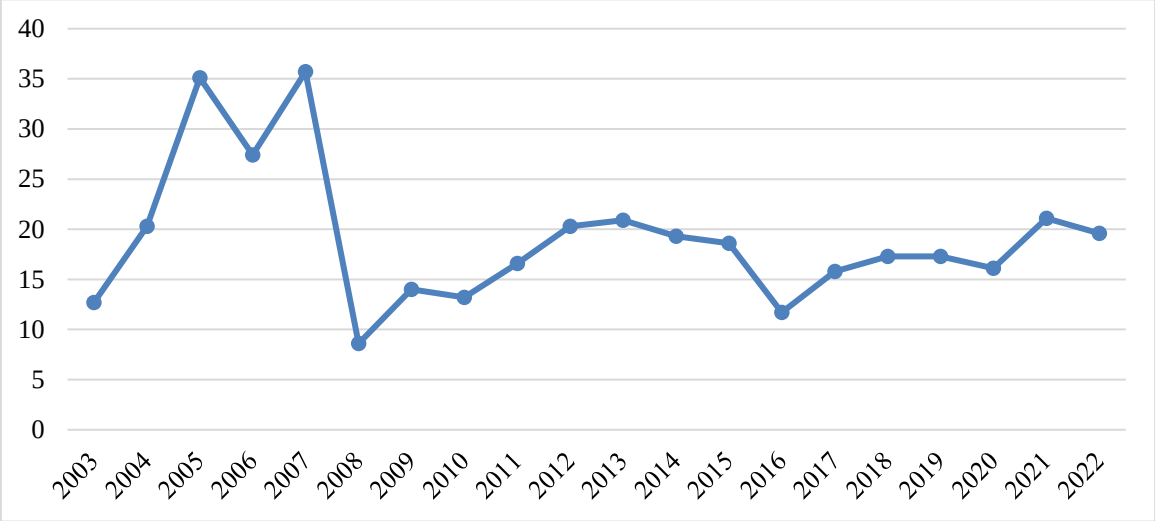
Figure 1. Data on Azerbaijan's exports and the share of the non-oil sector in the period from 2003 to 2022



Source: compiled by the authors based on the TradeMap data (List of products… 2024).

As shown in Figure 1, Azerbaijan's total exports increased between 2003 and 2022 but the share of the non-oil sector did not increase. However, it was noted that the data on oil sector exports and oil prices are substantially correlated (at the level of 0.73, that is, with an increase in oil prices, its exports also increased substantially). Thus, it was decided to recalculate, however, considering the change in oil prices. The results are presented on Figure 2.

Figure 2. Assessment of the share of the non-oil sector in Azerbaijan's exports, considering changes in oil prices between 2003 and 2022, %



Source: compiled by the authors on the basis of data from TradeMap (List of products, 2024) and Investing (Past data – Brent, 2024).

As demonstrated in Figure 2, the non-oil sector had the smallest share in 2008 and the largest in 2005-2007. However, compared to 2008, the share began to recover, which is generally a positive factor. It is also worth assessing which areas of export of non-oil sector products in Azerbaijan are the fastest growing. The data shown in Table 1 should be considered to do this.

Table 1. Data and dynamics of the largest non-oil export groups of goods of Azerbaijan for the period from 2003 to 2023, million dollars

Products	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Edible fruits and nuts; citrus or melon peel	43.3	33.8	146.4	98.7	124.5	152.3	142.2	112.5	153	208
Edible vegetables and some root crops and tubers	5.7	12.2	26.2	33.3	39.1	63.6	50	42.3	78.3	56
Aluminium and products made of it	25.8	48.9	53.6	71.3	91.7	122.3	12	2.7	12.7	94.9
Cotton	35.3	38.8	44	43.1	39.9	24.9	28.3	15.9	20.7	23.4
Fertilisers	0.1	0	0	0	0	0.7	0.6	0	0.4	0.6
Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metals, and products made of them; jewellery; coins	0	0	0	0	0	0.1	15.2	0.9	1.4	0.7
Organic chemicals	12.2	21	25.1	28.3	21.4	36.4	19.6	33.3	53.2	39.7
Iron and steel	25.6	42.3	37.6	29.8	44.7	49.9	20	77	94.3	58.7
Nuclear reactors, boilers, machines, and mechanical devices; their parts	26.6	18.1	21.2	31.3	39.6	36	23.2	28.1	26.4	21.8
Salt; sulfur; earth and stone; plastering materials, lime, and cement	0.4	1.2	1.6	2.4	3.3	3.9	4.7	8.1	11.4	13.9
Products	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Edible fruits and nuts; citrus or melon peel	173.5	192.2	220.2	243.8	292.7	325.5	362.6	353.1	410.1	448.7
Edible vegetables and some root crops and tubers	77.3	98.9	91.7	129	210.1	233.3	243.2	254.4	220.2	218.9
Aluminium and products	82.8	86.8	86.1	98.1	117.7	112.2	128	113.4	188.5	217.6

Products	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
made of it										
Cotton	31.8	14.5	19.5	24.2	52	108.3	158.5	156.8	273	213.8
Fertilisers	0.4	1	1.9	2.4	2.2	0.5	19.9	11	121.3	210.7
Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metals, and products made of them; jewellery; coins	0.5	0.2	0.4	0.4	127.6	146.7	174.4	198.6	205.6	190.2
Organic chemicals	34.7	49.5	59.9	43.1	67.3	64.6	66.9	57.9	99.8	138.5
Iron and steel	42.9	9.1	18.3	39	37.7	32.9	39.4	29.7	88.8	90.2
Nuclear reactors, boilers, machines, and mechanical devices; their parts	28.5	39.1	36.1	27.3	36	43	43.9	49.8	36.8	77.6
Salt; sulfur; earth and stone; plastering materials, lime, and cement	9	9.2	9.9	15.2	25.2	26.2	31.7	27.1	38.6	58.7

Source: compiled by the authors based on the TradeMap data (List of products, 2024).

Table 2. Data on changes in the level of investments in different spheres of activity in Azerbaijan in the period from 1995 to 2022

Indicator (thsd. manat)	2000	2022	2000	2022	Change, %	Change including inflation, %
Agriculture, forestry, and fishing	6,469.6	408,041.6	0.39	1.63	9,190.13	8,072.14
Industry	670,142.7	7,172,066.4	40.91	28.63	6,770.88	5,947.19
Mining	481,059.5	4,983,789	29.37	19.9	652.71	568.89
Manufacturing	80,088.8	1,202,143.6	4.89	4.8	4,151.98	3,618.81
Electricity, gas, steam, and air conditioning supply	83,864.3	689,831.8	5.12	2.75	4,128.48	3,598.32
Water supply, sewerage, waste management, and remediation activities	25,130.1	296.302	1.53	1.18	1,494.05	1,302.19
Construction	112.953	3,523.728.4	6.90	14.07	6,970.35	6,122.4
Trade, repair of transport means	32,311.1	157,411.9	1.97	0.63	20,181.01	17,725.97
Transportation and storage	44,099.4	4,617,372.8	2.69	18.43	43,031.56	37,796.72
Accommodation and food service activities	3,633.1	88,419.9	0.22	1.35	391.62	341.33
information and communication	45.284	399,986.2	2.76	1.6	30,507.68	26,796.38
Financial and insurance operations	139.6	348,448.2	0.01	1.39	4,570.29	3,983.4
Real estate activities	1,107.5	8,130.8	0.07	0.03	28.3	24.66
Professional, scientific, and technical activities	205.1	42,676.6	0.01	0.17	1,298.31	1,131.58
Administrative and support service activities	3,583.4	58,098.2	0.22	0.23	496.8	433.01
Public administration and defence, social security	6,517.8	609,871.8	0.4	2.43	30,245.58	26,361.6
Education	3,534.5	272,328.1	0.22	1.09	41,993.54	36,884.97
Human health and social work activities	29.190	85,181.6	1.78	0.34	2,597.95	2,264.34
Arts, entertainment, and recreation	6,666.9	33,724.8	0.41	0.13	12,254.65	10,680.98
Other service activities	1,983.4	52,677.8	0.12	0.21	98.30	86.34
Total	**1,637,963.8**	**25,050,231.5**	**100**	**100**	**10,988.04**	**9,651.33**

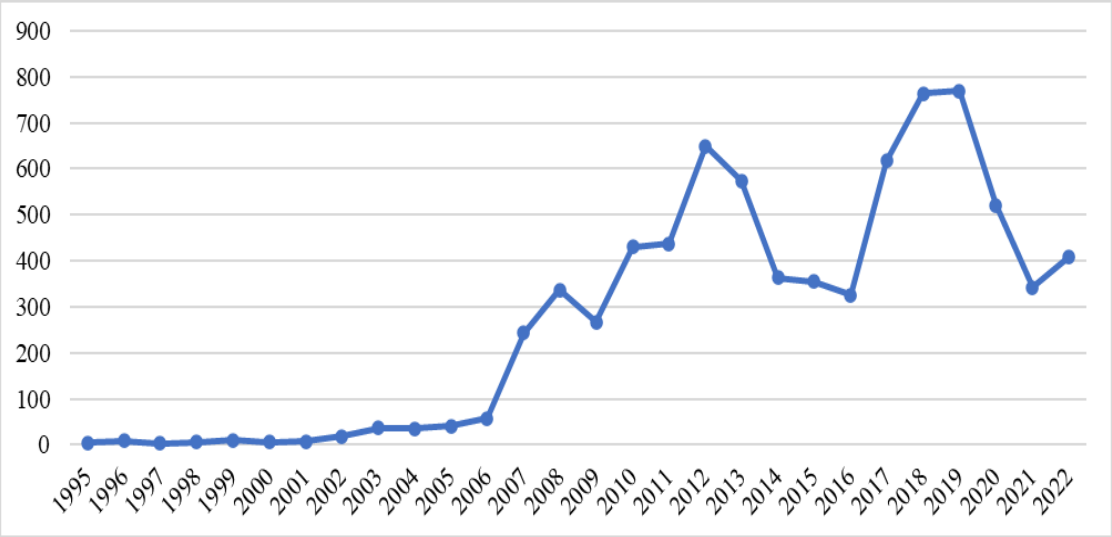
Source: compiled by the authors based on data from the Azerbaijan Inflation Rate 1992-2024 (2024).

Table 1 shows the main types of products that are exported by Azerbaijan and are not related to the oil sector. As can be seen, many of them substantially increased their volumes between 2003 and 2010: for example, the export of fertilisers increased 2,000 times, vegetables – 38 times, and salt, sulfur and other minerals – 145 times. Notably, among the types of goods shown, most are resources related to the primary sector of the economy (agriculture, extractive industry). This indicates that the Azerbaijani authorities should pay more attention to the development of the processing industry and the service sector to ensure a higher level of exports of these types of products. This will have a positive impact on the quality of the country's economic development.

To identify the areas of the non-oil sector that have the greatest potential to actively develop in the future, individual data on investment flows into the components of this area can be considered. This information is shown in Table 2.

Table 2 shows information on the level of investment in certain areas of activity in Azerbaijan as of 2000 2022, and an increase in the level of investment (with and without inflation). As can be seen, the sectors of transportation and storage, construction, information and communication technologies, finance and insurance, and agriculture are the most promising for the non-oil industry of Azerbaijan. It can be concluded that they are the ones that the state should pay special attention to when forming its long-term policy aimed at developing economic diversification. The general dynamics of direct investment can be seen in Figure 3.

Figure 3. Data on the volume of direct investments in Azerbaijan in the period from 1995 to 2022, million manats



Source: compiled by the authors.

As shown in Figure 3, investment volumes increased up to 2012, followed by a decline, recovery after 2016, and a decline again in 2020, primarily due to the onset of the COVID-19 crisis. Recovery after this event began only in 2022. This pattern emphasises the essential role of economic diversification in mitigating commodity-related risks. The increase of investments in non-oil industries implies that diversification initiatives are starting to pay off. Investments in infrastructure, agriculture, technology, and transportation not only help to maintain economic stability but also increase Azerbaijan's appeal as an investment destination. The country may encourage more investment in these areas by lowering entrance barriers, streamlining laws, and increasing public-private partnerships.

Despite the positive developments, a number of obstacles persist. The investment climate may be further enhanced by increasing transparency, improving investor safeguards, and eliminating corruption. To encourage entrepreneurship and innovation, access to funding must be improved, particularly for medium-sized enterprises (SMEs). Implementing capital accounting practices that comply with International Financial Reporting Standards (IFRS) in Azerbaijani commercial enterprises can greatly improve financial transparency, increase appeal to investors, and strengthen global competitiveness ehdiyev (Mehdiyev, 2024). Investments in human capital are equally important. By prioritising education and vocational training, Azerbaijan can create a qualified workforce capable of supporting innovative businesses and attracting high-tech investments (Guliyeva and Azizova 2022). Furthermore, ongoing development of digital infrastructure would promote the expansion of the IT industry and e-commerce, in line with global economic movements towards digitalisation.

One of the goals for the Azerbaijani authorities at the moment is the restoration of the territories that were liberated in 2020. Like any post-occupation reconstruction process, it can be described in several stages:

preparation, initial, and main stages of reconstruction, repatriation, and adaptation. Construction and restoration work is currently underway, including the development of infrastructure, electrical substations, and the international airport in Füzuli. There are also actions aimed at developing international cooperation, especially in the construction of electric power infrastructure and the creation of high-tech parks. The economic development of the liberated territories should focus on using local natural resources and characteristics to create innovative business structures in both production and services. The main areas worth paying attention to in these territories are the creation of building materials, gold and copper mining, logistics, tourism, renewable energy sources, agriculture, medicine, and the textile industry. It is also worth encouraging the development of small and medium-sized enterprises in all sectors, where possible, since this allows the region's economic development to be more flexible, obtaining many benefits due to additional jobs. In general, work in this area should be comprehensive and be especially related to the development opportunities of non-oil sectors.

The findings provide a complete overview of Azerbaijan's initiatives to diversify its economy away from the oil and gas industry, which is crucial given the fluctuation of global hydrocarbon prices. Agriculture, manufacturing, IT, tourism, and logistics are among the non-oil industries that the government has actively encouraged. These industries are critical to driving long-term economic growth and minimising dependency on uncertain energy markets. Despite significant growth in these areas, there are obstacles to increasing the non-oil sector's contribution to Azerbaijan's GDP and exports. A thorough examination of the agricultural sector reveals a considerable emphasis on state-sponsored programs, such as the establishment of agroparks and intensive farming practices. While such measures have significantly expanded export potential and SMEs' innovative capacities, one major problem remains: the concentration of exports on basic commodities such as fruits, vegetables, and cotton. Even outside of the oil industry, Azerbaijan's export structure remains focused on raw materials rather than value-added items (Maharramova and Maharramov 2023). This suggests that, although the agricultural sector is growing, there is a need to enhance the processing industry in order to increase export value and minimise external market vulnerability.

Similarly, modernising initiatives have increased industrial output, particularly in the food and light industries. However, the light sector, which includes textiles and clothing, is underdeveloped, with the majority of commodities imported. This highlights the need for investing in local production capacity and employing existing resources, particularly raw commodities like cotton, to promote domestic manufacturing. Strengthening this industry may result in a more stable export base and help to Azerbaijan's wider goal of developing a strong, varied economy. The development of technology parks and innovation centres bodes well for the growth of the IT industry. This may position Azerbaijan as a regional innovation hotspot, but the business faces problems such as limited infrastructure, particularly high-speed internet access, and a lack of a robust legal framework for digital commerce. Addressing these difficulties is critical for the IT industry's long-term competitiveness, as well as encouraging e-commerce, which has tremendous potential due to rising demand among younger clients.

Transportation and logistics are essential components of Azerbaijan's strategy, particularly the development of the Zangezur and Middle Corridors. These corridors might greatly strengthen Azerbaijan's position as a transit hub between Europe and Asia, increasing non-oil exports by improving access to international markets. The successful execution of these projects would also create opportunities for businesses including construction, manufacturing, and services. However, major infrastructure investments will be required to fully realise these benefits, and public-private partnerships may be important in securing the necessary resources and knowledge. In order to encourage foreign investment, the Azerbaijani government has implemented measures to simplify business procedures and strengthen investor rights. While these initiatives have prompted investment in certain regions, numerous obstacles remain, particularly in terms of regulatory clarity and high business costs. Expanding SMEs' access to capital and eliminating monopolistic arrangements in certain industries may further enhance the business environment. Based on these findings and the current situation of Azerbaijan's economy, numerous recommendations could be offered for further development of the non-oil sector:

1. Enhancement of value-added production. Azerbaijan should prioritise investments in processing industries, including agriculture and manufacturing. This would enhance the export of value-added products rather than raw resources, as well as the expansion of food processing, textile, and chemical manufacturing facilities.

2. Improving financial assistance for SMEs is vital. This may be accomplished by decreasing interest rates, increasing access to finance, and promoting the use of moveable assets as security. Government subsidies and increased market knowledge can help SMEs expand and participate in global value chains.

3. Expansion and modernisation of infrastructure. Azerbaijan's investment in transportation, logistics, and digital infrastructure, such as technology parks, innovation centres, and high-speed internet, will accelerate IT, logistics, and e-commerce growth and attract foreign and local investors.

4. Support of PPPs. Establishing PPPs can improve infrastructure development, especially in transportation and logistics. Simplifying PPP implementation requirements, as well as providing tax incentives and investor protection, can help to attract more money to infrastructure projects.

5. Support tourism and service industries. Promoting Azerbaijan's diversified landscapes, historical monuments, and resort locations may help diversify the economy. Investments in tourism infrastructure, such as hotels and cultural preservation, will provide jobs in both rural and urban regions.

6. Fostering investment in renewable energy. Supporting the growth of renewable energy sectors such as wind, solar, and hydroelectric power may supplement the oil and gas industry by attracting green investments and helping to long-term sustainability.

7. Investment in human capital. Improving vocational training, education, and innovation initiatives to generate a competent workforce will be crucial for promoting the expansion of high-tech businesses and IT sectors, which are critical to Azerbaijan's economic future.

By following these ideas, Azerbaijan may diversify its economy, lessen dependency on oil, and position itself for long-term, steady growth in the global market. These policies are consistent with the country's continuous attempts to modernise its economy and use its strategic position and resources outside the oil and gas sector. Azerbaijan's diversification strategy is reasonable but transitioning from a hydrocarbon-dominated to a more balanced and varied economy would need long-term investment, regulatory changes, and support for high-growth sectors such as IT, manufacturing, and logistics. The focus should now be on fostering value-added enterprises, ensuring infrastructure development, and enhancing the regulatory framework to support innovation and entrepreneurship, particularly in the non-oil industries that are expected to succeed.

4. Discussions

Thus, to ensure the efficient use of Azerbaijan's non-oil sector and ensure sustainable economic development, the government of Azerbaijan could adopt a comprehensive strategy focused on diversification, innovation, and inclusive growth. It may include some recommendations, in particular, increased support for agriculture; more active development of the innovation component, education, healthcare, and services; changes in the legislative framework and more active interaction in the framework of public-private partnerships. In addition, it is important to increase the volume of support for such industries and the quality of the selection of companies that will receive this support. Using such a strategy will allow achieving good results in the field of economic diversification.

The findings imply that in order to further neutralise these risks, Azerbaijan should take a more comprehensive strategy for supporting the non-oil sector, with an emphasis on innovation, value-added output, and infrastructure development. This aligns with Matallah's (2020) conclusions, which emphasise the need for resource-rich countries to diversify their economies to avoid the pitfalls of the "resource curse" and ensure long-term growth. In his analysis of economic diversification in the oil-exporting countries of the Middle East and North Africa, Matallah proved that oil rents substantially and positively impact the growth of oil-exporting countries in the Middle East and North Africa. Moreover, they also contribute to difficulties associated with dependence on oil and gas revenues. In this regard, the author concludes that maximising the income earned by the country can only be achieved through competent management of the diversification of the country's economy, that is, by stimulating the development of other areas besides oil. As part of the current study, it was also concluded that there are conditions in Azerbaijan that allow receiving sufficient benefits from the export of petroleum products. However, this also creates a certain danger due to the fact that they make the country overly dependent on exports of such products. Thus, this once again confirms the importance of securing a sufficiently high level of economic diversification to reduce the negative effects of dependence on exports of one type of product.

Furthermore, this research highlights the importance of long-term, sustained efforts in achieving economic diversification. The complexities of transitioning from an oil-dependent economy to one that is more balanced across various sectors are evident in the challenges faced by other resource-rich countries, as discussed by Lashitew *et al.* (2020). They noted that in resource-rich countries, there is an urgent need for economic diversification to mitigate the risks associated with unstable commodity prices and limited employment opportunities in the extractive sector. Despite this, achieving such a goal is quite a difficult task for statesmen. As successful examples of such diversification, researchers cite Oman, Laos, and Indonesia, linking them to human, social, intellectual capital and business potential. However, increased competitiveness has not always

accompanied improved diversification, especially in resource-rich countries (Nogoibaeva *et al.* 2024). The example of Oman illustrates the difficulty of achieving proper diversification: the country's manufacturing sector, despite rapid growth, still contributes a negligible share to GDP, and the country remains dependent on oil revenues. Thus, researchers conclude that there is a complex relationship between resource wealth and a country's competitive abilities and solving problems that arise in connection with resource wealth, which are quite difficult to eliminate. This study also noted that it is quite important for Azerbaijan to ensure a high level of economic diversification. This will reduce the risks that arise due to the too high level of dependence on the sale of petroleum products. However, this process itself is not simple and must be conducted over a sufficiently long period of time to show any results. Currently, it can be stated that Azerbaijan has managed to achieve certain results in this area for a fairly long time. However, to adhere to the same trend in the future, the state authorities should use the recommendations that were proposed above in the study aimed at supporting companies in the non-oil sector.

A study analysing the relationship between export diversification and renewable energy consumption was conducted by Shahzad *et al.* (2020; 2021). Researchers considered the consumption of renewable energy as a function of export diversification, economic growth, industrialisation, openness to trade, and natural resources. The results showed that policies promoting product diversification have a positive impact on the demand for renewable energy in both developed and developing countries. In addition, the paper confirms a non-linear relationship between export diversification and renewable energy consumption. Although this study has not paid attention to how economic diversification affects the development of renewable energy sources, nevertheless, it is worth recognising that such a relationship is one of the reasons why it remains an important component of the country's development.

A similar study was conducted by Fatima *et al.* (2021): The authors analysed the impact of export product diversification on the demand for renewable and non-renewable energy sources in the Persian Gulf countries from 1990 to 2019. The results showed that initially, product diversification reduces renewable energy consumption, but after a certain threshold, it increases the use of renewable energy sources, indicating an inverted U-shaped relationship between product diversification and energy consumption. This suggests that diversification can reduce dependence on oil and fossil fuels, which is consistent with the Sustainable Development Goals and promotes cleaner energy sources in the region (Guliyeva 2023). Researchers also noted the role of human capital, trade, and natural resources that affect energy consumption. Thus, it was recommended to support export diversification to increase the use of renewable energy sources, which can contribute to economic sustainability and the goal of combating climate change. This study did not pay much attention to the impact of economic diversification on the development of renewable sources. Nevertheless, it is worth noting that this interaction does exist. This has ambiguous consequences for Azerbaijan. On the one hand, the country's international specialisation is largely aimed at exporting petroleum products, which means that trends related to economic diversification (in other countries) are not beneficial for it. On the other hand, such trends are beneficial when conducted inside Azerbaijan since they can increase the stability of the economy from instability that can arise at any time, both inside the country and abroad. Thus, the formation of a policy of economic diversification is a truly effective method and an effective approach to achieving the main long-term goals of the country.

The short- and long-term asymmetric effect of oil prices and revenues from the sale of petroleum products on real GDP in oil-dependent economies was investigated by Charfeddine and Barkat (2020). Researchers noted that in the short term, Qatar's economy is more negatively affected by negative shocks to real oil prices than by the positive effects of oil revenues. This may indicate that in the short term, negative effects manifest themselves more clearly than positive ones. However, in the long term, the situation looks different since the positive effects have a relatively greater weight. In this regard, researchers recommend taking measures aimed at diversifying the economy to reduce asymmetry on the impact of the development of the country's economy from prices, supply, and demand for oil. Thus, the conclusions obtained in the framework of the study generally agree with those obtained: given the instability that may arise due to dependence on exports of petroleum products, it remains important to ensure a sufficient level of economic diversification. Therewith, this is typical for virtually all countries.

The findings of this study corroborate the premise that Azerbaijan's long-term economic performance is based on a well-executed diversification program. The country's priority should be to increase its non-oil industries' innovative abilities, enhance SMEs' access to finance, upgrade infrastructure, and invest in human capital. By addressing these crucial industries, Azerbaijan may achieve more sustainable growth while decreasing its reliance on the volatile oil and gas industry. The findings also call for continuous policy monitoring

and adaptation to keep the diversification process on track, with a particular emphasis on supporting value-added sectors and incorporating renewable energy solutions into the national economy.

Conclusions

As part of the study, it was shown that the modern development strategy of Azerbaijan is largely aimed at ensuring the diversification of the country's economy. This is crucial for sustainable economic growth, job creation, and reducing vulnerability to global fluctuations in hydrocarbon prices. The non-oil sector itself represents a fairly large range of industries, but agriculture, tourism, and information technology are the most actively developing among them in Azerbaijan.

The Azerbaijani authorities are currently actively working towards the formation of various programmes, the main purpose of which is the development of various sectors of the economy. Substantial investments were made in agriculture and brought quite extensive results, in particular, by increasing export potential and innovation opportunities. A similar situation is observed in industry, tourism, the information technology sector, and other areas. Attracting foreign investment and improving the business environment through reforms are central to this activity: government initiatives to simplify business registration, reduce taxes, and protect investors' rights are a major part of government policy in this area.

The study showed that the development of the Zangezur Corridor and the Middle Corridor also plays an important role in stimulating the growth of the non-oil sector and improving transport and transit relations. These projects not only contribute to the development of Azerbaijan's economy but also strengthen its position as the most important transit hub between Europe and Asia, offering new opportunities for construction, manufacturing, and services. Public-private partnership is also considered as one of the options, which will be especially effective in achieving the best results in the logistics sector, which will have a positive impact on other industries. The development of the legislative framework, solving problems in the field of e-commerce and assistance to SMEs will also achieve better results. With the active subsequent application of the already existing stimulation of the non-oil sector, it will be possible to achieve fairly good results in this area in the long term. In subsequent studies, it is important to examine the specific features of each of the non-oil spheres in more detail for their effective development.

Credit Authorship Contribution Statement

Kamran Abdullayev: contributed significantly to conceptualization, methodology, investigation, formal analysis, and writing activities.
Fikrat Guliyev: was involved in conceptualization, methodology, project administration, validation, and contributed to writing and editing.
Gunay Teymurova: participated in methodology, software, formal analysis, and visualization aspects.
Muslumat Allahverdiyeva: contributed to conceptualization, methodology, project administration, data curation, and validation.
Nigar Bagirova: played a key role in conceptualization, methodology, project administration, supervision, funding acquisition, and writing and editing tasks.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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Volume XV, Issue 4(32), Winter 2024

DOI: https://doi.org/10.14505/tpref.v15.4(32).16

Return on Equity in Albanian Banks: A Data-Driven Analysis Using XGBoost

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Article info: Received 20 August 2024; Received in revised form 18 September 2024; Accepted for publication 8 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: This paper estimates the determinants of bank profitability in Albania with respect to return on equity. This study will employ annual reports from eleven banks in Albania covering the period 2014 to 2023, supplemented by extra sources from the Albanian Association of Banks and the Bank of Albania. Data analyzed at a great level of detail using Python. It evaluates an integrated conceptual framework of the influence of financial metrics, institutional infrastructure, and customer service channels on RoE. An XGBoost regression model is applied to predict RoE since this algorithm has advanced ensemble learning capabilities in refining predictions by iterative error corrections. The model is fine-tuned for Mean Squared Error minimization and performs very well on the training data, as evidenced by an R^2 score of 0.9999. The model slightly overfits, as can be indicated by the lower performance metrics on test data: MSE of 31.8768 and an R^2 score of 0.6024. Concretely, number of outlets, investments in securities, and debit card issuance are the variables most influencing RoE, as can be inferred from the importance analysis. This paper contributes to the literature with useful insights into financial performance and operational dynamics in Albanian banks, evidencing variables that play a significant role in profitability and, therefore, supply scope for further research and model improvement.

Keywords: bank profitability; feature importance; machine learning; XGBoost.

JEL Classification: E44; G21; G28; C10.

Introduction

Forecasts of bank profitability are very important in any effective management of the financial institution and strategic planning, more so for those banks with specialized services or niche markets. Accurate profitability forecasts can help such institutions greatly make relevant business decisions, manage their resources efficiently, and develop a competitive edge over other banks. Traditional ways used in making predictions hardly capture the complex patterns and interactions that exist in financial data, hence less accurate results.

In the sphere of artificial intelligence, machine learning offers advanced techniques for the above-mentioned problems. Using algorithms and statistical models that learn from experience, machine learning offers superior predictive capabilities. More importantly, one of the main reasons that makes XGBoost an important technique is its capacity for dealing with large datasets and creating complex patterns; hence, in bank profitability

forecasting, it becomes very effective. The following paper presents the application of XGBoost in predicting profitability for specialty banks. Doing so, it fills the literature gap by proving its effectiveness in this context. The objective of this study is to provide novel insights into profitability forecasting by elaborating on model adaptability to changing market conditions and making more accurate predictions.

1. Literature Review

This chapter reviews the existing literature on the banking sector, highlighting the key research findings and theoretical perspectives that shape our understanding of its dynamics. We will explore major contributions to the field and identify gaps that our study aims to address.

Menicucci and Paolucci (2016) in their research have used panel data estimation with a representative sample of 28 large European banks between 2006 to 2015 to evaluate the effect of internal bank-specific factors on European bank profitability. The authors further support that bank size, being measured by the value of total assets, is the most important driver of profitability. This shows that with scales of operation, bigger banks have economies of scale and product diversification. Besides this, the study has also found from the resultants that in relation to profitability, asset quality exerts negativity, while the deposit ratio of the bank shows positive and impactful results for ROE. The capital strength of banks through the equity/total assets ratio secures profitability, in the sense that high equity reduces the costs of external financing, but net loans to total assets show no significant signs with accounting for profitability variations. The results offer rich insights for bank management, regulators, policy makers, shareholders, and other stakeholders on how stability and competition can be better preserved within the European banking market. The study also provides directions relevant for future investigation of the problem, in particular, the analysis of other factors, such as taxation or service quality, and an exploration into differences between banks in the different size and profitability groups.

In their study, Titko *et al.* extend the debate on performance management and performance drivers of the banking sector within the Baltic States. In their findings, it is noted that although Lithuanian data supported a positive relationship between bank size and its degree of profitability, Latvian data did not support such a hypothesis. Their findings from the research on the association between operational efficiency and bank profitability were very mixed for Lithuania and rather inconclusive for Latvia. The study also does not find any support for the notion that the advanced level of infrastructure and e-banking services is actually an explanation of high profitability, at least in the case of Latvia. Data was limited, and statistics from the local authorities were not consistent with the statistics provided by the European Central Bank. This, therefore, made the authors recommend that future analyses be based on individual banks, mostly in small banking sectors, with an extension of the research period if more concrete results are to be expected.

According to Aspal *et al.* (2019), Capital Adequacy is another internal factor unique to banks, apart from the asset factor. Asset Quality (AQ), Management Efficiency (ME), Earnings Quality (EQ), and liquidity are some of the critical factors of differences in financial performance by private sector banks in India. Findings demonstrated the negative relationship of Capital Adequacy with bank performance that is statistically non-significant. Asset quality was negatively and significantly related to profitability. This means that, if an asset quality lacks or a high level of non-performing assets exists, it will detract from high performance. Management efficiency, as indicated in the expenditure-to-income ratio, negatively relates to profitability to the bare minimum, meaning that it is very important for the bank to cut back on its expenditures in order to maximize the profits. On the other hand, it is noteworthy that Earnings Quality and Liquidity management had an overall positive and significant effect on the financial performance: banks with good earnings quality and good liquidity management are likely to achieve a more significant profit. Lastly, macroeconomic factors like GDP and inflation perform negatively related to bank performance, but their overall impact on the private banking sector financial performance was considered inconclusive.

Mashamba and Chikutuma (2023) identify the drivers of bank profitability in Zimbabwe, one of the countries that has experienced a myriad of economic challenge over the last ten years. Based on panel data of 11 commercial banks from 2011 to 2020, they found out that bank-specific variables such as non-interest income, liquidity, cost efficiency, capital adequacy, and bank stability - worthwhile and turning negative - all drive profitability to levels of statistical significance. The industry factor of bank concentration, however, has a negative effect on profitability. Surprisingly, though, the macroeconomic variables - GDP and inflation - are high in Zimbabwe, with very low growth rates and high inflation, and yet they do not seem to affect bank profitability. In addition, it appears that increasing regulatory capital reduces the positive impact of bank stability on profitability, suggesting that the possibility for risk-taking, and therefore profits, is reduced with higher capital requirements for banks. Other findings also include that there is no significant moderating effect of FinTech on bank performance,

thus proving that the impact of FinTech on the banks' competitiveness in non-interest income activities is limited. In its entirety, tha auhors draw a conclusion that it is the internal factors, controlled by bank managers and regulators, that are really important for bank profitability, not the external factors related to economic factors. They, therefore, provide policy recommendations toward the improvement of bank profitability and the strengthening of the banking sector in Zimbabwe.

According to Muchtar *et al.* (2021), the study investigates the risk determinants of banks in ASEAN countries moderated by bank scale, whereby Random Effects Model will be used to undertake analysis that involves panel data. Their study is on banks in ASEAN-4 and also Indonesia, that is, Indonesia, Malaysia, Philippines, and Thailand, examining such risk measures as Standard Deviation (STD) and Value at Risk (VaR). The results further indicate that, although of the ASEAN-4, the CAR is negatively related to STD, it has found no association with Bank Risk in Indonesia. Meanwhile, the NPLs do not often alter Bank Risk for ASEAN-4, but do have a significant effect on VaR in Indonesia. The LDR results in a negative effect on VaR in both regions. MP has a negative effect on STD and a positive effect on VaR in the ASEAN-4. However, it has no effect in Indonesia. Exchange Rate has a negative impact on STD in the ASEAN-4, and it has a positive effect in Indonesia. Interest Rates do not have an influence on neither STD nor VaR in either of the regions. TI has a negative influence on STD but has a positive effect on VaR in the ASEAN-4. In Indonesia, it negatively influences Bank Risk. Finally, bank scale or BUKU Bank (BB) has a negative impact on STD in ASEAN-4 and has no significant impact on Bank Risk in Indonesia.

In the research, Keka *et al.* (2023) have highlighted what determines the profitability of commercial banks in Kosovo and Albania. According to them, this research is very important for policy makers, regulators, and bank management. Determinants considered in this study include the number of employees, interest rates on loans, non-performing loans, total loans, among others. In carrying out this study, quarterly secondary data from the years 2010-2020 were sourced, totalling 400 observations. The research employs multiple linear regression and ordinary least square analysis so as to establish any kind of interactions between dependent and independent variables that would help in establishing what drives bank profitability. All the statistical analyses were done with the aid of specialized software such as STATA and SPSS. Results show that loan interest rate, total loans, and non-performing loans are the major variables affecting profitability, while total loans and number of employees are the major determinants of ROE. These findings, according to Keka et al., add some valuable lessons for fine-tuning bank management and policy making toward improved profitability and stability.

According to Chand *et al.* (2024), while exploring the interplay of globalization, institutional quality, and global uncertainties - the COVID-19 pandemic - in the banking sector of Fiji during the period of 2000 to 2021, all of the above affect the profitability of banks in small island economies. They have pointed out that bank-specific indicators are not sufficient to understand profitability, and they have established, for example, that while elements such as net interest margin and capital adequacy have a positive effect on performance, other challenges such as non-performing loans and global crises are factors that diminish it. Their findings favor a strong regulatory environment and political stability as ways of enhancing the resilience of the financial sector and propose exploring opportunities in remittances and economic growth. They also embrace the unique challenges that small economies like Fiji face and put emphasis on the need for an integrated approach to profitability and risk analysis. Notwithstanding the limitations of a small sample size and only being confined to the deposit and lending institutions, the study provides significant insights and areas that can be used as extensions in future studies to fill data gaps.

The relative value importance indicator obtained from the random forest model, Almaskati (2022) use it to obtain an assessment of comparative significance with respect to the various determinants affecting bank risk and profitability. From this study, they conclude that bank-specific factors are the main drivers of profitability, whereas country factors have a more significant impact on determining risk. They identify market power and size as key in profiling both profitability and risk. It also depicts the high contribution of a nation's financial development and regulatory quality in driving a bank's risk. This analysis also shows that the risk profile of a bank is driven by a number of variables with almost equal intensity while profitability is driven by very few dominant variables while others are relatively insignificant. Further research in the future into how sudden or structural changes in values of these key variables affect banks' profitability and risk should bring out insights into their effect and help regulators and policymakers zero in on what is most important for stability in the banking system.

In their empirical study, Mirovic *et al.* (2024) regarded the literature gap with the determinants of bank profitability in the Eurozone through an analysis using quarterly data from 2015 to 2020. Their study was conducted by descriptive statistics, panel unit root tests, and cross-section dependence tests with the application of static and dynamic panel models like pooled least squares, random effects, fixed effects, and generalized

method of moments. The Hausman test showed that the random-effects model was appropriate for the estimation of the determinants of profitability. In their result, they found that both bank-specific and macroeconomic factors had significant effects on profitability: non-performing loans and a cost-to-income ratio increase reduced ROA and ROE, while net interest margins, net income from fees and commissions, and trading assets boosted these measures of profitability. Moreover, ROA and ROE improved with enhanced GDP growth and were eroded by rising inflation, unemployment, and debt. Their findings are consistent with prior studies and underline the fact that profitability is required for shareholders' returns, customers' benefits, financial stability, regulatory compliance, and investor confidence. In this regard, this paper contributes to literature since most of the studies do not use all these macroeconomic variables. One of the known limitations is not considering economic cycles in the analysis, and further research is suggested in evaluating the consistency across different periods in an economic cycle: pre-pandemic crisis, during, and post-pandemic crisis.

In the case when studying the profitability of the Macedonian banking system during the period from 2007 to 2022, Kosumi and Xharku (2024) developed a model where the return on assets stood as a dependent variable. According to their results, factors such as the size of the banking sector, credit risk, liquidity, income diversification, and non-performing loans are the negative drivers of profitability. On the other side, capital adequacy, operational efficiency, GDP, and interest rates are positive determinants for the same. In detail, Macedonian banks should focus on asset management to improve profitability, increase non-interest income in order to avoid credit risk and non-performing loans, and maintain favorable liquidity ratios. Second-tier banks should adopt international expansion, improvement in the management of the loan portfolio, and investing in technology for improved crisis management. Diversifying income sources, hence boosting non-interest revenue, remains another way through which the banks could survive the crisis and strategically navigate the legal environment. This may serve as valuable information for policymakers, regulators, and bank management within North Macedonia. Future research will focus on covering a larger set of economic, legal, industry, and bank-specific factors that explain the profitability of banks.

According to Raiter (2021), most financial institutions are challenged in dealing with a wide variety of risks that affect it, especially on credit risk. Most banks do not really understand the risks of an individual loan or investment and even the total credit risk inherent in their portfolios. Credit risk is still the most crucial financial risk for most institutions. Effective risk management would, therefore, seek to keep the potential impact of these hazards within acceptable levels across society, including risks associated with the environment, technology, people, organizations, and politics. This paper examined the determinants of credit risk by commercial banks worldwide based on WDI and Bankscope data on 106 commercial banks worldwide. This analysis brought out that, in addition to currency rates and regulatory capital, variables like inflation, interest rate, and unemployment rates have a very strong impact on credit risk - one would be considering that a high value of these variables implies a high credit risk for banks. Conversely, bank efficiency, bank size, and the GDP growth rate seemed to bear a strong negative impact on credit risk, showing that credit risk decreases when times are economically good. It was also found that the private sector banks, in general, exhibited lower credit risk as compared to the public sector banks.

In their paper, Islam and Rana (2019) investigate the various bank-specific and macroeconomic factors impacting bank profitability by taking data from 23 commercial banks in Bangladesh for the period 2013-2017. The data has been obtained from annual reports of the respective individual banks, Bangladesh Bureau of Statistics, and different publications of the Bangladesh Bank. They hold their regression analysis through a fixed effect panel data model. In the case of this study, three profitability measures will be used: ROA, ROE, and NIM. For ROA, the results indicate that earning variables, including TIN and NII, and structure of assets, DPST, positively affect ROA, while the quality of assets, NPL, negatively affects it. For ROE, earning variables, TIN and NII, and strength of capital, CAP, all have a significant positive effect, while the quality of assets has a remarkable negative effect. In the case of NIM, earning variables are significantly related to capital strength and liquidity. It can be seen that among the macro variables, the GDP growth rate, inflation rate, and interest rate are found to be insignificant for influencing profitability. These findings would enable investors, policymakers, management, and other stakeholders to make informed decisions for future improvisations in the performance of the financial organizations.

Aktas *et al.* (2015) point out that banks normally maintain capital in excess of the legal requirement, thus implying that there could be other factors besides the regulatory requirement for capital that influence their capital structure. Their paper estimated two models for explaining the determinants of capital adequacy ratio in the Southeast European region. Model 1 includes bank-specific variables such as size, profitability measured by ROA, leverage, liquidity, net interest margin, and risk. The second model includes a considerable number of

environmental factors, such as the economic growth rate, inflation, real interest rate, stock market volatility of the Eurozone, deposit insurance coverage, and governance indicators. They have evidence from the analysis using Feasible GLS that size, ROA, leverage, liquidity, NIM, and risk significantly affect CAR, with the different signs indicating whether it is a positive or negative effect. The other factors playing important roles are environmental factors of economic growth rate, stock market volatility in the Eurozone, deposit insurance, and governance. This study consequently reveals that determinants of CAR in developed economies can be relevant in explaining CAR for banks within the SEE region, which, with the exception of Greece, are transition economies undergoing various economic and banking reforms.

Assfaw (2020) have estimated the determinant variables for capital structure in private commercial banks of Ethiopia based on data from 2010–2018. They ran a Clustered Robust random effect regression model which portrayed that on average, bank assets were financed by debt in an average percentage share of 86.53%. With an increase in bank size, there was a rise in leverage measures hence supporting the trade-off theory but contradicting the pecking order theory. In the second model, profitability negatively influenced the levels of debt, consistent with the pecking order theory but contrary to the trade-off theory. The tax variable positively influenced leverage, thus agreeing with the static trade-off theory. Tangibility of assets had a negative effect on leverage and thus conflicted with both the agency and the static trade-off theories. Earnings volatility positively affected leverage consistent with pecking order theory but not with trade-off theory. Growth opportunities, real GDP, and inflation had a minimal impact. The study, therefore, is to advise Ethiopian banks to put into consideration both factors, that is, microeconomic and macroeconomic factors in optimizing their capital structure and point out areas for future research.

Serwadda (2018) attempted to gauge the influence of intrinsic drivers on the profitability of commercial banks in Hungary from the period 2000–2015. In doing so, they applied a balanced panel data set of 26 banks with 416 observations, where they checked for profitability using return on average assets as the dependent variable against explanatory variables such as non-performing loans, overhead costs, bank size, net interest margin, liquidity risk, and capital adequacy ratio. Their findings showed that bank-specific factors have a great influence on the profitability of a bank, especially bank size and asset quality. On the contrary, those which weighed negatively in determining profit included non-performing loans, high overhead costs, and liquidity levels. Net interest margin and capital adequacy ratio had a positive but insignificant effect, and the recommendations were for banks to pay more attention to reducing and managing overhead costs, enhancing asset quality, and optimizing liquidity levels in order to realize higher profitability. It also recommended that bank managers keep tight reins on credit and liquidity risks, as well as strive to diversify income against the backdrop of effective cost controls.

2. Research Methodology

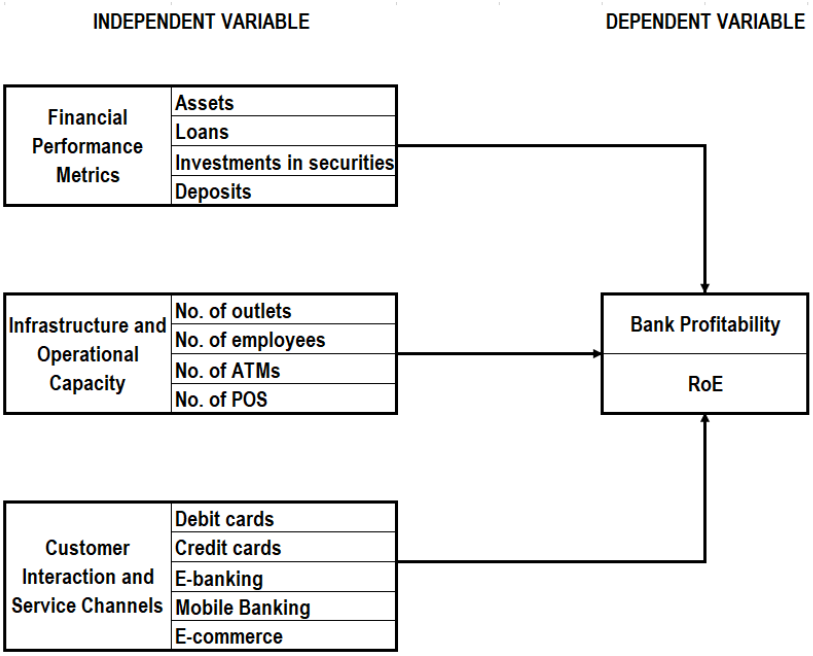
2.1. Data Source and Analysis

In this study, data were acquired from annual reports of eleven Albanian banks, covering the period 2014 – 2023. These banks include Banka Amerikane e Investimeve, Banka Kombëtare Tregtare, Credins Bank, Fibank Albania, Intesa Sanpaolo Bank of Albania, ProCredit Bank, Raiffeisen Bank Shqipëri, OTP Bank Albania, Banka e Tiranes, Union Bank, and Banka e Bashkuar e Shqipërisë. Downloaded directly from the official websites of the banks and supplemented by data from the Albanian Association of Banks and the Bank of Albania, these reports were subjected to analysis by means of Python, a very versatile and powerful programming language, oriented to the area of data treatment and statistical analysis.

2.2. Conceptual Framework

The purpose of this research is to evaluate Return on Equity's complex relation with other independent variables in order to find the driving factors of bank profitability. This analysis is based on the assumption that financial performance measures, such as assets, loans, investments in securities, and deposits, make major contributions to RoE while reflecting the bank's operational efficiency and market position. It is expected that the infrastructure and operational capacity variables will influence RoE, as such variables outlets, employees, ATMs, and POS terminals are bound to condition the bank's ability to effectively manage and leverage the bank's resources. The variables of customer interaction and service channels are also expected to have an influence on RoE, since these are related to debit cards, credit cards, e-banking, mobile banking, and e-commerce, which deepen relationships and increase revenue sources. This is visualized in the conceptual model of this study, which lays out these relationships and follows through with a clear depiction of how each of these variables contributes to the overall profitability of banking institutions.

Figure 1. Conceptual framework



Source: Author's calculations

2.3. Econometric Model Framework

For this research, we will use an XGBoost model since it is one of the best and most efficient algorithms for regression tasks. Since it is a boosting algorithm, XGBoost combines many weak models in order to develop a strong model for prediction. It makes iterated predictions for continuous variables by minimizing the loss function, and therefore in regression problems, it gives continuous variable predictions. Base learners are decision trees that are refined sequentially to correct errors made by previous models; therefore, a highly accurate model results from key ensemble learning principles.

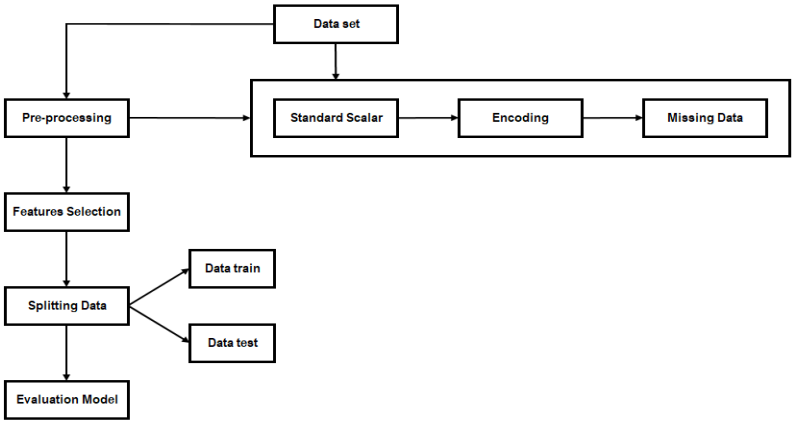
In the regression tasks, XGBoost is ready to minimize many different loss functions: Mean Squared Error and Mean Absolute Error; Huber Loss; Quantile Loss; Log-Cosh Loss; Poisson Loss. In this research, MSE will be used since it is a measure of average squared differences between predicted and actual values.

The training process initializes the model with basic predictions, and then decision trees are added sequentially, updating the predictions based on what each tree contributes. The other core hyperparameter is the learning rate, which tells by how much each new tree shall eventually impact the final prediction, the smaller the rate, the greater the number of trees needed for optimum performance. Careful data preparation is necessary when incorporating the XGBoost regression in a framework of an econometric model. All the features must be pre-engineered in such a way that they represent correctly the economic relationships that are to be studied. Normalization/standardization of features might end up as necessary to be more efficient for the algorithm. Parameter Tuning: Grid or random search methods are used to find the best combination of hyperparameters, which can be used in the XGBoost model. Train and test sets have to be validated to prevent overfitting situations and also to allow validation independent of train sets.

Metrics to use for assessing goodness of fit of the XGBoost regression model include MSE, MAE, or R-squared. Besides, XGBoost also provides feature importance estimates, explaining which variables are most influential for the predictions.

In Figure 2, the process of data preparation and model evaluation is illustrated. This figure outlines the key stages involved, beginning with the dataset and encompassing pre-processing steps such as standard scaling, encoding, and handling missing data. It then progresses through feature selection, data training, and splitting the data into training and test sets. Finally, the figure includes the model evaluation phase, providing a comprehensive view of the entire workflow.

Figure 2. Data Preparation and Model Evaluation Process



Source: Author's calculations

3. Research Results

The current chapter expounds on the financial performance, institutional infrastructure, and service capabilities of the institutions under study. The key financial metrics are first analyzed, followed by an overview of the infrastructure and operational capacity, and finally the analysis of customer interaction and service channels. The following three tables present information and its interpretation to provide nuanced insight into the performance of these institutions, their operational scale, and capacity to reach clients through the various service channels. This will be insightful in assessing strengths of the institutions and in identifying areas requiring improvement.

In Table 1, the financial performance indicators of these institutions are presented, which reveal a very high level of variability in assets, loans, security investments, and deposits. Mean values are ALL92.95 billion for assets, ALL34.28 billion for loans, ALL26.20 billion for investments in securities, and ALL76.67 billion for deposits. The extreme range of the asset values from ALL21,141 to ALL491.47 billion, and the variation of loans and investments, give a good example on the different scales and financial strategies the institutions employ. The wide range of deposits also portrays the disparity in financial capacity and deployment of resources by the banks.

Table 1. Descriptive Statistics for Financial Performance Metrics

	Assets	Loans	Investments in securities	Deposits
count	105	105	105	105
mean	92,946,330	34,276,150	26,204,990	76,670,990
std	124,233,200	39,937,910	37,941,650	103,438,500
min	21,141	16,847	0	34,235
25%	1,030,211	334,541	138,967	899,849
50%	38,216,890	22,157,380	7,540,288	27,022,120
75%	130,819,000	53,002,250	39,545,180	107,079,100
max	491,473,200	138,066,000	160,292,100	415,973,100

Source: Author's calculations

Table 2. Descriptive Statistics for Infrastructure and Operational Capacity

	No. of outlets	No. of employees	No. of ATMs	No. of POS
count	105	105	105	105
mean	37	571	69	1,021
std	25	400	55	1,933
min	5	74	0	0
25%	14	252	30	0
50%	32	447	59	213
75%	57	857	74	992
max	93	1,406	230	9,631

Source: Author's calculations

Table 2 shows the institutional infrastructure and capacity to handle activities. The average bank operates 37 outlets staffed by an average of 571 people, manages 69 ATMs as well as 1,021 POS terminals. The data show high variation in particular with regard to the number of employees and the number of POS terminals, from 74 employees to 1,406, and from no POS terminals at all to 9,631. This variability may hint at differences in scale of operations and investments in technology that have consequences for the ability to deliver services and manage customer interactions appropriately.

Table 3 outlines the metrics for customer interaction and service channels, with a focus on debit and credit cards. The average institution that issues debit cards are 95,514, while that of credit cards is 9,898. The debit card issuance ranges from 0 to 364,702 and that of credit card numbers from 0 to 73,719 show various strategies in customer engagement and provision of service. It is the very wide range of these figures that highlights a very different way of dealing with customer relationships and underlines the fact that individual customer relations strategies are an important means to meeting customer needs.

Table 3. Descriptive Statistics for Customer Interaction and Service Channels

	Debit cards	Credit cards
count	105	105
mean	95,514	9,898
std	101,002	16,253
min	0	0
25%	26,372	668
50%	60,504	3,814
75%	121,180	6,513
max	364,702	73,719

Source: Author's calculations

In the table below, we have results for both training and testing. According to this result of the training set, the accuracy of the XGBoost regression model will be at a high rate. The Mean Squared Error values are 0.045172, with a Mean Absolute Error of 0.139053. It is shown by these metrics that the average error which the model makes in the prediction of training data is low. The mean squared error brings out fine-squared differences between the predicted and true values, while the mean absolute error indicates a small average absolute error. The R^2 Score was very high at 0.999915, as was also the Explained Variance Score at 0.999915; this establishes that the model explains almost all variability in the training data and is a very good fit.

On the test set, model performance is such that it looks very promising, but there is an observable difference against the training set. The MSE is 31.876789, with an MAE of 4.185301, considerably higher than what was observed in the training set. This could be an indication that predictions on unseen data are not very accurate; probably a case of overfitting, where the model goes very well with the training data but poorly on new, unseen examples. The R^2 Score of 0.602384 and the Explained Variance Score of 0.779401 already show that generalizability to new data can be much improved, although it captures a fair share of the variance in the test data.

Table 4. Model Metrics

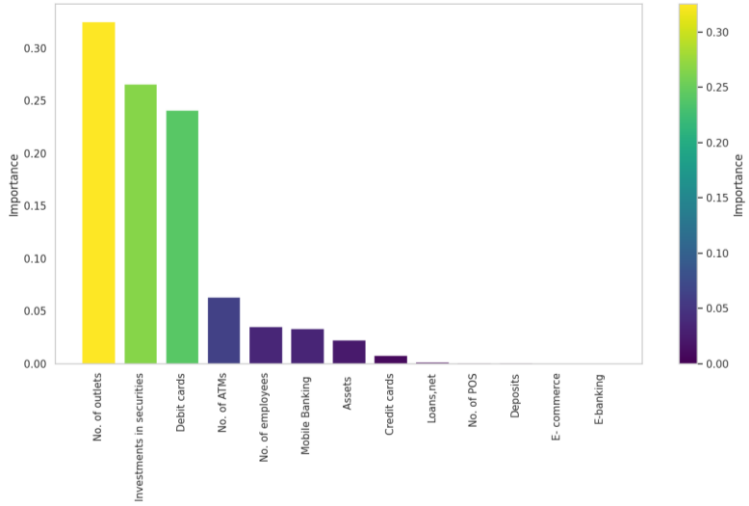
Metrics	Train	Test
MSE	0.0452	31.8768
MAE	0.1391	4.1853
RMSE	0.2125	5.6460
R2 Score	0.9999	0.6024
Explained Variance Score	0.9999	0.7794

Source: Author's calculations

According to the important analysis of the features in Figure 3, number of outlets was the most influential variable with respect to predictive power, accounting for about 32.5 percent. Next in a row comes investments in securities, contributing to about 26.6 percent of the predictive capability of the model. Debit cards are also important and represent about 24.1 percent of the importance. Comparatively, lower impacts are by features such as the number of ATMs with 6.3%, followed by the number of employees with 3.5%. Mobile banking, assets, and credit cards contribute even less, of 3.4%, 2.3%, and 0.8%, respectively. Loans, net, contribute 0.15%, number of

POS with 0.12%, deposits alone contribute minimally; e-commerce and e-banking do so less, with e-commerce at 0.0175% and e-banking at 0%. This distribution underlines how physically and financially transaction-related features are most primary in influence on other variables within the model.

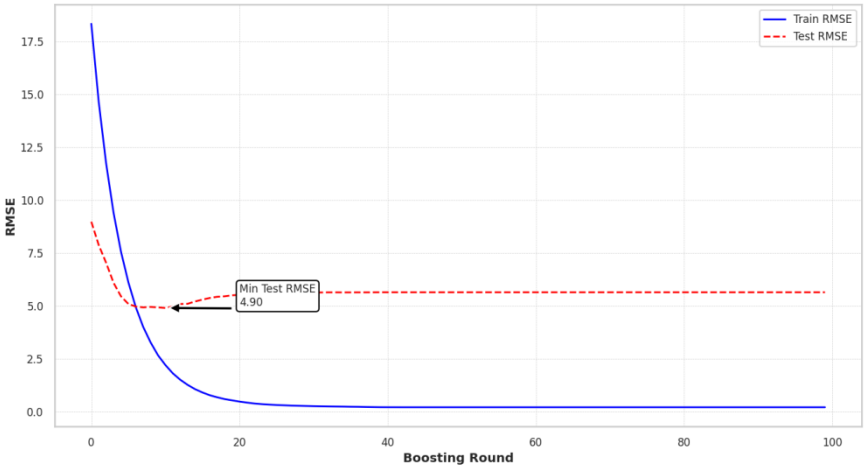
Figure 3. Feature Importances



Source: Author's calculations

Results from your XGBoost model are rather great at improving early on, and RMSE on both validation sets is decreasing rather fast during initial iterations. It learns and fits the data quite well; RMSE values decrease from 18.33297 and 8.98150 at iteration 0 down to 2.66945 and 4.93107 at iteration 9. Progress slows a bit in the middle stages; the RMSE values do decrease but at a slower rate. By iteration 20, the model's performance has already stabilized, most especially in training set, which holds an RMSE to about 0.21254. It indicates convergence, though the model shows some signs of overfitting since the testing set is still higher, which means it worked better on the training data than on the validation set. The model learned data quite well overall, and performance metrics are stable.

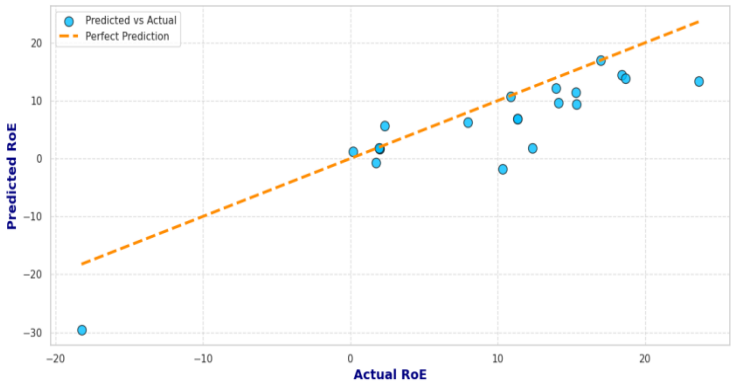
Figure 4. Training and Testing RMSE



Source: Author's calculations

In Figure 5, the comparison between predicted and actual Return on Equity (RoE) for the test set is depicted. This visualization provides insights into the model's prediction accuracy relative to actual RoE outcomes.

Figure 5. Predicted vs Actual Roe (Test Set)



Source: Author's calculations

4. Discussions

This study affords valuable results on the implication of XGBoost in bank profitability prediction, but more specifically, the implications for Albanian banks, which are concentrated in specialized activities. The results demonstrate the potential that machine learning algorithms, especially the XGBoost algorithm, can hold in improving predictions in matters related to profitability over traditional methods of such predictions.

4.1. Implication of the Results

The application of the XGBoost model turned out to have very high predictive accuracy that can be derived from the low Mean Squared Error and Mean Absolute Error, along with a high R-squared score. This clearly indicates that the model has been able to capture the complex relationship between independent variables and Return on Equity, thereby providing reliable forecasts of bank profitability.

This study contributes significantly to showing how XGBoost can be used with large datasets to bring out complex patterns that the traditional models might have missed. The capability of XGBoost to handle vast volumes of data, combined with the inclusion of a variety of facilities - ranging from financial performance indicators to institutional infrastructure, such as customer service channels - clearly demonstrates the strength of this model in the production of accurate predictions. This is of particular relevance to the instance of the specialty banks with their unique offerings and niche markets, in which traditional models are often incapable of accurate forecasts.

This also indicates the importance of inclusion of as wide range of variables as possible in profitability forecasting. It is in allowing such diverse factors as operational ability, customer interface metrics, and financial performance indicators to combine that the XGBoost model can give a picture on what could appear as a determinant of bank profitability. Such a multifaceted approach gives an enriched understanding of how various elements interact with each other and contribute to financial performance, plus assists banks in making more strategic decisions with more informed judgment.

4.2. Implications for Management of Banks

The results indicate that the use of advanced techniques of machine learning, as an example, XGBoost would enable the bank managers and decision-makers to have more precise findings and a view of action into the profitable aspect. In case profitability in future can be predicted precisely, then the banks shall be in a better position to allocate its resources, optimize operations, and develop strategies to maximize a competitive advantage. Moreover, awareness of the relative importance of various factors that influence profitability might allow managers to focus individual efforts on those initiatives that have the potential for having the greatest impact on financial performance.

The paper further resonates with the need for constant data monitoring and model update. Most probably, the factors impacting profitability may change as market conditions and internal dynamics change. This would mean the need for model predictions to respond to minimal considerations. For such a reason, constant updating of the XGBoost model with new data and recalibration of parameters shall keep the forecasts relevant and accurate to the point.

Conclusions and Further Research

Conclusions

The current research paper was able to confirm that the XGBoost model is effective in predicting the profitability of commercial banks, mainly specialization banks in Albania. The better performance of the XGBoost model compared to the other classical forecasting models, tested here in this paper, underlines that the XGBoost model has the potential to be a useful approach for financial institutions that aim to profit from predictions.

The approached in-depth analysis during this study presented several important results:

- High accuracy of XGBoost: The model of XGBoost showed a high share of predictions, relativised by errors, and proved to be considerably high in the R-squared value. This, therefore, proves the adequacy of the model for effective forecasting of bank profitability.
- Diversified variables: Diversifications of the variables included in the model have given a vast view of the profitability determinants, signifying the venture of working in a holistic manner for prediction.
- Value for Bank Management: The ability to come up with good profit projections is of overriding value to bank management in operational decisions and strategic planning.

Further Research

Though this study made major achievements in the profitability forecast, there are various aspects that would need more research:

- Other Machine Learning Algorithms: Further work may investigate what other machine learning algorithms, such as neural networks or support vector machines, would really compare with in terms of the performance of the XGBoost algorithms. This will provide a general view of which algorithms are likely to deliver the best performance and remain useful in the context of forecasting bank profits.
- Longitudinal Analysis: The extension of time of study and the incorporation of more longitudinal data can show changes in the performance of predicting profitability models over different points in time and under different economic conditions. Adaptations of XGBoost in Other Banking Sectors with Recognizable Features: Research on how other banking sectors or different regions adopt XGBoost into their systems may show its flexibility and adaptability.
- Integration of Macro-Economic Factors: Given that you will include in the model other additional independent variables, macroeconomic factors like the economic cycle or worldwide trends in finance can positively make the model more precision and accurate.
- Advancement and its Impact: In order to give the field a more prophetic view, an evaluation of the performance of big data analytics together with the impact of innovations in AI, it's a big plus as far as technology development is concerned.

This study, in short, demonstrates that XGBoost may make a significant difference in the accuracy of profitability forecasts for specialty banks. Further research in some of the indicated areas would clearly be necessary for better refinement in the use of such machine learning techniques, leading to even more robust and actionable insights into banking.

Credit Authorship Contribution Statement

Authors have contributed equally to this research.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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Volume XV, Issue 4(32), Winter 2024

DOI: https://doi.org/10.14505/tpref.v15.4(32).17

A Study on Socio-Demographic Determinants of Digital Financial Literacy in India

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Article info: Received 29 September 2024; Received in revised form 16 October 2024; Accepted for publication 08 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: Digital financial literacy has emerged as a key driver for fostering financial inclusion in India. As India has been witnessing rapid digitalization of financial services, digital financial literacy has become an imperative because of it's transformative potential to spread awareness, knowledge and influence user behaviors towards adoption of digital financial services.

The purpose of this study was to investigate relationships between various socio-economic and demographic factors and digital financial literacy variables in both rural and urban areas of India.

The study relied on a mix of quantitative surveys and qualitative interviews from the respondents belonging to urban and rural areas spread across eight districts of India. The primary data collected underwent several statistical analyses, including the Chi-Square Test, Cramer's V, correlation analysis, and multiple regression analysis to examine the relationships between socio-demographic factors and digital financial literacy.

The study revealed a strong positive correlation between education, age and income with digital financial literacy, underscoring their substantial impact. In contrast, other socio-demographic factors like occupation and social stratification were found to have lesser influence on the digital financial literacy in view of their weaker correlations. The study revealed that digital financial literacy is gender neutral considering negligible correlation between gender and variables of digital financial literacy. The existence of digital divide between urban and rural areas was evident in the study as the rural population lags in digital financial literacy to their urban counterparts. Regression analysis further validates the predictive significance of age, education, and annual family income on digital financial literacy.

The earlier research studies and available literature emphasize mainly supply side factors of digital financial literacy viz. measures taken by Governments, Regulators and Financial institutions. This study, focusing on demand side factors, put special emphasis on social and demographic variables and their degree of influence on digital financial literacy.

Key findings emerged from the study identify the socio-demographic factors influencing digital financial literacy and offer insights for policy makers to identify gaps in financial education and design targeted strategies based on socio-demographic parameters for broadening digital financial literacy.

Keywords: digital financial literacy; socio-demographic factors; digital financial services; gender neutral; digital divide.

JEL Classification: G20; G28; G41; G53.

Introduction

India has been witnessing digital revolution and the scale of digital transformation during last decade is massive and unprecedented. At the back of a robust digital public infrastructure, India is regarded as a leader in global digital revolution and have emerged as a frontrunner in digital landscape. The Global Findex Database published by World Bank in 2011 indicated then that only 35 percent of India's population with fifteen or more years of age

were constituents of formal financial sector having accounts with a bank, other financial institutions or a mobile money service provider. This figure jumped to 53 percent in 2014 and further to 78 percent in 2021 and the trend continues. Many, thus, recommend that India's financial journey is worth studying and deriving learning therefrom.

One of the major public policy priority and national commitment of India has been universal financial inclusion (Chakrabarty 2011). The universal financial inclusion has been defined as "the process of ensuring access to financial services, timely and adequate credit for vulnerable groups such as weaker sections and low-income groups at an affordable cost" (RBI 2008). By this it intends to uplift life of millions still lying below poverty line and have been deprived of benefits of formal economy. Therefore, there have been array of initiatives, targeted towards financial inclusion of population hitherto remaining unbanked and underprivileged, by Government of India, State Governments, Regulators, Banks and other stakeholders.

The National Strategy for Financial Inclusion (2019-24) has listed out key factors of financial exclusion viz. lack of surplus income, not suitable to customer's requirements, lack of requisite documents, lack of trust in the system, lack of awareness about the product, high transaction costs, remoteness of service provider and poor quality of services rendered. One critical factor emerged while looking at the factors is financial literacy which drives other important factors like trust, transaction costs and documents etc. Therefore, there has been continuous emphasis by the Government(s) and the other stakeholders to increase level of financial literacy by way of substantial investment in awareness initiatives so that the necessary level of product awareness is spread to the consumers to take a considered call for voluntary adoption of digital financial services.

The unprecedented strides in technological developments and digitalisation of financial services around the world, have warranted a need for strengthening financial and digital literacy. Globally, financial education, financial consumer protection, and financial inclusion are considered as key ingredients of economic empowerment and financial stability (GPFI 2016). With digital financial services making rapid strides, digital financial literacy acts as the first bridge to bring in people to the fold of formal finance. Awareness about technology, product and safety and security of transactions enable customers willingly embrace digital financial services.

Considering in India, where still a major chunk of population is outside formal finance and deprived of basic financial products like saving, credit and investment, digital financial literacy assumes greater significance. In order to empower the consumers to adopt Digital Financial Services and enhance the usage levels, while assuring them about safety and security of their money, it is imperative to support, strengthen and increase consumers' financial literacy and financial competencies. In majority of economies across the world, Financial literacy is being considered as a key life skill for individuals (OECD/INFE 2012a), and financial education would facilitate them in enhancing their financial knowledge, skills and attitudes (OECD/INFE 2015).

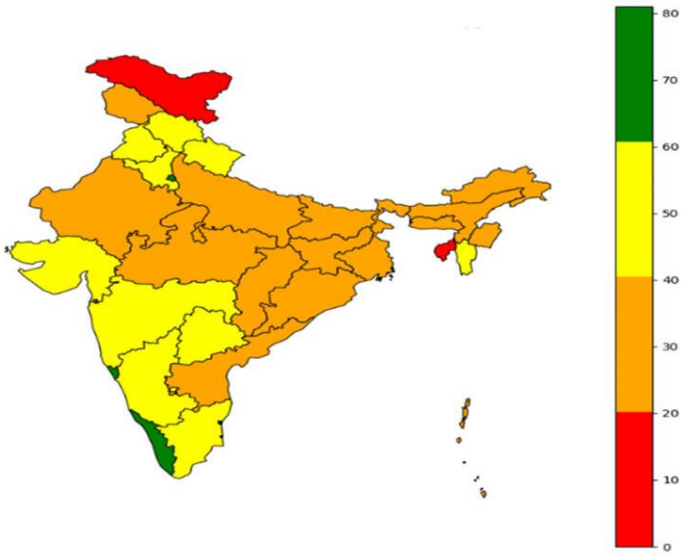
As India is witnessing significant strides in digitalisation and resultant impact on digital payment ecosystems, lack of digital financial literacy would prove to be a major deterrent. Without the consumers having adequate product knowledge and advantages it can accrue; consumers would not have enough motivation to embrace digital payments. This study is therefore attempted to collect first - hand information from the consumers about the drivers of digital financial literacy and deterrents. Amongst various factors being studied, the social, demographic and economic factors emerged as critical factors impacting digital financial literacy. India, being a geographically vast and diverse country, having many social and cultural practices, this study takes motivation to look into the socio-demographic factors which are associated with digital financial literacy in order to take the people to greater degree of financial awareness and thereby including them in mainstream financial ecosystem.

This study is based on the data collected through a primary survey carried out in eight districts of India. Empirical analysis is carried out to estimate the factors associated with digital financial literacy. The study is organised into seven sections. The next Section covers the discussion on digital financial literacy in India followed by literature review in Section 3. Objectives and Hypothesis of the study is outlined in Section 4, Methodology of the study in Section 5 and the empirical analysis is presented in Section 6. Policy implications of the findings of the study is given in Section 7, followed by final considerations of the study in the last Section.

2. Digital Financial Literacy in India

India has been progressing steadily on digital financial literacy front with various policy measures. A survey on digital literacy among various states indicates that only Kerala and Goa are the two states having digital literacy above sixty per cent. The majority of the states fall into the bracket of 20 to 40 percent indicating that huge efforts are needed for improving digital literacy (Figure 1).

Figure 1. Digital Financial literacy across States and Union Territories of India (%)



Source: Mothkoor and Mumtaz 2021

To achieve the desired objectives of digital financial inclusion, financial literacy (FL) is imperative. Some reasons for variation in level of adoption of digital financial inclusion across countries can be attributable to the barriers in Financial Inclusion (Sahay *et al.* 2020). National Centre for Financial Education (NCFE) conducted a survey on financial literacy in 2019 which reveals that only 27 per cent of the respondents possess minimum level of financial literacy. Furthermore, heterogeneity is observed regarding various components of financial literacy within the socio-economic groups with urban population and salaried individuals found to possess better financial awareness (Jangili *et al.* 2023).

On the pathway to digital financial inclusion, digital financial literacy acts as a critical enabler. Digital financial literacy initiatives served in sustainable manner would better attract hitherto underserved and unprivileged population to the fold of formal financial ecosystem. However, as of now, penetration of digital financial services is far from satisfactory and many of India's rural population are yet to activate themselves for digital financial services. The issue of digital divide is seen prominently between rural and urban areas and needs to be bridged expediently. In order to make the financially excluded people embrace digital financial services, measures are needed to step up digital financial education activities.

The major objectives of this study are to identify the socio-demographic determinants of digital financial literacy in India. Further, this study attempts to identify the relationship of select socio-demographic factors with digital financial literacy in rural and urban areas and also to identify the socio-demographic factors which significantly predict digital financial literacy levels.

3. Literature Review

Socio-demographic factors play a critical role in influencing digital financial literacy. The literature review on digital financial literacy brings out some important factors or determinants influencing financial literacy among people. Various studies in this area suggest that women found lagging behind men in financial literacy levels (Lusardi and Mitchell 2011; Brown and Graff 2013). Social and economic factors play a key role in influencing digital financial literacy and amongst all factors, education is the most important (Thaler 2013).

Financial literacy has been gaining global focus because it is increasingly being realized that to enable a customer to take an informed decision, the information of the product is imperative. Financial literacy equips customers with the essential knowledge and understanding of the available financial products, enables them to make informed choices, and makes them aware of grievance redressal mechanisms. Emphasis is now being given to spread financial awareness among various vulnerable groups in the society viz., women, youth, children, elderly, small entrepreneurs, etc. who require handholding (National Strategy Financial Inclusion 2019-24).

In India, digitalization has not picked up in expected pace in rural areas owing to several factors impeding growth of digitalization in rural areas. Possible reasons for the slow growth of digitalization may be inadequate infrastructure, less literate people, low internet connectivity, low economic status and low awareness. Financial

literacy and awareness are the most critical factors for growth of digital financial inclusion (Mandal and Dua 2023).

Lack of digital financial literacy is the key parameter resulting in rural population being away from digital technology. Digital financial literacy makes a customer aware, imparts knowledge and skill to use financial information for better financial inclusion. For the rural people living in hinterland areas, there needs concerted efforts to increase awareness about financial services to achieve the desired outcome (Nedungadi *et al.* 2018).

Financial literacy has an impact on borrowing, debt management, and investment options. Among various socio-demographic factors, education remains the most prominent factor which drives the people to adopt a financial product or not and that is probably the reason the digital financial literacy scores higher in urban areas than rural areas (Dash and Ranjan 2023).

India has been witnessing steady progress with the digital revolution, and there has been upward trend witnessed in general awareness level of people on various digital payment products and access to smart phones. The use of digital payments has increased with increasing education and income levels, and the proportion of cash transactions has declined post-COVID-19 (Behera *et al.* 2023).

FinTechs by using IT software, applications and digital channels and platforms are delivering financial services to customers, households and business establishments through smartphones and promoting the cause of financial inclusion by providing access to households and small firms, hitherto excluded, to financial products and services. However, higher levels of digital financial literacy are needed to attain improved access to financial services through Fintech, their effective utilization and to prevent issues such as miss-selling, frauds, unauthorized use of data, discriminatory treatment, and behavioral issues like excessive indebtedness. Therefore, Digital financial literacy is likely to become an increasingly important aspect of education for the Digital Age (Morgan *et al.* 2019).

An individual possessing digital financial literacy carries requisite knowledge and skills for effectively dealing with digital means which would enable them to make better financial decisions. There are two specific challenges for developing financial competency i.e. overall lack of financial literacy among adults and fintechs requiring technological shrewdness. Within each of these areas, there are separate areas of focus which includes types of banking, internet access, adult learning environments, and technology utilization behaviors. If the adult population are not equipped with requisite skillset for new digital environment, they would not be in a position to take an appropriate financial decision and thereby creating larger gaps in financial inclusion between the literate and illiterate, financially (Golden and Cordie 2022).

Financial services are still beyond the reach of lower economic strata of society. A study conducted among the tribal population revealed that only miniscule range of population i.e. around 18 per cent people are using electronic means of financial services. A study suggested that digital financial inclusion has not reached the bottom level of society. Lack of awareness, illiteracy and fear of the use of it are the major factors behind digital financial exclusion (Praveenkumar 2019).

Population groups with low levels of digital and financial literacy have a higher risk of falling victim to online frauds or scams (OECD 2021).

As financial services are becoming increasingly online, there remains a risk of exclusion of the people who do not have access to digital technology or who lack familiarity about their usage. Therefore, in order to bridge the digital divide, it is imperative that everyone is brought into the modern financial ecosystem. Towards this objective, tailored digital literacy programs are required to cater to the specific needs and capabilities of different social and demographic groups. These tailored programs would provide hands-on training about using digital financial services, navigate online platforms, and protect against cyber risks, thereby empowering individuals to fully participate in the digital economy (Swaminathan 2024).

Digital financial literacy has emerged as an important life skill for people belonging to all social and economic strata notwithstanding which caste, religion, sex, education, wealth and other socio-economic variables they belong to. However, in India, it has still not caught much attention particularly in rural areas where the literacy level is very low or below the average level. A study conducted in this regard indicates that variables like gender, education level, profession, income, land ownership or having an independent house have positive and strong association with digital financial literacy (Abdul Azeez *et al.* 2022).

Digital Financial Literacy and demographic factors have a strong impact of Digital Financial Inclusion. A survey conducted in Indonesia finds that demographic factors like gender, age, occupation, marital status and income have strong association with digital financial literacy and digital financial inclusion. The study underscores importance of targeted financial literacy initiatives and inclusive policies for promoting broader access to digital financial services and pushing social and economic development of a country (Widyastuti *et al.* 2024).

The studies collectively reveal that digital financial literacy serves as a critical enabler of digital financial inclusion. It emerges that to bring the underprivileged and underserved population to the fold of formal financial ecosystem, financial literacy about the digital financial services and products is important. Amongst many factors of digital financial literacy, socio-demographic factors play an important role. However, challenges such as low economic status, low literacy, lack of awareness and level of education act as impediments. Regional studies, such as those in Odisha and Telangana, underscore the importance of socio-economic and demographic factors, including age, education, and income levels, in influencing digital financial literacy. Addressing these socio-demographic barriers is essential for spreading digital financial literacy across diverse population groups.

4. Research Methodology

This study employed a descriptive research design and is based on primary data collected through a purposive random survey from eight districts of India having a sample size of 660 out of which 350 respondents belong to rural areas and 310 belong to urban areas. The selection of the eight districts was carried out considering their geographical location in diverse regions of the country. A description of the data collected according to select socio-demographic factors is as below (Table 1).

Table 1. Descriptive Profile of Survey Respondents

Sl No.	Specifications	Rural		Urban	
		No. of Respondents	Percentage	No. of Respondents	Percentage
1	AGE				
	18-25	72	20.6	81	26.1
	26-35	91	26.0	116	37.4
	36-45	84	24.0	46	14.8
	46-60	59	16.9	42	13.5
	Above 60	44	12.6	25	8.1
	Total	350		310	
2	GENDER				
	Male	304	86.9	260	83.9
	Female	46	13.1	50	16.1
	Total	350		310	
3	EDUCATION				
	HSC or below	122	34.9	63	20.3
	Higher Secondary	139	39.7	144	46.5
	Graduation or Above	89	25.4	103	33.2
	Total	350		310	
4	OCCUPATION				
	Service	77	22.0	97	31.3
	Business	210	60.0	188	60.6
	Daily Worker	63	18.0	25	8.1
	Total	350		310	
5	INCOME (in INR)				
	Below 250,000	198	56.6	153	49.4
	250,000-500,000	68	19.4	66	21.3
	500,000- 1,000,000	41	11.7	60	19.4
	Above 1,000,000	43	12.3	31	10.0
	Total	350		310	

Sl No.	Specifications	Rural		Urban	
		No. of Respondents	Percentage	No. of Respondents	Percentage
6	SOCIAL STRATA				
	General	179	51.1	176	56.8
	OBC	79	22.6	62	20.0
	SC	59	16.9	62	20.0
	ST	33	9.4	10	3.2
		350		310	

Source: Survey by the Author

The collected data is analysed in view of association of six socio-demographic parameters *i.e.* age, education, gender, social stratification, annual family income and occupation with digital financial literacy and it's variables.

The primary data collected from eight districts of India underwent statistical analysis using Chi-Square Test, Cramer's V, correlation and multiple regression to examine the relationships between socio-demographic parameters with digital financial literacy.

Chi-Square Test and Cramer's V

The Chi-square Test was carried out to explore whether a statistically significant association is there between categorical variables *i.e.* socio-demographic factors and digital financial literacy. This helped in exploring the relationship between these variables. Cramer's V values complemented the Chi-Square Tests to measure the strength of these associations. By using both these methods, a comprehensive understanding of degrees of association between the socio-demographic factors and the digital financial literacy could be achieved.

Correlation Analysis

Given that the primary data highlighting the influence of various socio-demographic factors on digital financial literacy, correlation analysis was performed to investigate the relationship between independent variables *i.e.* socio-demographic factors and dependent variables *i.e.* digital financial literacy. The analysis helped in assessing the strength of the relationships and identifying patterns between socio-demographic factors (such as education, income and age) and digital financial literacy.

Multiple Regression Analysis

To measure and analyze the influence of various socio-demographic factors such as education, age, and annual financial income on digital financial literacy, multiple regression analysis was conducted. This method allowed in predicting effect of multiple independent variables on the dependent variables, offering a more detailed and comprehensive view about how these factors influence digital financial literacy.

The following multiple regression equation was used in the study:

$$Y=\beta0+\beta1X1+\beta2X2+\beta3X3+\epsilon \quad \text{Eq. 1}$$

where Y = Dependent Variable (Digital Financial Literacy)

β0 = Intercept(When the impact of all socio-demographic factors are assumed as '0')

β1,β2, and β3 are the coefficients of the independent variables [X1(Age), X2(Education) and X3(Annual Income)]

and ϵ as error term

5. Research Results

A break-up of the data collected in primary survey shows that customers possess maximum awareness about credit/debit cards and mobile wallets. Respondents are also reasonably aware about UPI(Unified Payment Interface) and Internet banking in both urban as well as rural areas. The financial literacy levels of Pre-paid cards were found to be less among respondents and indicates their less popularity. Chi-square values are found to be statistically significant for most of the modes except for credit/debit cards and pre-paid cards. The same was further substantiated by significant Cramer's V values (Table 2).

Table 2. Profile of Customers on Financial Literacy about Digital Payment Platforms

			Yes	No	Total	χ2	Cramer's V
Credit Card / Debit Card	Rural	N	326	24	350	1.660 NS	0.050 NS
		%	93.1%	6.9%	100.0%		
	Urban	N	296	14	310		
		%	95.5%	4.5%	100.0%		
	Total	N	622	38	660		
		%	94.2%	5.8%	100.0%		
Pre-paid Card	Rural	N	89	261	350	2.746 NS	0.064 NS
		%	25.4%	74.6%	100.0%		
	Urban	N	62	248	310		
		%	20.0%	80.0%	100.0%		
	Total	N	151	509	660		
		%	22.9%	77.1%	100.0%		
Internet Banking	Rural	N	226	124	350	7.127*	0.104*
		%	64.6%	35.4%	100.0%		
	Urban	N	230	80	310		
		%	74.2%	25.8%	100.0%		
	Total	N	456	204	660		
		%	69.1%	30.9%	100.0%		
UPI	Rural	N	241	109	350	8.767*	0.115*
		%	68.9%	31.1%	100.0%		
	Urban	N	245	65	310		
		%	79.0%	21.0%	100.0%		
	Total	N	486	174	660		
		%	73.6%	26.4%	100.0%		
Mobile Wallets	Rural	N	293	57	350	22.164*	0.183*
		%	83.7%	16.3%	100.0%		
	Urban	N	295	15	310		
		%	95.2%	4.8%	100.0%		
	Total	N	588	72	660		
		%	89.1%	10.9%	100.0%		
Mobile Banking	Rural	N	225	125	350	18.267*	0.166*
		%	64.3%	35.7%	100.0%		
	Urban	N	246	64	310		
		%	79.4%	20.6%	100.0%		
	Total	N	471	189	660		
		%	71.4%	28.6%	100.0%		

N.B:- * - *Significant at 5% Level (P<0.05), NS – Not Significant at 5% Level (P>0.05) for DF=1.*
Source: Survey by the Author

Socio-Demographic Factors and Digital Financial Literacy

Strong positive correlation coefficients for Age, Education and Annual Family income were evident in rural areas with education emerging as the most influential factor (Table 3). This suggests that people with higher educational levels, greater incomes and higher age groups are more likely to possess greater degree of financial literacy about digital financial services in rural areas. Conversely, Occupation and Social Stratification exhibited very weak correlations, while Gender demonstrated negligible correlation.

Table 3. Correlation of Socio-Demographic Factors with Digital Financial Literacy in Case of Rural Customers

Socio-Demographic Factors	Digital Financial Literacy
Age	0.687*
Gender	-0.003
Education	0.718*
Social Stratification	0.075
Occupation	0.032
Annual Family Income	0.704*

N.B:- * - *Significant at 5% Level (P<0.05) for DF=349.*
Source: Survey by the Author

In a pattern, similar to rural customers, strong positive correlation was observed for Age, Education and Annual Family income in urban areas too with education as the most important factor(Table 4). This indicates that higher educational levels drive digital financial literacy. Furthermore, the data suggests that people with higher family incomes and higher age groups would carry better awareness about digital financial products. In contrast, Occupation and Social Stratification were found to have lesser influence owing to very weak correlations, while Gender exhibited insignificant influence.

Table 4. Correlation of Socio-Demographic Factors with Digital Financial Literacy in Case of Urban Customers

Socio-Demographic Factors	Digital Financial Literacy
Age	0.687*
Gender	-0.003
Education	0.718*
Social Stratification	0.075
Occupation	0.032
Annual Family Income	0.704*

N.B:- * - *Significant at 5% Level (P<0.05) for DF=309.*
Source: Survey by the Author

The results of a regression analysis reemphasize that age, education, and annual family income are key determinants of digital financial literacy among rural customers. All three factors were found to be statistically significant, with annual family income displaying strongest influence, followed by age and education. These finding indicate that socio-demographic status, represented by income and age plays a critical role in influencing a customer's financial literacy levels about digital payment services in rural areas (Table 5).

Table 5. Multiple Regression of Socio-Demographic Factors with Digital Financial Literacy in case of Rural Customers

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-0.051	0.009		-5.578	0.000
Age	0.072	0.007	0.377	10.171	0.000
Education	1.702	0.035	0.216	49.005	0.000
Annual Family Income	0.147	0.013	0.457	11.508	0.000

N.B:- $r = 0.741$, $R^2 = 0.549$
Source: Survey by the Author

The regression analysis carried out for the data of urban respondents reveal that age, education, and annual family income are key determinants of digital financial literacy, similar to findings for rural customers. All these three socio-demographic factors emerged statistically significant, with age of the customer exhibiting strongest influence, followed by education and income. These finding reveal that socio-demographic status, represented by age, education and annual family income are significant predictors of digital financial literacy among urban customers (Table 6).

Table 6. Multiple Regression of Socio-Demographic Factors with Digital Financial Literacy in case of Urban Customers

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.032	0.008		4.142	0.000
Age	0.109	0.014	0.401	7.824	0.000
Education	1.697	0.037	0.201	45.463	0.000
Annual Family Income	0.033	0.011	0.172	3.384	0.001

N.B:- $r = 0.754$, $R^2 = 0.569$
Source: Survey by the Author

6. Discussions

The study revealed that age, education, and annual family income are the key socio-demographic determinants of digital financial literacy in both urban and rural areas. Education emerged as the most critical factor exhibiting strongest correlation with digital financial literacy indicating that people with higher education levels would have greater likelihood of aware about digital financial services. Age also found to be an important factor, suggesting that customers of certain higher age groups are more likely to be financially literate on digital payment products and services. Income too emerged as an important parameter, exhibiting more stronger association in rural areas than urban areas with higher correlation coefficients. In contrast, gender, social stratification, and occupation had minimal impact on digital financial literacy. The gender, particularly, does not seem to be associated with literacy levels of digital transaction platforms in both rural and urban areas indicating digital financial literacy a gender-neutral phenomenon. Urban respondents displayed higher literacy levels for most of the digital financial products except for pre-paid cards. A very narrow gap was observed for credit/debit cards between urban and rural respondents indicating similar literacy patterns in both areas. Multiple regression analysis further highlighted combined effects of age, education, and annual family income on the digital financial literacy, underscoring their strong predictive power.

Conclusions and Further Research

Digital financial literacy is a critical enabler of digital financial inclusion and aids in economic empowerment of individuals and households to effectively engage with the evolving digital economy. This study investigated the influence of socio-demographic factors such as gender, age, education, annual family income, social stratification and occupation on digital financial literacy. The study provided valuable insights into the socio-demographic determinants associated with digital financial literacy.

Key findings emerged from the study suggest that education, age and annual income significantly influence digital financial literacy, while gender, occupation, and social stratification exhibited weaker associations. Education, as a factor, has specifically exhibited robust association with digital financial literacy which indicates that education is a significantly contributing factor in increasing financial literacy levels. The digital divide between urban-rural population was evident in the study. However, the study indicated that rural population is not far behind their urban counterparts and almost at par for some digital financial products and fast catching up for others. These insights can help policymakers and financial institutions to develop targeted approaches and tailor their financial education and literacy strategies to spread awareness about digital financial services across all regions, ultimately bringing the underserved and underprivileged people to the fold of digital financial inclusion and thereby aiding in their economic empowerment.

In the present study, the data was collected only from eight districts of India. Considering India being a geographically vast country, the findings of this study may not be generalized for the entire nation or other equivalent countries. A study covering all the districts of the country is recommended to further substantiate the findings. Further, out of various socio-demographic factors, only six factors have been taken up for this study leaving the scope for further studies considering the remaining factors and devise governmental, regulatory and institutional strategies accordingly.

Acknowledgments

This study was conducted under the aegis of Global Centre for Rural Studies of Utkal University, Bhubaneswar, India. We gratefully acknowledge the support of other Members of Faculty of Department of Business Administration, Utkal University for providing valuable insights on the subject matter.

The Authors received no financial support for the research, authorship and/or publication of this article.

Credit Authorship Contribution Statement

Nirmala Chandra Pattnayak: Conceptualized the study, research design and preparation of the survey questionnaire jointly with the co-author. He carried out the survey, conducted the data analysis and wrote the original draft.

Rashmita Sahoo: Conceptualized the study, research design and preparation of the survey questionnaire jointly with the first author. She supervised data analysis, validated the results. She reviewed and edited the draft article and it's findings and conclusion.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies in the writing process before submission.

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DOI: https://doi.org/10.14505/tpref.v15.4(32).18

Factors Affecting the Intention to Continue Using Online Payment Applications of SMEs at Viet Nam

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Article info: Received 16 October 2024; Received in revised form 7 November 2024; Accepted for publication 29 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: This study aims to identify the factors influencing the intention to continue using online payment applications among small and medium enterprises (SMEs) in Vietnam. The research employs a mixed-methods approach, combining qualitative and quantitative techniques. A theoretical framework was developed based on existing studies, which was subsequently refined to suit the context of SMEs in Vietnam. Data were collected through a Google Forms survey targeting 388 businesses familiar with online payment technologies such as Banking, Momo, Zalo Pay, AirPay, and ViettelPay. The data were analyzed using Smart PLS 4 software. Findings: The analysis reveals six key factors affecting the intention to continue using online payment applications: privacy security, social influence, perceived risk, perceived usefulness, information technology knowledge, and trust. This study contributes to the limited body of research focusing on SMEs in Vietnam and their adoption of online payment technologies. It provides a context-specific evaluation of factors driving continued usage intentions, offering insights for both academia and practice. The study is limited to SMEs in Vietnam, which may affect the generalizability of the findings to other contexts. Future research could explore these factors across different industries or regions. The study offers management strategies for enhancing SMEs' trust and perceived usefulness of online payment technologies, ultimately fostering continued adoption. The findings can contribute to the broader adoption of digital payment systems, promoting a cashless society and improving economic efficiency in Vietnam.

Keywords: online payment; continuous improvement; financial services; SEMs in Viet Nam.

JEL Classification: O33; M15; L86; G20; C10.

Introduction

After the COVID-19 pandemic, the rate of online payment users in Vietnam has increased. Consumers began shifting from traditional shopping to online shopping to simplify the process. According to the 2021 E-commerce

White Paper published by the E-commerce and Digital Economy Agency (Ministry of Industry and Trade), the size of Vietnam's retail e-commerce market in 2020 reached $11.8 billion. Among this, items such as food accounted for an increasingly higher proportion through online shopping. Statistics show that food is the most purchased item online, accounting for 53%, followed by footwear, clothing, cosmetics, and household items.

According to Visa's 2021 statistics report, in Vietnam, users are currently using several electronic payment methods: contactless cards account for about 7%, contact cards 8%, QR codes 7%, contactless mobile payments 5%, online cards 7%, and online e-wallets 15%.

According to PayNXT360 (2020), internet payments in Vietnam are expected to record a CAGR of 22.8%, reaching $27.6935 billion by 2025. The mobile wallet payment segment, by value, is projected to grow at a CAGR of 23.0% during the 2018-2025 period. Allied Market Research's statistics on electronic payments in Vietnam for the 2020-2027 period show that mobile payments will become a trend, with a CAGR of 30.2% during 2020-2027.

According to a report by Statista (2021) updated in October 2021, Vietnam will have five notable and most rapidly growing types of mobile payments compared to other electronic payment methods during the 2020-2025 period: MoMo, Viettelpay, Airpay, Zalopay, and Grappay. By 2025, it is predicted that the number of Vietnamese people using MoMo will reach about 59 million; Viettelpay will have about 28 million users; Shopee's Airpay will have about 12 million users; Zalopay will have about 6 million users, and Grappay will have about 2 million users. The urgency of continuing online payments at Small and Medium sized Enterprises (SMEs) in Vietnam is critical to their long term recovery. The Central Bank of Vietnam has taken steps to facilitate electronic payments by suspending fees and charges on most electronic money transfers (Policy Tracker 2021). As the digital economy continues to grow, the acceptance of online payments for merchants to use on a daily basis is expected to increase, further reducing the reliance on traditional payment methods. The banking industry outlook for 2024 also predicts a continued shift to e-wallets showing a sustainable trend towards online payment methods (Wade, Tomlinson, Srinivas 2023). Studies on electronic wallets and mobile commerce have also shed light on the factors that influence intention to continue using, focusing on the trend of merchants persistently using e-wallets as a payment system (Tan, Chong, & Ong 2024, Du, Razzaq, & Waqas, 2023). The moderate impact of situational factors on determinants of perceived risks affecting the intention to use online money transfer payment application or shopping further emphasizes the importance of a supportive environment for SMEs to continue to make online payments (Zhao, & Khaliq 2024). As SMEs in Vietnam overcome the challenges of the current economic landscape, it is essential that they embrace online payment options to ensure continued growth and competitiveness (Nguyen & Thi Dao 2024).

The goal of continuing online payments in SMEs at Vietnam is an important aspect of digital transformation in the country. As a developing country, Viet Nam has witnessed an increase in technology adoption, especially among the young population (Hoang, & Le Tan 2023). Factors influencing the intention to continue using online payment methods, such as mobile banking, have been studied in the context of Vietnam (Nguyen, & Dao 2024). In addition, intention to continue using business-to-business (B2B) electronic commerce platforms has been explored, emphasizing the importance of online transactions and payments for SMEs (Hussein *et al.* 2020). The moderation role of the flow experience on mobile commerce in Vietnam has been studied, emphasizing the importance of user experience in shaping the intention to continue using digital payment methods (Nguyen *et al.* 2024). The adoption of digital payments in Asia, including Vietnam, has changed financial behavior in the region, with the expansion of internet networks playing a key role in this change (Susanto *et al.* 2022). The factors influencing intention to continue using electronic wallets have also been examined, highlighting the impact of technology on shaping the future of trade in Vietnam (Kumar *et al.* 2024). Vietnamese consumers' intention to continue using online payment methods such as e-wallets has been influenced by market dominance and convenience in transactions (Nguyen *et al.* 2024). Corporate social responsibility has been identified as a sustainability factor to development of SMEs in emerging countries such as Vietnam (Thanh *et al.* 2021). As the Vietnamese market continues to grow, the intention to continue online payment methods in SMEs will be crucial to promote digital transformation and economic growth in the country. Contributing to that development, the authors surveyed SMEs and consulted experts on "factors influencing the intention to continue online payments in SMEs in Vietnam" with research questions: What are the main factors that influence a SMEs intention to continue using online payments? (question 1) How does the intermediary factor of satisfaction impact SMEs to intention continuing to use online payments? (question 2) In addition to the above influencing factors, the authors also studied external factors of SMEs to measure whether their ability to continue online payments was affected, such as the size of the business or the operating time of the business.

1. Literature Review

1.1. Theoretical Models

Currently, research on the use and acceptance of technology is based on popular models such as The TCT Model, the TAM Model, the Expectation Confirmation Model (ECM), and the UTAUT2 Model. Details are as follows:

The TCT Model was proposed by Liao *et al.* (2009) based on the combination of three models: the TAM Model, the ECM Model, and the Cognitive Model of Satisfaction Decisions (COG). The TCT Model aims to explain the factors that influence consumers' intention to continue using technology applications. The TCT Model includes six factors: Confirmation, Perceived Usefulness, Perceived Ease of Use, Attitude, Satisfaction, and finally, the Intention to Continue Using.

The TAM Model was proposed by Davis (1989) to predict the likelihood of users accepting technology applications. The model also helps determine what modifications need to be made for users to accept these technology applications. This model shows that two factors determine the decision to use a technology application by consumers: Perceived Usefulness and Perceived Ease of Use, and through two intermediary factors: Attitude and Behavioral Intention.

The ECM Model was proposed by Bhattacherjee (2001) to describe users' behavior in continuing to use technology products. The ECM Model indicates that Perceived Usefulness and Confirmation are two factors that influence Consumer Satisfaction. At the same time, Satisfaction is the direct factor that affects users' Intention to Continue Using technology products.

The UTAUT2 Model was developed by Venkatesh *et al.* (2012) to explain the intention to accept and use technology, including four traditional factors: Perceived Usefulness, Perceived Ease of Use, Facilitating Conditions, and Social Influence. Additionally, three other factors were added to the UTAUT2 Model: Hedonic Motivation, Price Value, and Habit.

1.2. Privacy Security (PS)

Consumer perceptions of security refer to their expectation that personal information shared on a seller's website will not be accessed, stored, or altered by unauthorized parties (Chellappa & Pavlou, 2002). Security is a crucial concern for individuals when purchasing online because most transactions occur on the web, where user information is transmitted through potentially insecure environments (Raman & Annamalai, 2011). Security is a key factor that people concern about in using the internet to purchase because most transactions are carried out on the web where information about users is transferred through an insecure environment (Raman & Annamalai, 2011). Perceived security reflects how users evaluate the level of security and protection of personal information when they use mobile payment services (Quynh & Anh, 2021). One of the main barriers to customer acceptance is security, with payment security concerns when shopping online potentially involving both monetary loss and privacy issues (Kwon and Lee, 2003). In online payments, the issue of information loss can occur for both sellers and buyers (Quan, 2021). Many people are reluctant to use mobile payments for online transactions due to concerns about user data security (Kristina and Harris, 2020).

Consumers tend to trust sellers more when they feel their data is handled securely. The level of trust consumers have is directly influenced by the security measures sellers implement (Flavián & Guinalíu, 2006). Security acts as a foundational element of trust, significantly impacting consumer confidence (Hayuningtyas & Widiyanto, 2015). The more robust the security provided by the seller, the greater the consumer's trust (Kim *et al.* 2003).

Junadi (2015) proposed a model based on UTAUT, adding twoadditional factors in measurement that are related to theperception of security; the security thatusers receive is partly explained by the safety of the electronicpayment system and is the same impact on the consumer'sintention to use electronic payment systems. The trust insafety and security when using M-Payment services is animportant factor contributing to increased intent to use theservice, and although the results do not show a significantimpact of this variable on usefulness, there is still a positivecorrelation between safety, security, and usefulness (Liu & Tai, 2016). Basically, the awareness of security will increase the value ofuser trust and with it a parallel impact on the user's intentionto use e-wallets in Indonesia. This result was similarly verified in study of Karim *et al.* (2020) for the Malaysian market. Therefore, the group has proposed the following hypothesis:

H1: Privacy security positively affects the intention to continue using online payment technology.

H2: Privacy Security has a positive effect on trust.

H3: Privacy Security positively affects the perceived usefulness.

1.3. Trust (TRU)

Once individuals have built trust in online payments, they are overshadowed by the benefits that online payments bring (Rahadia *et al.* 2022). Using technology in payments implies that users accept risks, and they are easily susceptible to losing trust due to negative consequences that may occur afterward (Puriwat and Tripopsakul, 2021). Users' trust can be directly influenced by privacy protection issues and indirectly by efforts to protect their information (Thang *et al.* 2022). Based on the existing research, the group has proposed the following hypothesis:

H4: Trust positively affects the intention to continue using online payment technology.

1.4. Perceived Usefulness (PU)

Perceived usefulness refers to individuals' beliefs about whether a new technology can improve the way they conduct business and enhance their performance (Ajzen, 1991; Jahangir and Begum, 2008). Similarly, Davis *et al.* (1989) and Doll *et al.* (1998) have described perceived usefulness as consumers' perceptions of whether the technologies they are using will increase the efficiency and effectiveness of their tasks.

Perceived usefulness can be understood as the degree of confidence users have when they perceive benefits from using mobile payments (Quynh & Anh, 2021). Usefulness is a significant factor that affects the acceptance of the application, and users will only use it when they see the benefits (Quan, 2021). Consumers are interested in payment through internet connections when they shop online because of the benefits the application provides (Kwon & Lee, 2003).

Previous research by Amin *et al.* (2014) demonstrated that perceived usefulness not only positively influences satisfaction but also has a beneficial effect on trust. When customers perceive that a new system or product offers added value, they are more likely to trust it. Similarly, Lee and Jun (2007) found that perceived usefulness positively impacts trust. Horst *et al.* (2007) further identified trust as a key determinant of perceived usefulness. Additionally, Chinomona (2013) confirmed that perceived usefulness positively affects trust.

H5: Perceived usefulness positively affects the intention to continue using online payment technology.

H6: Perceived usefulness positively affects trust

1.5. Perceived Risk (PR)

Perceived risk in online shopping can include various issues such as privacy protection, the level of online payment security, the reliability of internet retailers, and the intangible nature of online shopping - customers cannot touch, feel, or handle the items they intend to purchase (Kwon & Lee, 2003). The risks that occur can directly affect the effectiveness of online payment activities, making users feel hesitant to use the service (Nguyen, 2021). When consumers trust a sales website, they accept the potential risks, and their trust can easily waver when they encounter negative experiences (Thu & Tuyen, 2017).

Perceived risk is negatively related to trust (Eastlick *et al.* 2006; Kimery and McCord, 2002; Swaminathan et al., 1999). Higher levels of trust are likely to reduce perceived risk. For instance, Jarvenpaa *et al.* (1999) suggest that increased trust in online sellers lowers perceived risk, which, in turn, enhances a buyer's willingness to make purchases online. Similarly, Heijden *et al.* (2003) found that reducing perceived risk boosts trust and attitudes towards online purchasing, thereby increasing a buyer's willingness (or intention) to purchase online.

H7: Perceived risk positively affects the intention to continue using online payment technology.

H8: Perceived risk has a negative impact on the trust

1.6. Social Influence (SI)

In the study by Nur (2021), the influence of surrounding relationships, such as relatives and friends, on the adoption of electronic payment services was also mentioned [44]. The greater the social influence, the greater the intention to adopt this technology. Social influence is defined as “the degree to which an individual perceives that other important persons believe he or she should use the system” (Kripanont, 2007). Moreover, it refers to the way other people affect a person’s beliefs, feelings and values (Foon *et al.* 2011, Jaganathana *et al.* 2014). For new users of e-wallets, they are in the stage of just experiencing the service and are considering whether to continue using it. At this time, suggestions from media and shares, reviews from those around them will have a certain influence on their intention to continue. The research by Quynh & Anh (2021) and the study by Rahadi (2021) have demonstrated the positive impact of social influence on the decision to use mobile payment applications.

Varadarajan & Yadav (2002) have defined the e-marketplace as “a networked information system that serves as an enabling infrastructure for buyers and sellers to exchange information, transact, and perform other

activities related to the transaction before, during, and after the transaction". Most of the internet-based services allow their consumers to interactions/ communications among themselves that help to diminish their uncertainties related to online services. Many online shoppers would tend to wait and observe the experiences of others who have tried it before considering adopting it. While this experience could be either positive (successful cases) or negative (bad experiences), here we are more interested in positive experience because it reduces the customers perception regarding risk related issues and thus facilitates internet banking services.

Based on the existing research, the group has proposed the following hypothesis:

H9: Social influence positively affects the intention to continue using online payment technology

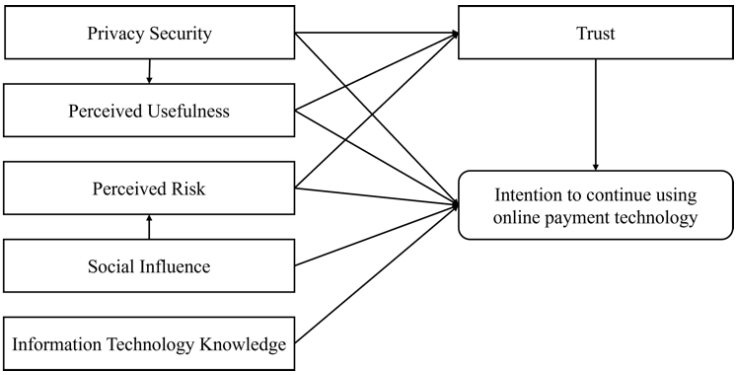
H10: Social influences have a negative and significant impact on perceived risk

1.7. Information Technology Knowledge (ITK)

Mobile payment using facial recognition has increased due to the restrictions of the COVID-19 pandemic. Additionally, QR code-based contactless payment systems have gradually become new and more useful systems after the COVID-19 pandemic (Sang, 2023). Helping users understand the mechanisms of mobile payment, through which they see the differences in each payment method, promotes online payment activities (Nguyen, 2021). If users do not understand the technology, it will be very difficult to process the information and use the system (Kristina and Harris, 2020). Customers tend to adopt technology when they perceive the benefits that technology brings, and conversely, if they find it difficult to use, they will seek a new technology with similar benefits. Based on the existing research, the group has proposed the following hypothesis:

H11: Information technology knowledge positively affects the intention to continue using online payment technology.

Figure 1. Proposed research model



2. Research Methodology

The research employs two main methods: qualitative and quantitative.

Qualitative research is a method that uses non-numerical data to gather information and gain a deeper understanding of a problem or phenomenon. The study examines theoretical foundations from previous research to build models and measurement scales. The next step involves using qualitative methods to focus on the factors influencing the intention to continue using online payment applications. The study explores theoretical bases for factors such as privacy security, social influence, perceived risk, perceived usefulness, IT knowledge, and trust. After that, opinions and feedback are compiled, and a survey is prepared for preliminary research.

Quantitative research is a method that uses numerical data to collect information and test hypotheses. The authors chose to use a convenient sampling method, which saves time, reduces errors, and minimizes costs. To ensure an appropriate sample size for the study, the authors followed the guidelines for exploratory factor analysis (EFA), determining that the minimum sample size should be five times the total number of observed variables (Hair *et al.* 2014). With 29 observed variables, the minimum sample size needed for EFA is 145. For regression analysis, the research team used the formula $N \geq 50 + 8m$ to determine the minimum sample size, where N represents the survey sample size and m represents the number of independent variables (Green and Salkind, 2010).

Since the research model includes 6 independent variables, the minimum sample size required is calculated to be 98. To enhance the accuracy and reliability of the research results, the team decided on a sample size of 388. To collect data quickly and conveniently, the authors employed an online survey method using Google Forms. The data collection period lasted 10 days, from March 15, 2024, to April 5, 2024, and a total

of 388 survey samples were obtained. After a selection process, the authors found that all 208 survey responses met the requirements for analysis and reporting research results. The study uses various methods to analyze the data using Smart PLS software, including descriptive statistical analysis, testing the measurement model, and testing the structural model.

3. Result

3.1 Descriptive Statistics

The group conducted an online survey, resulting in 412 observations. After filtering, the group decided to use 388 samples (n = 388). The sample was evaluated based on the following attributes

Table 1. Demographic demographic variables statistics

		Frequency	Percentage
Company Establishment Time	1 year	219	56.4
	2 years	65	16.7
	3 years	45	11.5
	Over 4 years	59	15.4
Technology Application Time	Occasionally	175	45.2
	Frequently	213	54.8
Enterprise size	Small	172	44.3
	Medium	216	55.7

Establishment Time: Out of the total 388 observations, 45 stores were established 3 years ago, accounting for 11.5%; 65 stores were established 2 years ago, accounting for 16.7%; 59 stores were established more than 4 years ago, accounting for 15.4% of the surveyed stores. Additionally, 219 stores were established 1 year ago, accounting for 56.4%. These results indicate that SMEs at Viet Nam established within a year tend to use online payment methods and have a high intention to continue using the application.

Technology Application Time: The sample size shows that 175 stores occasionally use technology, and 213 stores frequently use it among the total observed samples. Occasionally accounts for 45.2%, and frequently accounts for 54.8%. This indicates that the difference in technology application time among the stores in this study is not significant but rather quite uniform.

Enterprise size: The sample size shows that 172 **enterprises** are small, and 216 **enterprises** are medium sized in the total observed samples. Small **enterprise** account for 44.3%, and medium-sized **enterprise** account for 55.7%. This indicates that the difference in **enterprise** size in this study is not significant but rather quite uniform.

3.1. Testing the Measurement Model

3.1.1. Evaluating Construct Reliability

Although studies can use Cronbach's Alpha coefficient or composite reliability (CR) to test the reliability of the scale, Giao & Vuong (2019) suggest that Cronbach's Alpha might either overestimate or underestimate the reliability of the scale.

Table 2. Composite Reliability and Convergent Validity

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)	Outer loading
CI	0.878	0.925	0.804	0.891 – 0.904
ITK	0.886	0.921	0.746	0.847 – 0.869
PR	0.903	0.932	0.774	0.873 – 0.891
PS	0.882	0.914	0.680	0.800 – 0.834
PU	0.905	0.929	0.725	0.831 – 0.870
SI	0.863	0.907	0.709	0.829 – 0.857
TRU	0.855	0.902	0.697	0.821 – 0.841

Additionally, they argue that composite reliability is more suitable for PLS models than Cronbach's Alpha. The composite reliability index ranges from 0 to 1, with 1 being the perfect level. For exploratory research models, composite reliability should be ≥ 0.6 (Juliandi, 2018). According to the table, the composite reliability of CI is 0.925, ITK is 0.921, PR is 0.932, PS is 0.914, PU is 0.929, SI is 0.907, and TRU is 0.902.

The outer loading coefficient can be used to evaluate the quality of the observed variables of a factor on a scale. According to Hair *et al.* (2013), a good outer loading coefficient is from 0.7 upwards. The table shows that the loadings of the observed variables on the scale are all greater than 0.7, and no observed variable has an unreliable loading. Therefore, the scale has good internal consistency.

3.1.2. Evaluating the Convergent Validity of the Scale

The average variance extracted (AVE) can be used as an index to test convergent validity. AVE reflects the average variance for each latent construct in the research model. The scale achieves convergent validity when AVE > 0.5 (Hair *et al*. 2005). AVE < 0.5 means that the error variance exceeds the explained variance (Giao & Vuong, 2019). The average variance extracted for the constructs is presented in the table: CI = 0.804, ITK = 0.746, PR = 0.774, PS = 0.680, PU = 0.725, SI = 0.709, TRU = 0.697. All constructs have AVE > 0.5, indicating that the scale has good convergent validity.

3.1.3. Discriminant Validity of the Scale

The scale achieves discriminant validity when the square root of the AVE is greater than the variance of any other latent construct (Giao & Vuong, 2019). In Table 3, following the Fornell-Larcker criterion, the square root of the AVE is presented in diagonal cells, and correlations between variables are shown below it. Thus, if the absolute value of the square root of the AVE is greater than any correlation coefficient in the same row and column, the scale has discriminant validity. The Fornell-Larcker table (Table 3) shows the square roots of the AVE. These values are all greater than the values in the same rows and columns, demonstrating good discriminant validity.

Table 3. Fornell - larcker discriminant validity

	CI	ITK	PR	PS	PU	SI	TRU
CI	0.897						
ITK	0.566	0.864					
PR	-0.539	-0.274	0.880				
PS	0.609	0.337	-0.436	0.824			
PU	0.625	0.405	-0.533	0.493	0.851		
SI	0.585	0.294	-0.463	0.500	0.469	0.842	
TRU	0.621	0.308	-0.487	0.528	0.521	0.446	0.835

3.2. Testing the Measurement Model

3.2.1. Evaluating Multicollinearity Issues

Table 4 shows the results of the variance inflation factor (VIF) values for the scale. All observed variables have VIF values less than 3 (Hair & Alamer, 2022). Therefore, it can be concluded that multicollinearity is not present among the observed variables.

Table 4. VIF Values

	CI	PR	PU	TRU
ITK	1.244			
PR	1.619			1.478
PS	1.689		1.000	1.399
PU	1.824			1.582
SI	1.564	1.000		
TRU	1.697			

3.2.2. Evaluating Model Fit

The most commonly used measure for evaluating the structural model's explanatory power is the coefficient of determination (R^2). R^2 measures the variance explained in each dependent variable and is thus a measure of the model's explanatory power (Shmueli & Koppius, 2011). This coefficient represents the amount of variance in the endogenous constructs explained by all exogenous factors linked to it. R^2 is also known as the in-sample predictive power (Rigdon, 2012). According to Table 5, the R^2 coefficients for both CI and TRU are 0.401 and 0.675, respectively. Therefore, the model is well explained.

Table 5. R^2 Values

	R Square	R Square Adjusted
CI	0.675	0.670
PR	0.214	0.212
PU	0.243	0.241
TRU	0.401	0.396

3.2.3. f^2 Values

The f^2 effect size facilitates the assessment of how much an exogenous construct contributes to the R^2 value of a latent predictor variable. The f^2 values of 0.02, 0.15, and 0.35 respectively indicate small, medium, or large effects of the predictor concept on a dependent variable (Cohen, 1988). According to Table 6, the f^2 values of the hypotheses indicate a medium effect (0.019 – 0.321).

Table 6. f^2 Values

	CI	PR	PU	TRU
ITK	0.208			
PR	0.019			0.054
PS	0.056		0.321	0.113
PU	0.046			0.068
SI	0.072	0.273		
TRU	0.087			

3.2.4. Evaluating Out-of-Sample Predictive Power

In PLS-SEM, each component model will have an R^2 value representing the explanatory power of the independent variables on the dependent variable, and a Q^2 value representing the predictive power of the independent variables on the dependent variable. Tenenhaus *et al.* (2005) suggested that Q^2 is considered an indicator of the overall quality of the component model. If all component models have $Q^2 > 0$, the overall structural model of the study also achieves overall quality. Hair *et al.* (2019) provided the levels of Q^2 corresponding to the predictive power of the model as follows:

$0 < Q^2 < 0.25$: low predictive accuracy

$0.25 \leq Q^2 \leq 0.5$: medium predictive accuracy

$Q^2 > 0.5$: high predictive accuracy

According to Table 7, Q^2 for NT = 0.297, indicating medium predictive power for the model; Q^2 for YDTT = 0.570, indicating high predictive power for the model.

Table 7. Q^2 Values

	Q^2_predict
CI	0.570
PR	0.206
PU	0.235
TRU	0.297

3.2.5. Hypothesis Testing

According to the hypothesis testing results in Table 8, the outcomes of the hypotheses and the relationships in the model are interpreted as follows: The analysis results indicate that SI, PS, ITK, PU, and TRU have a positive impact on CI. The impact coefficients are βSI = 0.191, βPS = 0.175, βITK = 0.290, βPU = 0.165, βTRU = 0.220, with all P-values less than 0.05 at a 5% significance level. In addition, PR has a negative impact on CI (βPR = -0.100, PPR = 0.040 < 0.05) at a 5% significance level. Additionally, PS, PU, PR have an impact on TRU. The impact coefficients are 0.308, 0.253, and -0.218, respectively, with P-values < 0.05. Thus, all proposed hypotheses are accepted. PS have an impact on PU and SI have an impact on PR. The impact coefficient are 0.493, -0.463 with P-values < 0.05.

Table 8. Hypothesis Testing

	Original Sample	Standard Deviation	T Statistics	P Values	Result
ITK -> CI	0.290	0.040	7.281	0.000	Accept
PR -> CI	-0.100	0.049	2.058	0.040	Accept
PR -> TRU	-0.218	0.071	3.065	0.002	Accept
PS -> CI	0.175	0.054	3.221	0.001	Accept
PS -> PU	0.493	0.049	10.064	0.000	Accept
PS -> TRU	0.308	0.066	4.670	0.000	Accept
PU -> CI	0.165	0.056	2.962	0.003	Accept
PU -> TRU	0.253	0.067	3.784	0.000	Accept
SI -> CI	0.191	0.052	3.660	0.000	Accept
SI -> PR	-0.463	0.052	8.866	0.000	Accept
TRU -> CI	0.220	0.057	3.832	0.000	Accept

3.2.6. Testing the Mediating Role of TRU

According to Table 9, the results demonstrate the mediating role of TRU in the use of e-wallets between other variables and the dependent variable CI's use of e-wallets as follows: TRU's use of e-wallets plays a mediating role in the relationship between PS and CI use of e-wallets, with an impact coefficient of 0.068 and a P-value of 0.004. Therefore, this mediating role is statistically supported. TRU's use of e-wallets plays a mediating role in the relationship between PU and CI's use of e-wallets, with an impact coefficient of 0.056 and a P-value of 0.005. Therefore, this mediating role is statistically supported. TRU's use of e-wallets plays a mediating role in the relationship between PR and CI's use of e-wallets. In addition, PR mediates the effect of SI on CI and PS mediates the effect of PS on CI with P-values < 0.05

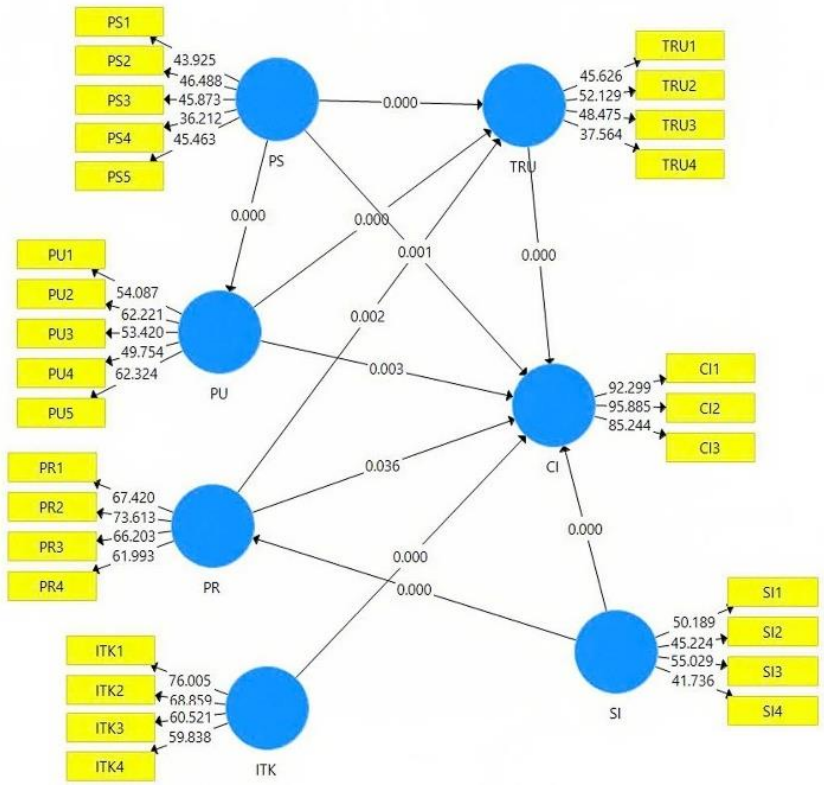
Table 9. Mediation Test for TRU

	Original Sample (O)	T Statistics	P values	Result
SI -> PR -> CI	0.046	1.986	0.047	Accept
PS -> PU -> CI	0.081	2.782	0.005	Accept
PR -> TRU -> CI	-0.048	2.213	0.027	Accept
PS -> TRU -> CI	0.068	2.918	0.004	Accept
PU -> TRU -> CI	0.056	2.801	0.005	Accept
SI -> PR -> TRU	0.101	2.763	0.006	Accept
PS -> PU -> TRU	0.125	3.397	0.001	Accept

3.2.7. PLS – SEM Model

After conducting the tests, the final research model is presented in Figure 2.

Figure 2. PLS-SEM Model



4. Discussion, Managerial Implications, Limitations, Future Research Directions

4.1. Discussion

The rapid development of 4.0 applications has significantly boosted the popularity and attention given to online payments. The research team successfully achieved the main objective of identifying factors influencing the intention to continue using online payment applications among SMEs at Viet Nam. Through the research process, six key factors were identified as having a positive impact on this intention: Social Influence, Trust, Perceived Usefulness, Privacy Security, Perceived Risk, and IT Knowledge.

Based on these findings, the research team proposed several solutions and recommendations for SMEs at Viet Nam to enhance the quality of their online payment services. These suggestions can help shop owners develop new business strategies and increase sales. The study also provides a foundation for these shop owners to assess critical factors and develop strategies that align with their conditions and the current market situation.

4.2. Managerial Implications

4.2.1. For SMEs

To enhance the intention to continue using online payment applications, SMEs should focus on improving their application knowledge by participating in communities that share experiences, thereby enhancing personal experience and quickly updating new features. Additionally, they need to carefully select online payment applications by thoroughly researching the provider to ensure that the application offers strong information security and quick 24/7 risk management. Furthermore, taking advantage of promotional programs from the application providers can help reduce costs and increase profits. These solutions are not only feasible but also offer significant environmental benefits by reducing the need for printed receipts, and social benefits by improving the user experience and attracting more promotions for both SMEs and customers. However, to prevent technical and security risks, SMEs should collaborate with application experts for regular system maintenance and implement strong security measures to counter threats from cyberattacks.

4.2.2. For Businesses Producing Online Payment Technology

To enhance the effectiveness and adoption of online payment applications among small enterprise, a well-structured approach focusing on user interface development, security enhancement, professional customer support, transparency, usability, and risk minimization is essential.

Developing a User-Friendly Interface: A user-friendly interface is crucial for the seamless adoption of online payment applications. The first step in this process is to conduct thorough user research to understand the needs and habits of users. This will be followed by designing and testing the interface with a sample group to gather feedback. Based on the feedback received, the interface will be improved to optimize the user experience. Finally, the updated version with the new interface will be released, and user feedback will be monitored to ensure the interface meets their expectations. The resources required for this initiative include a market research team and UX/UI designers, along with the necessary budget for development and testing. The effectiveness of this solution can be measured by tracking the Customer Satisfaction Score (CSAT) and the User Retention Rate.

Enhancing Security: Security is a significant concern for users of online payment applications. To address this, the first step is to assess the current security system through a comprehensive audit. Next, advanced security measures such as two-factor authentication, data encryption, and protection against cyberattacks will be implemented. Employee training in cybersecurity will further strengthen the overall security posture. Regular security checks and continuous updates to the system will ensure ongoing protection. This initiative will require security experts, an IT team, and a budget for upgrading and maintaining the security system. Effectiveness will be gauged by monitoring the number and severity of security incidents, as well as assessing employee awareness before and after training.

Providing Professional Customer Support: Professional customer support is essential for retaining users and ensuring their satisfaction. 24/7 support system will be established with various contact channels, including online chat, phone, and email. Support staff will undergo training to enhance their customer service skills. Continuous monitoring of customer feedback will allow for ongoing improvements to the support services. The effectiveness of this support can be measured through metrics such as average response time and customer satisfaction scores. This solution will require a dedicated customer support team, training costs, and a Customer Service Management (CSM) system.

Ensuring Transparency: Transparency is key to building trust with users. The first step is to review and update terms of use, service fees, and related costs to ensure they are clear and transparent. This information will be made publicly available on the website and application, with notifications sent to current users. Educational materials will be created to guide users on how to use the app effectively and understand the security measures in place. The effectiveness of these transparency efforts will be evaluated through user feedback, and continuous improvements will be made. Necessary resources include a legal team, communication team, and budget for documentation and communication activities. Effectiveness will be assessed by evaluating users' understanding of terms and policies and the rate of complaints related to transparency.

Improving Usability: Usability plays a vital role in user satisfaction and retention. The first step is to evaluate the current usability of the application through user surveys. Based on the feedback, new features will be developed and integrated into the application. These features will be tested with a sample group, and optimizations will be made based on their feedback. Finally, the updated version will be released, and the effectiveness of the new features will be monitored. The product development team and user research team, along with the budget for feature development and testing, will be required for this initiative. User satisfaction with the new features and the rate of their usage will be key metrics for measuring effectiveness.

Minimizing Risks: Risk management is critical in ensuring the long-term success of online payment applications. The first step is to conduct a thorough risk analysis to identify potential threats. Preventive measures and contingency plans will be developed for identified risks. Employee training programs will be implemented to raise awareness and enhance risk management skills. Regular checks will be conducted to monitor and evaluate the effectiveness of these risk mitigation measures.This initiative will require a risk management team, a training team, and a budget for implementing and maintaining preventive measures. The frequency and severity of risks and employee awareness before and after training will serve as measures of effectiveness.

4.2.3. Social Implications

The government is actively promoting the use of online payment applications through several key policies aimed at integrating digital payments into both business operations and daily life. Notably, Prime Minister's Decision No. 1813/QĐ-TTg, signed on October 28, 2021, outlines a plan for the development of non-cash payments in Vietnam from 2021 to 2025. This initiative is designed to transition traditional payment methods to non-cash options,

thereby facilitating easier access for businesses and consumers. Additionally, the government supports the development and expansion of online payment applications in rural areas, enhancing financial services for residents in remote locations. Specific security requirements for internet banking systems have also been established, including measures such as firewalls, antivirus protection, and safeguards against DDoS attacks, to protect users' personal information and assets. Furthermore, investments in internet infrastructure are being made to improve network quality and coverage, making online payments more accessible and convenient for the general population. These efforts reflect a commitment to modernizing the financial landscape and ensuring that digital payment methods become a seamless part of everyday life.

4.3. Limitations and Future Research Directions

The study encountered several limitations due to time constraints, which inevitably impacted its outcomes. One significant limitation is the narrow scope of the research. The study focused exclusively on small and medium-sized SEMs at Viet Nam, which may not accurately reflect the intentions of similar business owners across Vietnam. A broader scope that includes various industries could offer a more comprehensive understanding of the factors influencing the continuation of online payment applications.

Another limitation stems from the complexity of human behavior and intent. These factors are intricate and often extend beyond individual control and awareness. The use of questionnaires in surveys can only provide a partial prediction of the continuation intentions of small and medium-sized business owners. To improve accuracy, future research should consider incorporating experimental methods that can offer deeper insights into these intentions.

To address these limitations and enhance the robustness of future studies, several directions are proposed. First, expanding the sample size will improve the reliability of the research findings. A larger sample will provide a more accurate representation of the target population. Second, broadening the research scope to include a wider range of industries will contribute to a more reliable and comprehensive understanding of business owners' intentions. Third, future research should explore additional factors that may influence the intention to continue using online payment applications. This exploration will help identify other variables that could impact user behavior. Finally, investigating the continuation intentions of larger-scale business owners will offer a multi-dimensional perspective and a deeper understanding of the usage patterns across different business scales.

By addressing these aspects, future research can provide a more detailed and accurate picture of the factors affecting the use of online payment applications and contribute valuable insights for both businesses and policymakers.

Conclusions

This study sheds light on the key factors influencing the intention of small and medium enterprises (SMEs) in Vietnam to continue using online payment applications. The research reveals that privacy security, trust, perceived risk, perceived usefulness, social influence, and IT knowledge are crucial determinants of this behavior. By addressing these factors, businesses can enhance user experience and satisfaction, thereby fostering a broader adoption of online payment systems. This is particularly vital in the context of Vietnam’s digital transformation and its movement toward a cashless economy.

The findings offer valuable insights for policymakers and online payment service providers to design strategies that encourage sustained use among SMEs. Enhancing security, usability, and trust will not only drive adoption but also contribute to a more inclusive and efficient financial ecosystem.

Future research should explore additional contextual factors, such as industry-specific barriers or cultural influences, that may impact the continuation of online payment adoption. Expanding the study scope beyond SMEs to include larger enterprises or regional comparisons would also provide a more comprehensive understanding of the digital payment landscape.

Acknowledgments

We extend our heartfelt gratitude to Industrial University of Ho Chi Minh City for its invaluable support, which made this research possible. We also express our sincere appreciation to our colleagues for their insightful discussions and constructive feedback throughout the development of this paper.

Credit Authorship Contribution Statement

Nguyen Thi Phuong Giang: Conceived and developed the research idea, formulated the study objectives, determined the sample size, and contributed to the questionnaire design. Conducted data analysis and

contributed to writing the results and discussion sections. Co-authored the conclusions, limitations, future research directions, and implications.

Thai Dong Tan: Conducted literature review, contributed to theoretical development, and assisted in designing the research model. Participated in data collection and co-authored the conclusions, limitations, future research directions, and implications.

Nguyen Binh Phuong Duy: Worked on the introduction, assisted in developing the questionnaire, and contributed to logical computations. Co-authored the conclusions, limitations, future research directions, and implications.

Le Huu Hung: Provided statistical analysis support, assisted in interpreting results, and contributed to the discussion section. Co-authored the conclusions, limitations, future research directions, and implications.

Le Thi Hong Nhung: Worked on refining the research framework, ensured adherence to methodological standards, and contributed to editing and finalizing the manuscript. Co-authored the conclusions, limitations, future research directions, and implications.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of use of generative AI and AI-Assisted technologies

The authors declare that they have not used generative AI and AI-assisted technologies in the writing process before submission, but only to improve the language and readability of their paper and with the appropriate disclosure.

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DOI: https://doi.org/10.14505/tpref.v15.4(32).19

The Use of Artificial Intelligence to Detect Suspicious Transactions in the Anti-Money Laundering System

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Article info: Received 10 October 2024; Received in revised form 27 October 2024; Accepted for publication 28 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: Artificial intelligence (AI) is being actively implemented in anti-money laundering (AML) systems due to its potential to improve the detection of suspicious transactions. The article examines AI's effectiveness in detecting and reducing financial crimes of private military companies.

The research employs machine learning (ML) algorithms and neural networks, anomaly detection methods, and economic impact assessment. A combination of supervised and unsupervised learning methods enables the creation of accurate predictive models for detecting money laundering anomalies.

The results show that AI models outperform traditional rule-based systems, reducing false positives by 30% and increasing high-risk detection by 25%. This proves the advantages of AI over conventional anti-money laundering methods, which often cannot adapt quickly.

The research emphasizes the transformative impact of AI on anti-money laundering systems, optimizing accuracy and resource allocation. Further research should focus on improving AI algorithms and their application in new financial technologies.

Keywords: artificial intelligence; money laundering; suspicious transactions; machine learning; insurance.

JEL Classification: E42; G38; H6

Introduction

Given rapid globalization and increasingly complex financial transactions, effective detection and prevention of money laundering have become critically important. Digital technologies are pivotal in promoting transparency within public authorities, thereby minimizing corruption risks through enhanced data accessibility and auditability (Lazor *et al.* 2024). Traditional AML systems often cannot keep up with criminal organizations' new tactics. AI plays an important role in this context, offering innovative solutions to improve the detection of suspicious transactions and strengthen AML systems (Ricadela 2024). AI contributes significantly to public service improvement and fraud prevention by optimizing processes, predicting risks, and enabling efficient resource allocation (Kruhlov *et al.* 2024). AI can process large volumes of transactions with high accuracy, uncovering complex patterns of illegal activity and increasing the overall efficiency of systems. The need to attract investments in the primary sectors is essential for economic development, especially within the Industry 4.0 paradigm, which emphasizes digitization and smart technologies (Nikonenko *et al.* 2022).

However, several important issues remain underexplored. First, the effectiveness of various AI techniques, such as ML algorithms and neural networks, in detecting money laundering needs further study (Strategy and Transactions in Insurance 2024). Second, there is a need to study how to integrate AI technologies into existing AML practices and their impact on regulatory compliance. Enterprise economic security involves a comprehensive assessment of risk factors influencing an organization's financial stability and long-term viability (Lelyk *et al.* 2022). Third, it is important to explore how AI can reduce the number of false positives that are problematic with traditional approaches. The European Union's approach to anti-corruption regulation relies heavily on transparency, integrity, and accountability in public institutions to mitigate risks of financial misconduct (Melnyk *et al.* 2021). This research aims to fill these gaps by evaluating AI capabilities to improve the detection of suspicious transactions. The objectives include:

1.Analyze the current use of AI in AML systems and assess its effectiveness.

2.Assess the possibility of integrating AI into traditional AML methods to improve monitoring systems.

3.Identify challenges and limitations of implementing AI in AML systems, including regulatory, technical, and operational aspects.

1. Literature Review

The integration of AI into AML systems has attracted considerable research attention due to its potential to improve the detection of suspicious financial transactions. Bertrand *et al.* (2020) examined how AI-driven AML systems can be consistent with data protection rights. They noted that although AI can significantly improve the efficiency of such systems, it may conflict with existing legal standards, especially in European countries. The researchers emphasize the need to develop a strategy that would protect fundamental rights while supporting the effectiveness of the fight against money laundering. In 2021, the same authors continued the study in the European context. They point out that AI-driven AML systems may violate the fundamental rights of European citizens. The authors emphasize the importance of creating a reliable legal framework to protect the rights of individuals when using AI in AML. This research is important for addressing the legal challenges associated with AI use and points to the need for additional legal and technical measures. Abrahamyan (2023) investigated money laundering threats associated with major international sporting events. The researcher notes that large-scale financial transactions in international sports increase money laundering risks. Although AI can mitigate these threats, Abrahamyan (2023) notes that current AI technologies do not cover all aspects of complex financial transactions in this area.

Hayble-Gomes (2022) analyzed how predictive modeling can improve the Suspicious Activity Reporting (SAR) process. The study shows that AI can identify key signs of suspicious behavior, increasing the accuracy and effectiveness of SAR reports. However, the author draws attention to the shortcomings of predictive modeling, in particular to the issue of interpretation and transparency of AI-generated decisions. He emphasizes the need for more comprehensible AI techniques in AML. Fritz-Morgenthal *et al.* (2022) analyzed the implementation of transparent and reliable AI in financial risk management. The authors note the importance of explainable AI, especially in AML. There needs to be more transparency in systems to prevent trust and legal problems in the financial sector. This research is key to understanding the impact of AI on financial risk and legal liability, emphasizing the need for effective and understandable AI systems. Kute *et al.* (2021) reviewed AI techniques for detecting money laundering. They analyzed both the advantages and limitations of different AI models. The authors emphasize the need for clear methods to increase interoperability and trust in models among regulators and financial institutions.

Ashwini and Hussain (2023) examined the general impact of AI on the banking industry. The researchers note drastic changes in banking operations thanks to AI, particularly in AML procedures. At the same time, the authors draw attention to the fact that the rapid introduction of AI precedes the development of a regulatory framework, which causes risks related to data confidentiality and transparency of decisions. The study highlights the need for a cautious approach to using the capabilities of AI while minimizing risks effectively. Turksen *et al.* (2024) reviewed the legal issues of automated monitoring of suspicious financial transactions. The researchers emphasize the importance of strengthening the integrity of AI systems used in AML by bringing them into compliance with current legal regulations. The study shows that AI can significantly increase the effectiveness of detecting suspicious transactions, but strict regulation is required to minimize legal and ethical risks. Pavlidis (2023) explored the role of AI in anti-money laundering and asset recovery. The author emphasizes that AI is a powerful tool due to its ability to quickly and accurately analyze large data volumes. However, the effective implementation of AI in AML requires technological innovations and significant regulatory and organizational reforms to use these systems responsibly.

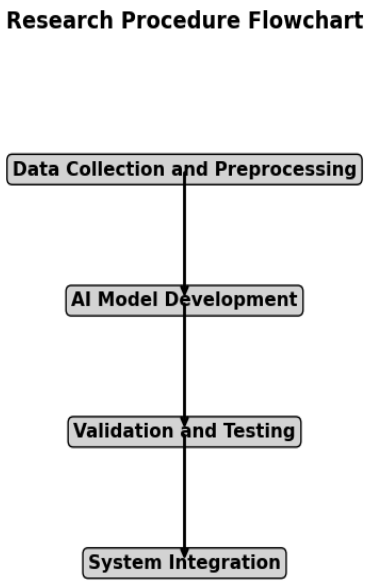
Despite significant progress in implementing AI in AML systems, several issues still need to be solved. First, while much attention is paid to the technical aspects of AI, there is a lack of research on the long-term impact of these technologies on privacy and fundamental rights, especially outside of Europe. Although current studies identify the benefits of AI for improving AML processes, more attention should be paid to possible biases and errors in the operation of AI systems. An important direction for further research is the integration of intelligible AI into AML systems. Although some works partially address this issue, practical implementation in real financial institutions needs further study. The existing literature contains conflicting findings regarding the ability of AI to detect sophisticated money laundering schemes, emphasizing the need for further empirical research. Finally, although the AI potential in AML is generally recognized, existing studies do not adequately address the organizational and regulatory changes required for successful technology integration. This points to the need for future research to develop comprehensive frameworks that integrate technical, legal and organizational aspects to maximize the effective use of AI in the fight against money laundering.

2. Methods

2.1. Research Design

The first stage of the research involved data collection and preparation. The dataset consisted of 1 million anonymous financial transactions. The data were cleaned to remove errors and normalize transaction amounts and code categories (Appendix A).

Figure 1. Research Stages



Source: developed by the author based on MiniTAB (2024)

The data were divided into learning (80%) and test (20%) sets. The next stage was the creation of an AI model. The Random Forest and Gradient Boosting algorithms were combined. These algorithms work efficiently with large data sets and help to detect anomalies. The model was trained on pre-processed data to identify patterns

that indicate suspicious transactions. The assessment and testing followed this. After learning, the model was tested on the test data set. Such metrics as precision, recovery, and F1-score were evaluated. Anti-money laundering experts also conducted manual verification of random transactions to assess the practical effectiveness of the model. The final stage is provided for system implementation. The tested model was integrated into the existing monitoring system of the financial institution. A pilot project was launched to monitor transactions in real-time, with continuous performance monitoring for three months (Figure 1).

2.2. Sampling

The study aimed to identify suspicious transactions in a dataset provided by Deutsche Bank. This bank is one of the leaders among international financial institutions in Germany. Deutsche Bank processes a huge number of financial transactions daily, making it an ideal target for applying AI systems in the fight against money laundering. The large volume and variety of data open wide opportunities for analysis. The bank is known for its modern technological solutions that contribute to the effective integration of AI for fraud detection and anti-money laundering.

Furthermore, Deutsche Bank has extensive experience in complying with international anti-money laundering regulations. Its investment in advanced compliance solutions makes the bank an important object for AI research in this area. Operating in many countries, the bank provides data that spans different economies, allowing comprehensive and global research.

Germany was chosen for the study because it has one of the strictest anti-money laundering systems, which meets the European Union's (EU) and the Financial Action Task Force on Money Laundering (FATF) standards. This creates favorable conditions for testing AI-based solutions. Being one of Europe's largest economies, Germany offers a variety of transactional data, making it ideal for investigating suspicious transaction detection systems. Financial institutions are required to keep detailed records of transactions, which ensures the availability of quality data for analysis. Germany is also actively innovating in the fight against money laundering, making it a key country to explore the application of AI in this area. As a leading financial center, it provides access to both domestic and international transaction data, which allows for the assessment of AI effectiveness in various environments.

The dataset contained one million anonymous transactions filtered by volume, frequency, and risk scores. This volume provided various transaction types, from small to large amounts. The sample was designed to reflect a typical financial profile, increasing the results' accuracy and applicability. Transactions were divided into categories: domestic transfers, international transfers, deposits, and cash withdrawals. This classification made it possible to investigate operations vulnerable to money laundering in more detail.

2.3. Methods

The study includes a combination of methods for data collection and analysis:

1. Training of ML models. The Scikit-learn Python library and the Random Forest and Gradient Boosting algorithms were used to create and train the models. The training process included cross-validation to fine-tune model parameters and avoid overfitting. The best model configuration is selected based on the highest F1 score obtained during verification.

2. Methods of detecting anomalies. The unsupervised anomaly detection algorithm, Isolation Forest, complements the supervised machine learning models. This approach helps identify anomalies that the basic model might have missed. A combination of supervised and unsupervised methods provides a more accurate detection system.

3. Assessment of economic impact. The economic consequences of the identified suspicious transactions were assessed in detail. A risk-based method was used to determine the financial impact of each transaction, taking into account the amount of the transaction, the frequency, and the profiles of the parties involved. This strategy made quantifying the potential financial risks associated with undetected suspicious transactions possible.

2.4. Tools

1. Scikit-learn libraries, NVIDIA GPUs, and cross-validation methods were used to train the models.

2. Matplotlib and Seaborn libraries were used to visualize the anomalies, which allowed a better understanding of the patterns revealed by the algorithm.

3. Using a risk-based approach, Excel and Python's Pandas were used to calculate the financial implications of each flagged transaction.

3. Results

The study uses a dataset containing 1 million anonymous financial transactions from a leading financial institution. Transactions were divided into four categories: domestic transfers, international transfers, cash deposits, and cash withdrawals. Table 1 presents an overview of the distribution of these categories.

Table 1. Categories of Transactions

Transaction type	Account	Percentage (%)
Domestic transfers	400,000	40.00
International transfers	250,000	25.00
Cash deposits	200,000	20.00
Withdrawals	150,000	15.00

Source: developed by the author based on Transaction Types (2024)

Analysis of transaction structure is key to risk assessment. A high proportion of domestic transfers may indicate the need for additional monitoring to detect anomalies. International transfers require special attention because of their complexity and high amounts, as they can be vulnerable to risks such as money laundering. Table 2 presents the results of three machine learning models: decision tree, random forest, and gradient boosting. Key metrics such as F1 score, precision, and sensitivity are used to evaluate the performance of these models in detecting suspicious transactions.

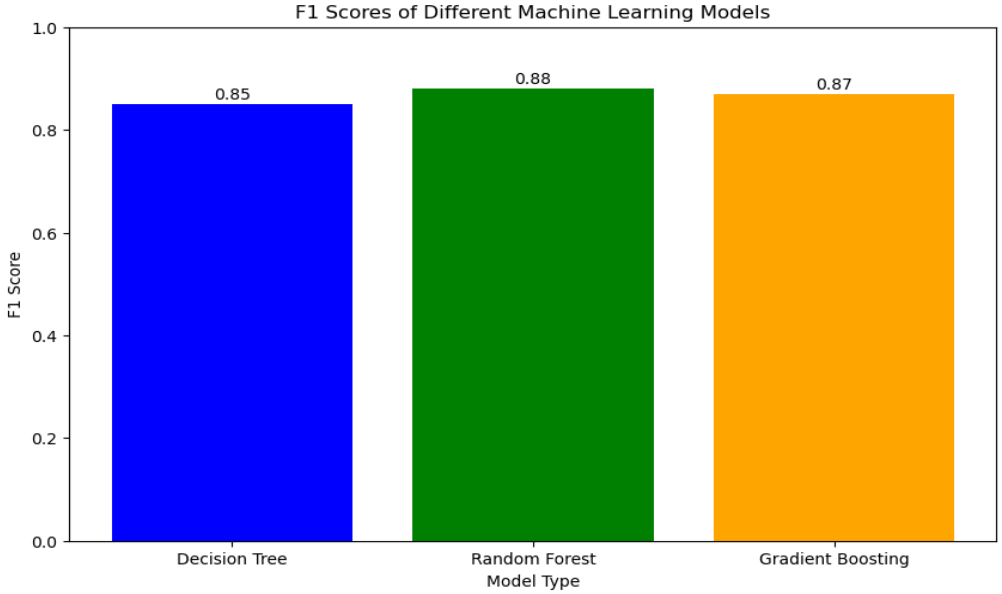
Table 2. Model Configurations and Performance Indicators

Model type	F1 score	Accuracy	Sensitivity
Decision tree	0.85	0.84	0.86
Random forest	0.88	0.87	0.89
Gradient boosting	0.87	0.86	0.88

Source: developed by the author based on Widyastuti et al. (2024), Hyperparameter Tuning Random Forest Pyspark Restackio (2021)

Random forest is the most efficient model with an F1 score of 0.88, showing an excellent balance between accuracy (0.87) and sensitivity (0.89), allowing for accurate detection of suspicious transactions and reduction of false positives. Gradient boosting performs similarly with an F1 score of 0.87, slightly inferior to random forest. The decision tree shows an F1 score of 0.85 but loses to more complex models. Figure 2 presents the F1 results for three models: decision tree, random forest, and gradient boosting, detecting suspicious transactions in the AML system.

Figure 2. F1 Scores of Different ML Models



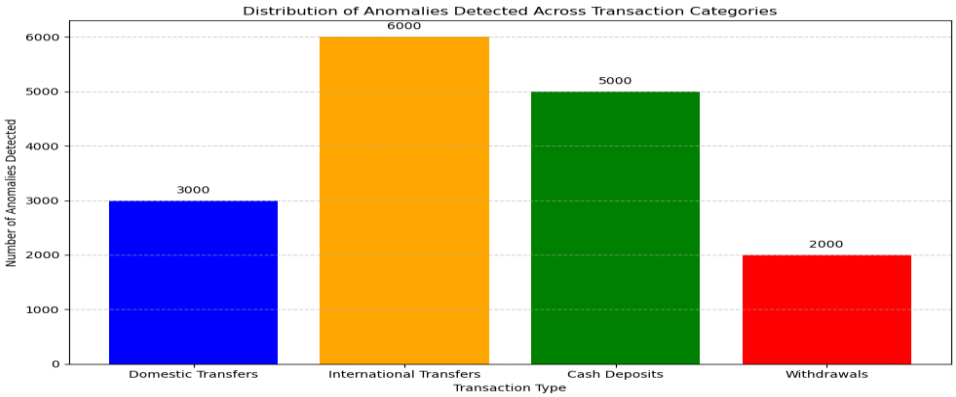
Source: Buhl (2023), Kundu (2022)

The vertical axis shows the F1 score, reflecting the precision and recall balance. The value ranges from 0 to 1, where 1 means perfect balance. The random forest model achieved the highest F1 score of approximately

0.88, showing the best performance in detecting suspicious transactions with a harmonious balance between accuracy and coverage. Gradient boosting reached 0.87, which is also a high score. The decision tree showed a lower result of 0.85, which indicates less efficiency.

Due to its ensemble nature, random forest combines the predictions of several trees, minimizing errors. Gradient boosting gradually improves accuracy by focusing on previous errors. A decision tree, capable of classifying transactions, does not strike a balance between accuracy and sensitivity very well. The F1 score is critical to AML systems, ensuring the reduction of the risk of erroneous decisions. The Isolation Forest algorithm identified 15,000 potential anomalies for further analysis. Figure 3 shows their distribution among four types of transactions: domestic, international transfers, cash deposits, and withdrawals.

Figure 3. Distribution of Detected Anomalies by Transaction Categories

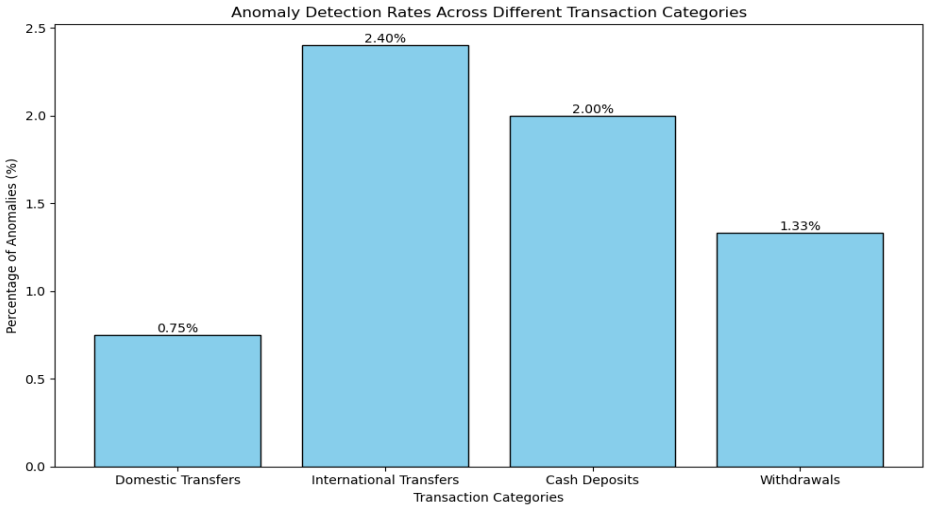


Source: The Many Use Cases for Anomaly Detection in Business Data (2024), A Guide to Building a Financial Transaction Anomaly Detector (2024)

International transfers have the largest detected anomalies, indicating their increased risk and complexity. They are often checked as part of the fight against money laundering. This is determined by different regulatory regimes, currency exchange, and the involvement of several financial institutions, which increases the likelihood of suspicious activity. Cash deposits also show many anomalies, which may indicate money laundering attempts through large or frequent deposits that do not correspond to the customer's usual financial activity. Such a situation emphasizes the importance of careful monitoring of such operations.

Although less risky, domestic transfers can also contain suspicious patterns, especially for large or frequent transfers. This may indicate attempts to launder money through local accounts using less stringent controls. Withdrawals show the lowest level of detected anomalies, which may be caused by the difficulty of detecting suspicious activity without additional context, such as the withdrawal location or subsequent use of the funds. However, this does not mean such transactions are safe — detecting violations may require more detailed analysis or a combination of monitoring with other types of transactions. Figure 4 illustrates anomalies detected by the Isolation Forest algorithm in financial transactions.

Figure 4. The Level of Detection of Anomalies in Different Categories of Transactions



Source: Dynatrace (2024), How to Detect Anomalies in Payment Transactions (2024)

Each point on the chart represents a transaction by its amount and frequency. Anomalous transactions detected by the Isolation Forest algorithm are highlighted in a contrasting color, such as red, making it easier to distinguish them from normal transactions. Anomalies are distributed unevenly between different types of operations. International transfers show a higher density of anomalies, as the many marked points in this category demonstrate. This may indicate suspicious activity, such as money laundering. Large or frequent cash deposits are also often anomalous, which can indicate suspicious activity.

Domestic transfers and withdrawals have fewer anomalies, indicating their predictable behavior. Anomalous transactions often focus on specific amounts that differ from the average. For example, large international transfers are often anomalous. A high frequency of operations in a short time can also indicate anomalies, which is manifested in the clustering of points on the chart. The economic impact was analyzed using Pandas Excel and Python, financial consequences were assessed, and key statistical data were obtained (Table 3).

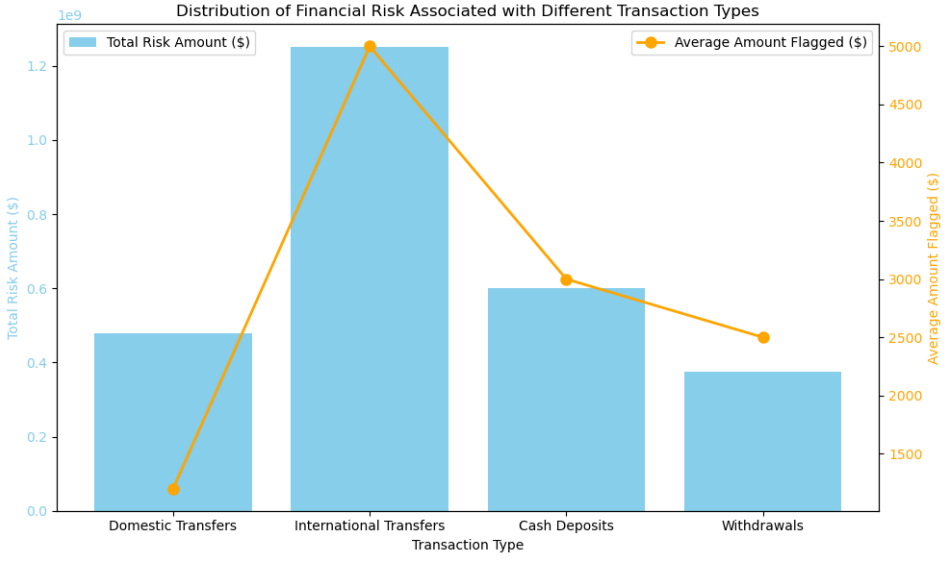
Table 3. Financial Consequences of Transactions

Transaction type	Marked Average Amount ($)	Total amount at risk ($)
Domestic transfers	1,200	480,000,000
International transfers	5,000	1,250,000,000
Cash deposits	3,000	600,000,000
Withdrawals	2,500	375,000,000

Source: developed by the author based on Tamplin (2023), Simon and Simon (2021)

The average amount of suspicious domestic transfers is $1,200, which is lower than international transactions but indicates risky domestic transactions. This indicator reaches $5,000 for international transfers, indicating greater fund involvement. The average size of suspicious deposits is $3,000, with large cash deposits making them difficult to trace. Withdrawals have an average amount of $2,500. The total financial risk from suspicious domestic transfers reaches $480 million, while for international transfers, this amount is $1.25 billion, indicating the greatest risk because of the large amounts and number of transactions. Cash deposits generate $600 million at risk, while suspicious withdrawals generate $375 million, the lowest indicator because of fewer transactions. International transfers carry the greatest risk because of the large amounts of money laundering. Domestic transfers and cash deposits also pose significant risks because of high volume and high average amounts. Withdrawal has the lowest risk. Figure 5 illustrates these risks.

Figure 5. Distribution of Financial Risk by Transaction Types



Source: Segal (2024), Financial Crime Academy (2024)

The highest financial risk is associated with international transfers since their value is much higher than other transactions despite the lower frequency. The large amounts of funds characteristic of cross-border transactions can explain this. International transfers have the most significant average amounts, which indicates a high risk for financial institutions. Cash deposits also carry significant risk, although the average amounts are smaller than international transfers. Many such transactions accumulate overall risk despite the smaller amounts

of each transaction. Because of smaller average amounts, domestic transfers and withdrawals show the lowest overall risk. In the insurance sector, the analysis covered premium and claims transactions. It was found that anomalies in insurance transactions occur less often than in other types of transactions, which indicates a lower risk of suspicious activity. Data on insurance activity, including premiums and claims, was used to assess the potential risk of suspicious behavior. Table 4 summarizes the results of insurance transactions.

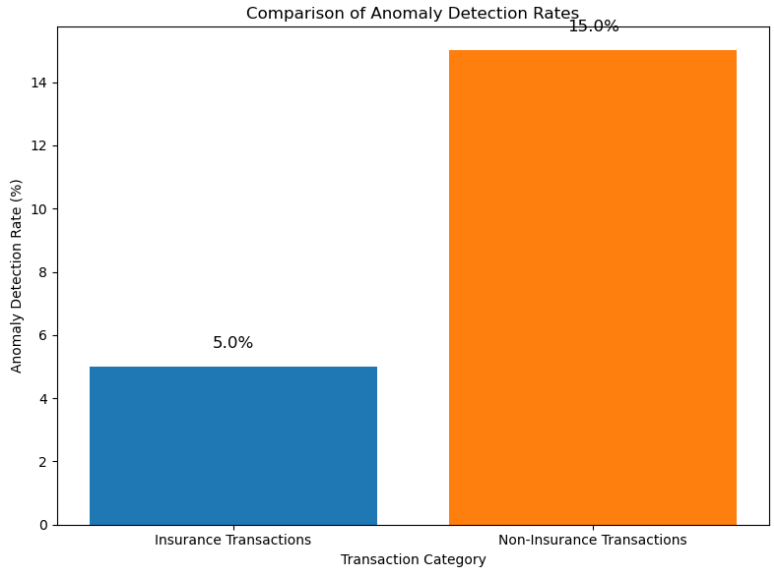
Table 4. Insurance transactions

Type of insurance transaction	Account	Percentage (%)	Marked Average Amount ($)	Total amount at risk ($)
Insurance premiums	100,000	10.00	2,500	250,000,000
Insurance claims	50,000	5.00	4,000	200,000,000

Source: developed by the author based on Strategy and Transactions in Insurance (2024)

Insurance premiums account for the majority of transactions compared to claims. However, the average amount of insurance claims exceeds premiums and significantly affects financial risk. Although insurance claims are less frequent, their amounts are often significant, making them important to monitor for suspicious activity. The low percentage of anomalies in insurance transactions compared to other transactions indicates a lower likelihood of suspicious behavior. This may result from the structuredness of insurance transactions and their regulated environment. Figure 6 compares anomalies in insurance and non-insurance transactions, revealing the main differences.

Figure 6. Comparison of Anomaly Detection Indicators



Source: Seasonal-Trend Decomposition Using LOESS (STL) - Statsmodels 0.15.0 (+429) (2024)

The histogram illustrates that insurance transactions have fewer marked anomalies than non-insurance transactions. For example, this indicator can be 2% in insurance transactions, while it is 8% in non-insurance transactions. This indicates a lower probability of suspicious behavior in insurance operations, indicating greater stability and reduced susceptibility to fraud. A clear difference between the categories demonstrates that non-insurance transactions have more suspicious transactions. Insurance transactions may have regular payouts and claims that meet standards, reducing the risk of anomalies. The results in Figure 6 require further analysis to identify the reasons for such performance, including testing the effectiveness of anomaly detection systems.

4. Discussion

The results of this study indicate a growing interest in AI use in the AML in financial systems. AI-based models show great potential in detecting suspicious transactions, going beyond traditional rule-based systems. They make it possible to identify complex patterns and anomalies in large data volumes. However, certain aspects should be taken into account when analyzing our findings.

According to the studies by Bertrand *et al.* (2020, 2021), there are doubts about the compatibility of AI in the fight against money laundering with human rights. Our results do not fully refute these concerns. The use of

AI raises concerns about data privacy and possible bias. Although our algorithms are effective at marking suspicious transactions, there is a risk of privacy rights violation. Bertrand *et al.* (2020) noted that these systems may conflict with the personal data protection provided by the General Data Protection Regulation (GDPR). However, explainable AI (XAI) in our model offers a more transparent approach that partially solves these problems. Abrahamyan (2023) drew attention to money laundering risks through international financial transactions. Our research supports this view, showing that AI can detect illegal transactions in the banking sector and specific industries, such as the financing of sporting events. Unlike Abrahamyan (2023), we demonstrate a more targeted approach to monitoring such risk areas.

Hayble-Gomes (2022) focused on predictive modeling for Suspicious Activity Reports (SAR). We improved this approach using deep learning (DL) techniques that improve detection accuracy. However, this also needs to be improved in interpreting the results, a problem that Hayble-Gomes also raised. Our research shows the importance of a balance between accuracy and transparency to ensure the reliability of processes. Fritz-Morgenthal *et al.* (2022) emphasized the importance of AI transparency for financial risks. Our results support this view, showing that implementing XAI increases trust in AI systems. We also focused on the accuracy of money laundering detection. Kute *et al.* (2021) emphasized the need for transparent AI models to combat money laundering. Our study demonstrates the practical use of XAI in real systems, although transparency remains a challenge that requires further improvement. Ashwini and Hussain (2023) noted that AI has increased the efficiency of banking transactions. Our research supports this finding, indicating reduced false positives and improved compliance in AI systems. Turksen *et al.* (2024) considered the legal aspects of using AI to monitor transactions, including the risks of excessive automation without human oversight. Our research supports the need for a hybrid approach where AI systems are complemented by human control. Pavlidis (2023) noted that AI opens up new opportunities in the fight against money laundering. Our results confirm this, emphasizing the need to improve legislation to match technological progress.

Overall, our research confirms that AI significantly improves the detection of suspicious transactions and reduces compliance costs. However, further adaptation of regulatory norms and improvement of explainable AI technologies are critical to addressing privacy and transparency issues. The practical application of the results of this research in financial institutions is to increase the effectiveness of the fight against money laundering with the help of AI. It is also important to improve regulatory compliance procedures. Policymakers can use these findings to develop ethical rules for using AI in the financial sector.

4.1. Limitations

One of the main disadvantages of using AI in AML systems is the high risk of obtaining false positive results. This can lead to inefficient operation and verification of legitimate transactions without reason. Moreover, AI relies on large amounts of data for training, which raises concerns about privacy and compliance with financial regulations in different countries. Implementing such technologies also requires significant technical resources, creating financial difficulties for small companies.

4.2. Recommendations

Financial institutions must implement sophisticated AI models, including DL and ensemble methods. These tools can effectively detect complex transaction data patterns and improve suspicious activity detection. It is important to ensure that AI algorithms are regularly updated and retrained to adapt to changes in money laundering strategies and new regulatory requirements. This will help to maintain the effectiveness and compliance of AML initiatives.

Conclusions

Implementing AI in AML has become a major development in the financial sector. Financial transactions are becoming more complex, and money laundering techniques are becoming more sophisticated, which shows the limitations of traditional detection methods. This research highlights the need to use AI to improve the effectiveness of AML systems, suggesting a shift to more proactive and intelligent approaches to preventing financial crime. The results demonstrate that AI methods for detecting suspicious transactions are significantly superior to traditional methods. ML algorithms and data analysis have demonstrated greater accuracy in detecting potential money laundering, reducing false positives, and increasing AML systems' effectiveness. AI can analyze large data volumes in real-time, allowing faster and more accurate recognition of suspicious patterns and activities, strengthening regulatory measures against financial crimes.

The study's results emphasize the significant impact of AI on the field of AML. Financial institutions can use AI tools to improve transaction monitoring, ensure regulatory compliance, and reduce money laundering risks. AI technologies increase the effectiveness of the fight against money laundering and create a safer and more transparent financial environment. These changes also contribute to increasing confidence in financial systems.

Further research should focus on several important areas to improve the use of AI in AML systems. First, advanced AI techniques such as DLand natural language processing (NLP) must be explored to improve detection capabilities. Second, ethical and privacy issues related to AI-based monitoring of financial transactions should be assessed to ensure the responsible use of the technology. Finally, cross-sector studies that compare the application of AI in different financial settings and legal frameworks can provide valuable insights into best practices and areas for improvement. Continuous innovation and research are critical to maintaining the effectiveness of AI in the fight against financial crimes and adapting to new threats in the financial sphere.

Credit Authorship Contribution Statement

The authors equally contributed to the present research, at all stages from the formulation of the problem to the final findings and solution.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of use of generative AI and AI-Assisted technologies

The authors declare that they have not used generative AI and AI-assisted technologies in the writing process before submission.

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Appendices

Appendix A

Financial transactions data pre-processing procedure

1. Data collection

Purpose: Obtain and verify the integrity of a data set.

Action: Securely receive anonymous transaction data from a financial institution. Check the dataset for completeness and accuracy.

2. Data verification

Purpose: Identify and understand the structure and content of the data set.

Action: Perform initial verification using Python libraries (e.g., Pandas). Check for missing values, data types, and overall structure.

3. Processing of missing values

Purpose: Resolve any missing or null values in the data set.

Action: Apply appropriate imputation methods or remove rows/columns with extra missing values.

4. Data normalization

Purpose: Standardize numerical values to ensure comparability.

Action: Use normalization methods such as min-max scaling or standardization.

5. Coding of categorical variables

Purpose: Convert categorical data into a numerical format suitable for machine learning algorithms.

Action: Use such methods as One-Hot Encoding or Label Encoding.

6. Development of functions

Purpose: Create new features that can improve the performance of the model.

Action: Create additional features based on existing data, such as transaction frequency or average transaction amount per user.

7. Data splitting

Purpose: Split the data set into training and testing sets to evaluate the model performance.

Action: Use a stratified distribution to ensure that each set is representative of the general distribution of the data.

8. Data verification

Purpose: Ensure that processed data meets quality standards.

Action: Perform checks to verify that the pre-processing steps have been applied correctly and that the data is ready to train the model.

9. Documentation

Purpose: Document pre-processing steps and solutions for reproducibility.

Action: Record all pre-processing steps, including data imputation techniques, scaling techniques, coding procedures, and splitting strategy.

DOI: https://doi.org/10.14505/tpref.v14.4(32).20

The Impact of Marketing Tools on the Recyclables Circulation in the Circular Economy

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Article info: Received 1 October 2024; Received in revised form 17 October 2024; Accepted for publication 11 November 2024; Published 30 December 2024. Copyright© 2024 The Author(s). Published by ASERS Publishing. This is an open access article under the CC-BY 4.0 license.

Abstract: Increasing the efficiency of the recyclables circulation is a generally recognized necessity in view of the worsening of environmental problems. In this context, marketing plays an important role as an effective stimulus for the transition to a circular economy. The aim of the study is to determine marketing tools capable of influencing the improvement of the efficiency of the recyclables circulation, in accordance with the determined aspects of green growth. The work used the methods of correlation, regression, and statistical analysis, as well as case studies. The conducted research proved the correlation between the waste recycling rate and all dimensions of green growth. These include increasing the efficiency of resource use, protecting natural capital, developing a green economy, and increasing social inclusion. The regression analysis, where the level of waste recycling was the dependent variable, found a statistically significant effect of social inclusion. This gave grounds to propose a list of marketing tools that could be useful for increasing the efficiency of the recyclables circulation for each of the studied aspects of green growth. This can be useful for developing strategies and approaches depending on specific needs. It is appropriate to use marketing tools determined for this specific direction (information campaigns, etc.), in particular, in case of insufficient efficiency of the recyclables circulation caused by a low level of social inclusion.

Keywords: circular economy; marketing tools; secondary resources; waste recycling; green growth; social inclusion; green initiatives.

JEL Classification: C10; F18; F64; Q59.

Introduction

The circular economy arose in response to the need to stimulate and support sustainable development (Arruda *et al.* 2021). In the course of its development, the concept of the circular economy has undergone changes in views on its essence. Today, the issue of whether the circular economy can contribute to economic growth and the achievement of environmental goals at the same time remains open (Kirchherr *et al.* 2023). The priority task of the circular economy is to increase efficiency of the recyclables circulation (Morseletto 2020).

The need to increase the efficiency of the recyclables circulation is determined by the ever-increasing amount of waste (Chen *et al.* 2020; Wowrzeczka 2021). Finding ways to increase the efficiency of the recyclables circulation is an urgent task for the researchers (Li *et al.* 2022; Shen and Worrell 2024). Many studies have emphasized the importance of marketing as an important tool for achieving this circular economy goal (Hole and Hole 2020; Wang *et al.* 2020). Marketing uses various methods and techniques that can encourage citizens to buy more ecological products, and companies to implement ecological technologies and approaches in their activities (Limjaroenrat and Ramanust 2023; Šagovnović and Stamenković 2023). It can be assumed that successful marketing can be one of the key ways that will enable the circular economy to achieve two goals at the same time: economic growth and environmental improvement (Maziriri 2020).

The concept of green marketing, i.e. marketing that promotes environmental goals (Shabbir *et al.* 2020), is closely related to the concept of green growth. This concept focuses on economic growth while reducing negative environmental impact (Dogaru 2021; Allan and Meckling 2023). According to the definition of the Green Growth Index, its dimensions can include efficient and sustainable use of resources, protection of natural capital, green economic opportunities, and social integration (Terzić 2024).

There are certain gaps in research regarding the identification of the relationship between the mentioned aspects and the level of efficiency of recyclables circulation. While the relationship between efficient and sustainable use of resources and the efficiency of recycling secondary resources may be obvious, the relationship with other aspects is not well established in the literature. If such a relationship exists, it can be proven that the efficiency of the recyclables circulation depends on a wider range of variables than it seems at first glance. Accordingly, this potentially expands the list of possible marketing tools that can be used to promote the use of secondary resources. In other words, this approach provides another look at the tools of marketing. This happens due to the addition of such tools to it that were not previously considered for the purposes of increasing the efficiency of the recyclables circulation.

The aim of the study is to identify marketing tools capable of influencing the improvement of the efficiency of the recyclables circulation, in accordance with the determined aspects of green growth. Aim involved the fulfilment of the following research objectives:

- Estimate the change in the level of waste recycling in European countries in 2021 compared to 2004;
- conduct a correlational and regression analysis of the impact of green growth measurements on the waste recycling rate in selected European countries;
- form a list of marketing tools that can be used to increase the efficiency of the recyclables circulation depending on the determined aspects;
- describe examples of successful use of the specified tools.

1. Literature Review

Many researchers confirmed the appropriateness of the transition to a circular economy in order to increase the efficiency of the use of secondary resources. Lonca *et al.* (2020) assessed the environmental effects of the implementation of circular economy strategies using the example of a closed cycle of recycling of plastic bottles in the USA. Calvo-Porral and Lévy-Mangin (2020) emphasized that the transition from a linear consumption model to a closed production model is an important direction of the circular economy, but it is necessary to investigate in detail the attitude of consumers towards circular products. Consumer reactions to products made from recycled or recyclable materials are a relevant issue for many studies. Boyer *et al.* (2021) investigated the consumers' willingness the United Kingdom to pay for circular economy labels with a numerical indication of the proportion of recycled content on the label. Confente *et al.* (2020) found that consumers' "green" self-identity has a positive effect on the willingness to buy bioplastic products. These works prove the importance of using marketing tools to improve the efficiency of the recyclables circulation in the circular economy. The consumers' willingness to make a choice in favour of more ecological products significantly reduces waste volumes and/or increases the share of waste that can be recycled.

A number of studies proved the effectiveness of other marketing tools for increasing consumer interest. Li *et al.* (2021) noted the effectiveness of ecological design as an effective marketing tool to achieve circular

economy goals. Gustavo *et al.* (2021) focused their research on identifying green marketing measures in supermarkets capable of reducing waste from short-life food products. Sugandini *et al.* (2020) analysed environmental supply chain management and green marketing strategies in the context of their impact on green purchase intentions. Hayat *et al.* (2023) studied the impact of corporate social responsibility on encouraging consumers to make sustainable purchases. Alonso-Almeida *et al.* (2020) examined the impact of circular economy promotion on circular consumption and economic competitiveness at the institutional level. Boháček *et al.* (2021) investigated aspects of citizens' motivation to participate in plastic bottle recycling, as well as willingness to recycle bottles depending on socio-demographic characteristics.

Special attention should be paid to works investigating the use of digital marketing tools to promote environmental ideas. Almestarihi (2024) investigated environmental digital marketing methods and tools to increase customer engagement and improve the state of the environment. The tools and methods recognized by the researchers include: social networks, search engine optimization, content marketing, e-mail, influencer involvement. Bojanowska and Kulisz (2020) investigated the impact of eco-marketing in social networks on consumers, in particular, on attitudes towards ecological packaging and the use of zero-waste technologies. Dash *et al.* (2023) studied the use of social media and the involvement of influencers in sustainable marketing strategies.

This study differs from the previous ones as it begins with the identification of the impact of green growth aspects on the efficiency of the recyclables circulation. After that, a number of marketing tools were identified for each direction that had a significant impact, potentially influencing the improvement of the efficiency of the recyclables circulation within the corresponding direction. This made it possible to make a wide list of marketing tools that can be applied depending on specific needs (increasing the efficiency of resource use, protecting natural capital, promoting the development of the green economy, or social inclusion). It is appropriate to continue research in this area in view of revealing the importance of marketing tools that are not used enough, but have the potential to increase the efficiency of the circulation of secondary resources.

2. Research Methodology

2.1. Research Design

The first stage of the work contains a brief overview of the change in the waste recycling rate in European countries in 2021 compared to 2004. The purpose of this stage was to emphasize the importance and priority of waste recycling for European countries, as well as to prove the existence of successful practices for improving recycling efficiency. In this case, 2004 is a base for comparison as this year saw the largest increase in the number of the EU member states. Ten new countries joined the union at once, which had a significant impact on the EU's environmental policy, in particular, the policy of managing secondary resources.

The second stage of the research provided for the analysis of how the Municipal waste recycling rate is related to the Green Growth Index and the corresponding indicators (measures of green growth). These include Efficient and sustainable resource use (ESRU), Natural capital protection (NCP), Green economic opportunities (GEO), Social inclusion (SI). The purpose of this stage in the context of the research issue was to determine whether the specified aspects of green growth affect the improvement of the efficiency of the recyclables circulation.

The third stage involved making a list of marketing tools that can be used to achieve the goals of increasing the efficiency of the recyclables circulation for each of the noted aspects. It was assumed that if the positive impact of a particular direction is significant, the use of marketing tools to increase the value of the corresponding indicator will also have a positive impact. In other words, lists of marketing tools were proposed for: 1) increasing the efficiency and sustainability of resource use; 2) improvement of natural capital protection; 3) expanding the opportunities of the green economy; 4) improving social inclusion. An example of its successful implementation by large European companies was provided for each of the proposed marketing tools. The creation of the specified lists is useful for the development of strategies and approaches to increase the efficiency of the recyclables circulation depending on specific needs.

2.2. Sample

The sample of countries for the study, as well as the initial values of key indicators, are presented in Table 1.

Table 1. West Recycling Rate of European Countries

Countries	Municipal waste recycling rate 2004	Municipal waste recycling rate 2021	Green Growth Index	Efficient and sustainable resource use (ESRU)	Natural capital protection (NCP)	Green economic opportunities (GEO)	Social inclusion (SI)
Austria	57.4	62.5	77.78	78.97	80.28	38.99	93.45
Belgium	53.5	55.5	64.33	50.36	77.07	27.96	90.54
Bulgaria	17.2	28.2	63.93	50.84	78.31	32.07	82.58
Croatia	3.2	31.4	68.07	63.99	83.74	25.48	81.66
Czechia	5.5	43.3	75.13	74.56	81.67	40.09	85.85
Denmark	41	57.6	76.08	77.69	71.56	50.53	90.8
Estonia	24.8	30.3	68.27	62.91	74.24	32.9	86.92
Finland	33.6	39	71.69	69.43	73.06	37	90.55
France	29	43.8	70.93	64.98	78.51	31.28	91.91
Germany	56.4	67.8	75.01	64.95	82.65	46.76	92.04
Greece	10.1	21	64.46	61.25	77.01	19.32	84.85
Hungary	11.8	34.9	69.75	65.74	81.18	32.67	81.87
Ireland	29.5	40.8	59.95	65.43	59.22	15.03	88.17
Italy	17.6	51.9	70.89	65.86	80.39	32.61	87.15
Latvia	4.4	44.1	68.85	71.75	76.38	24.07	84.55
Lithuania	1.9	44.3	68.57	68.52	73.33	30.91	83.68
Luxembourg	41.5	55.3	67.99	66.38	74.78	25.13	88.23
Malta	6.3	13.6	50.72	43.13	63.37	9.87	82.37
Netherlands	46.9	57.8	66.04	56.52	71.23	30.2	92.88
Poland	4.9	40.3	66.66	57.3	76.02	32.66	86.27
Portugal	13.5	30.4	69.54	64.81	78.66	28.06	89.27
Romania	1.1	11.3	68.01	64.88	77.32	32.72	80.02
Slovakia	6.1	48.9	74.04	73.67	84.3	38.3	81.43
Slovenia	20.4	60.8	67.68	60.05	78.97	31.21	84.64
Spain	30.9	36.7	68.33	60.83	75.99	29.51	91.29
Sweden	43.9	39.5	76.64	77.3	77.99	37.56	94.71
Switzerland	48.7	53.3	75.78	80.89	78.17	31.31	92.42
Norway	36.5	38.22	67.45	64.36	68.85	28.21	92.6
Iceland	16.4	26.42	51.88	56	44.6	13.63	87.29

Source: generated by the author based on 2010-2021 Green Growth Index Map. Global Green Growth Institute; Waste recycling in Europe 2023

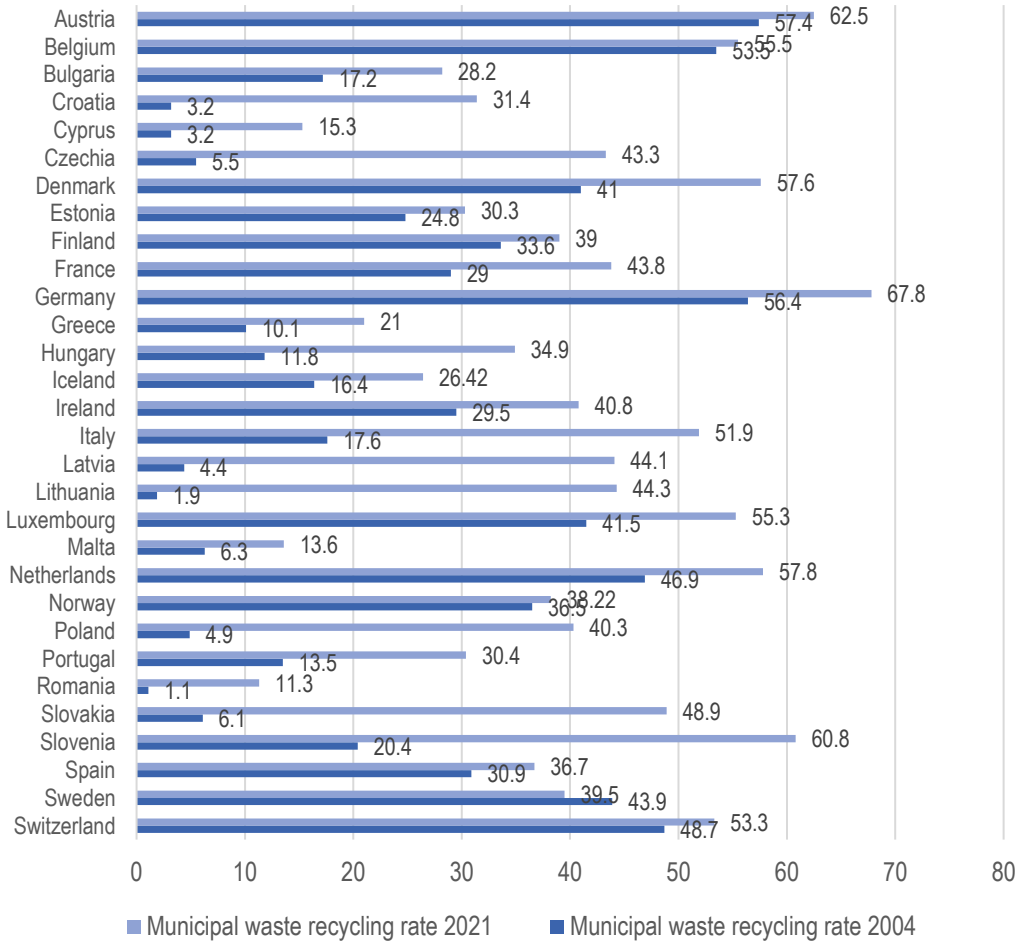
2.3. Methods

Correlation and regression analyses are key research methods. Correlation analysis was used to identify relationships between the waste recycling rate and the Green Growth Index and its aspects. This made it possible to verify the existence of a linear relationship between these indicators. Regression analysis made it possible to assess the impact of independent variables, which were aspects or components of the Green Growth Index, on the dependent variable — the waste recycling rate. An important difference between regression analysis and correlation analysis is that the regression model is able to take into account the influence of other variables. Statistical analysis was also used in the work to assess changes in the waste recycling rate by country. An important method was the case study to analyse the practice of European companies and describe the most successful practices that are effective in the context of improving indicators within the studied aspects of green growth.

3. Research Results

The environmental policy of European countries places special emphasis on the need to increase the efficiency of the recyclables circulation. In view of the priority of this circular economy objective, significant efforts have been made in the last two decades to ensure an appropriate waste recycling rate in European countries. Figure 1 shows the change in the waste recycling rate of individual European countries in 2021 compared to 2004.

Figure 1. Change in the waste recycling rate in European countries - comparison of 2021 with 2004



Source: generated by the author based on Waste recycling in Europe 2023

Figure 1 shows that especially significant changes affected countries that had rather low waste recycling rates in 2004. For example, Slovenia in 2004 had a waste recycling rate of 20.4. But in 2021, the country broke into the top three in terms of waste recycling, along with Austria and Germany, reaching a value of 60.8. At the same time, some countries are still characterized by a rather low waste recycling rate in 2021 (less than 20), in particular, Cyprus, Malta, and Romania.

The observed changes indicate the importance of increasing the efficiency of the recyclables circulation and testify to the existence of successful practices for achieving this goal in Europe. However, it is important to assess which dimensions of green growth can have a significant impact on increasing the efficiency of the recyclables circulation. Effective and sustainable use of resources, protection of natural capital, green economic opportunities, and social integration are included in the study. These aspects correspond to the constituent components of the Green Growth Index.

Table 2. Results of correlation analysis between the waste recycling rate and aspects of green growth

	Green Growth Index 2021	Efficient and sustainable resource use (ESRU)	Natural capital protection (NCP)	Green economic opportunities (GEO)	Social inclusion (SI)
Municipal waste recycling rate 2021	0,557359	0,40436	0,300185	0,541797	0,52945

Source: generated by the author based on 2010-2021 Green Growth Index Map. Global Green Growth Institute; Waste recycling in Europe, 2023

If there is a relationship between them and the waste recycling rate, it can be argued that the waste recycling rate is affected not only by the improvement of resource efficiency, but also by less obvious factors - the increase of

social inclusion, the development of opportunities for the green economy, etc. Table 2 contains the results of the correlation analysis between the waste recycling rate and the aspects of green growth.

The results of the correlation analysis indicate a statistically significant moderate (0.3 – 0.5) and significant relationship between the waste recycling rate and green growth indicators. The closest relationship is observed between the waste recycling rate and the integral value of the Green Growth Index (0.56), green economy opportunities (0.54) and social inclusion (0.52). This proves the previous assumption that less obvious factors can have a significant impact on recycling rates. A regression analysis was conducted using the 2021 Municipal Waste Recycling Rate as a dependent variable to identify the influence of the components of the Green Growth Index on this indicator (Table 3).

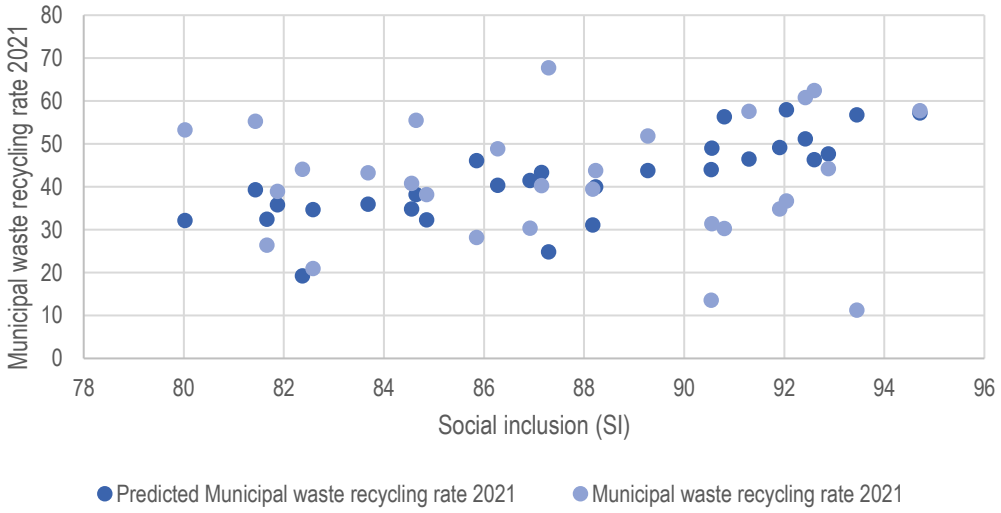
Table 3. Results of regression analysis between the Municipal Waste Recycling Rate 2021 and the 2021Green Growth Index

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	-125.4	57.71802	-2.17264	0.039908	-244.524	-6.27622	-244.524	-6.27622
Efficient and sustainable resource use (ESRU)	0.080699	0.302225	0.267015	0.791739	-0.54306	0.704461	-0.54306	0.704461
Natural capital protection (NCP)	0.241197	0.354549	0.680291	0.50283	-0.49056	0.97295	-0.49056	0.97295
Green economic opportunities (GEO)	0.489642	0.365272	1.340485	0.19264	-0.26424	1.243526	-0.26424	1.243526
Social inclusion (SI)	1.470161	0.569421	2.581851	0.016361	0.294933	2.645388	0.294933	2.645388

Source: calculated by the author based on 2010-2021 Green Growth Index Map. Global Green Growth Institute; Waste recycling in Europe, 2023

The results of the regression analysis between indicators in Table 3 indicate a statistically significant influence of Intercept and SI on the dependent variable in view of the P-value. According to the Determination Index values, the obtained model can explain about 45.82% of the change in 2021Municipal Waste Recycling Rate. Additional information about the adequacy and appropriateness of the model can be obtained from the graphs in Figure 2 and 3. Figure 2 contains the SI Line Fit Plot, Figure 3 – SI Residual Plot.

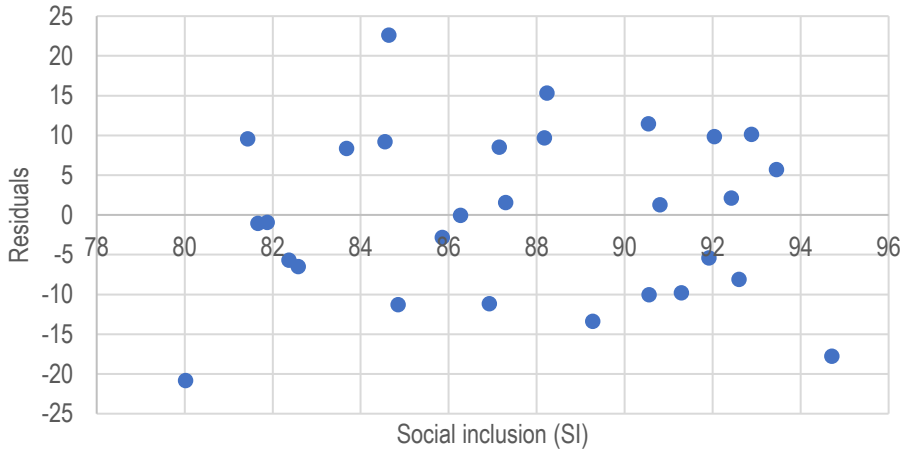
Figure 2. SI Line Fit Plot



Source: graphed by the author based on 2010-2021 Green Growth Index Map. Global Green Growth Institute; Waste recycling in Europe, 2023

Figure 2 gives grounds to conclude that the model is generally appropriate, because most of the points are close to the regression line. This indicates that the model adequately describes the relationship between the variables. At the same time, several significant deviations are observed, therefore the model does not consider all factors that have a significant impact on the dependent variable. This may be indicated by the high statistical significance of the Intercept, which may indicate the existence of influential variables not included in the model.

Figure 3. SI Residual Plot



Source: graphed by the author based on 2010-2021 Green Growth Index Map. Global Green Growth Institute; Waste recycling in Europe, 2023

In general, Figure 3 confirms the adequacy of the model. The residuals are randomly distributed along the axis, but there are also some regularities, for example, mostly positive/negative values of the dependent variable for individual ranges, the formation of clusters. So, the model may not fully show all aspects of the relationship between the variables. As in the findings above, it can be assumed that the model can be improved by adding new influential variables.

Therefore, the conducted correlation analysis proved that all the studied dimensions are related to the waste processing rate. However, according to the results of the regression analysis, SI is the only indicator that has a statistically significant effect on the dependent variable. This may be explained by the fact that, unlike correlation analysis, the regression model is able to take into account the influence of other variables. It may be assumed that SI has the most pronounced and pure effect among the studied independent variables. On this basis, a list of marketing tools capable of increasing the efficiency of the recyclables circulation within each of the studied components was made (Table 4).

Table 4. Marketing tools and examples of their use to increase the efficiency of the recyclables circulation

Marketing tools	Examples
	ESRU
Environmental labelling, increasing citizen involvement	The German Federal Government uses the Blue Angel label, which designates only environmentally friendly products and services. One of the brand's initiatives is called "We love second-hand", making a call to buy school notebooks only with the Blue Angel label, because they are made from 100% recycled paper.
Promotion in social networks, content marketing, "green" advertising	The German company Adidas in partnership with Parley presented shoes that were made from recycled marine plastic waste, as well as tools used by poachers. The French company Danone emphasized its participation in achieving the goals of the circular economy. The company has made a global commitment that its products will be 100% compostable, recyclable or reusable by 2030. Both companies actively promote their ideas through social networks.
"Green" packaging, extending the product life cycle	The Swedish company IKEA not only promotes furniture from recycled materials, but also introduced a programme of exchanging old furniture for store credit for its customers. In addition, the company uses "green" packaging - today less than 10% of the company's packaging is made of plastic.
	Natural capital protection
Initiatives to support corporate social	In its advertising proposals, the German company BMW actively emphasizes the advantages of its products for the environment, in particular, electric cars. In the production of cars, the

responsibility	company uses up to 20% of parts made from recycled plastic. "We must set an example ourselves" — it is emphasized on the company's official website, emphasizing the high level of corporate social responsibility.
GEO	
Investor marketing	Dutch company Unilever uses investor marketing to promote environmental initiatives. Together with other large companies, Unilever is investing $100 million in the development of infrastructure for the collection and processing of plastic waste in a number of countries.
Promotion of "green" logistics	The German company DHL uses recycled materials for the manufacture of packaging for parcels. The packaging itself is also recyclable. Starting in 2022, the company's boxes and envelopes will be 100% recyclable. The foil is at least 80% made from recycled materials, 100% recyclable and has the Blue Angel label.
Employer branding, talent attraction strategies	Many leading companies (H&M, Sweden; Philips, Netherlands; Novo Nordisk, Denmark) emphasize their contribution to the environment, using it, among other things, as an employer branding tool. This allows companies to attract talent, including for the development of material reuse initiatives.
Innovation showcases	The Finnish company Stora Enso, which produces paper and packaging, participates in events where modern innovations are demonstrated. The company's innovations include solutions based on the use of recyclable materials.
SI	
Information initiatives, green branding	A number of leading companies support initiatives that inform citizens about the importance of environmental issues. Such companies include, for example, Inditex (Spain), Luxottica (Italy), Red Bull (Austria), Sonae (Portugal), Solvay (Belgium), which also use recycled materials in the manufacturing of products or packaging. The Danish company GoGreen participates in rallies, organizes lectures and parties in order to promote the ideas of sustainable development. One of the company's projects is the creation of a digital version (application) of city guides. Such guides inform users where to buy sustainable, certified, and recycled products.

Source: developed by the author

Therefore, the identified relationships gave grounds to conclude that the use of effective marketing tools within each of the components of green growth has the potential to make a positive contribution to increasing the efficiency of the recyclables circulation. The distribution of such tools by components is useful for the development of strategies and approaches to increase the efficiency of the recyclables circulation depending on specific needs. For example, if there is an insufficient level of social inclusion in the country, which negatively affects the recyclables circulation, it is appropriate to use such tools as the implementation of information initiatives, green branding using the example of leading companies.

4. Discussions

The results of the study quantitatively show the impact of green growth components on the efficiency of the recyclables circulation. Relevant marketing tools were also determined, which contribute to the achievement of goals depending on the component. Comparing the author's conclusions with the results of other works will allow to deepen the understanding of the researched concepts.

Lonca *et al.* (2020) proved that implementing a closed-loop approach to recycling plastic bottles is environmentally efficient. The researchers also noted that increasing the "circularity" of materials mitigates the negative impact on the environment. These conclusions are reflected in this study, which also includes a list of specific marketing tools that can help to achieve the observed effects. In particular, it was indicated that environmental labelling and the involvement of citizens contribute to increasing the efficiency and sustainability of the use of resources. This thesis is supported by the work of Calvo-Porral and Lévy-Mangin (2020), who established that the positive image of "circular" products is a key incentive for changing the perception of such products by consumers. Confente *et al*. (2020) found a positive influence of "green" self-identity on the desire to purchase bioplastic products. Boyer *et al.* (2021) also found that when choosing between alternatives, consumers usually prefer products that are more "circular". However, a deeper analysis proved that when the share of recycled content increases, the willingness of customers to pay more decreases or disappears. The researchers conclude that the use of circular economy numerical labels may be the most profitable strategy for some low-recycling appliance manufacturers. Li *et al.* (2021) found that increasing the level of greening of products could be a profitable strategy for companies when there is a high or low effect of marketing efforts. With a moderate effect, greening has a significant impact on the growth of profits and, as it should be assumed, on the desire to purchase the product. These two studies indicate the importance of a comprehensive study of the effects of the

implementation of individual marketing tools, because the same tool can have different effectiveness in different contexts.

Other researchers proved the effectiveness of the marketing tools proposed by the author. Sugandini *et al.* (2020) proved the importance of green supply chain management in green marketing. The author's work also noted the importance of promoting green logistics, so the conclusions of both studies are consistent, proving the link between green marketing and green logistics. Almestarihi (2024) noted that environmental efforts are important both at the government level (in Jordan) and at the company level (Patagonia, Google, IKEA, Tesla). The researchers indicated that the use of content marketing is effective for creating educational resources. Influencer marketing has a positive impact on customer engagement and brand awareness. The researcher concluded that the environmental friendliness of the brand improves the customers' attitude, which confirms the importance of corporate social responsibility. Hayat *et al.* (2023) found a direct positive effect of corporate social responsibility on impulsive green purchases, and green advertising and plastic bans — on planned green purchases.

Furthermore, the author's work proposed the use of marketing in social networks as a tool for increasing the efficiency of the recyclables circulation. At the same time, Bojanowska and Kulisz (2020) found that the use of social networks to promote ideas related to ecology, in particular, zero-waste production, does not attract enough attention. The researchers noted that the reaction to relevant ideas is not the same for different genders: women pay more attention to manifestations of green marketing (using the example of Poland). Boháček *et al.* (2021) also focused on the fact that the consumers' willingness to participate in green initiatives significantly depends on their socio-demographic characteristics. This once again confirms that the use of the tools proposed in the author's work may have different effectiveness in different cases. Therefore, the context should be considered during their implementation.

Some techniques and tools were covered by Gustavo et al. (2021). The researchers determined that the following aspects should be taken into account for effective promotion of products with a short shelf life: product, place, price, and promotion. This means that the placement of relevant products in supermarkets affects the sales volumes, as well as the dynamics of pricing for such products.

In further studies, it is important to take into account the influence not only of large companies, but also of other market participants, for example, institutional influence. Alonso-Almeida *et al.* (2020) found that soft circular economy institutional promotion initiatives are effective both in increasing the level of circular consumption and in improving market competitiveness. At the same time, tough initiatives affect mostly the increase in cyclical consumption rates. The researchers found that not all institutional initiatives are effective. The obtained results can be useful from the perspective of implementing the proposed marketing tools for increasing the efficiency of the recyclables circulation in the practice of large companies. These tools have the potential to improve the performance of such companies by focusing on the environmental qualities of products, which makes a significant contribution to sustainable development and green growth.

A limitation of the study is that it analysed the impact of green growth components on increasing the efficiency of the recyclables circulation in general. Relevant marketing tools, potentially affecting the increase in the efficiency of the recyclables circulation, were determined by researching the practices of companies, but were not tested on specific indicators. In terms of coverage, this approach is an advantage of the research, as it allows considering the maximum number of marketing tools that can be useful in the context of the set tasks. However, it lacks numerical support, so further research may focus on identifying the impact of the use of certain marketing tools on increasing the efficiency of the recyclables circulation.

Conclusions and Further Research

Marketing has the potential to be the tool that can combine the circular economy's goals of growing the economy, while improving the environment. In particular, appropriate marketing tools can be used to increase the efficiency of the recyclables circulation.

According to the results of the correlation analysis conducted in the study, all green growth component correlate with the waste recycling rate. The results of the regression analysis give grounds to note that social inclusion has the most significant and net effect on the efficiency of the recyclables circulation. Considering these results, the study offers a wide range of marketing tools for increasing the efficiency of the recyclables circulation depending on specific needs. These needs vary by region and scale and can be classified according to the content of green growth components. These include: the need to increase the efficiency of the use of resources, improve natural capital protection, promote the development of the green economy, or increase social inclusion.

Summarizing the above, it is worth noting that this study is an important contribution to marketing research. Comparison with other studies reveals the advantages of the author's work, while determining the scope of further work. Among other things, further research should include an in-depth study of the empirical impact of individual marketing tools and consider the impact of all stakeholders. In particular, it is important to assess the role of the state, small and medium-sized business entities from the perspective of their use of marketing tools. The obtained results can be used in the practice of large companies through the implementation of the proposed marketing tools, which will allow emphasizing the environmental friendliness of products.

Credit Authorship Contribution Statement

Olena Sadchenko: Conceptualization, Validation, Project administration;
Yuliia Zabaldina: Investigation, Writing – review and editing, Methodology;
Zoreslava Liulchak: Writing – original draft, Software.
Lilia Bublyk: Formal analysis, Data curation.
Olena Kanishchenko: Visualization, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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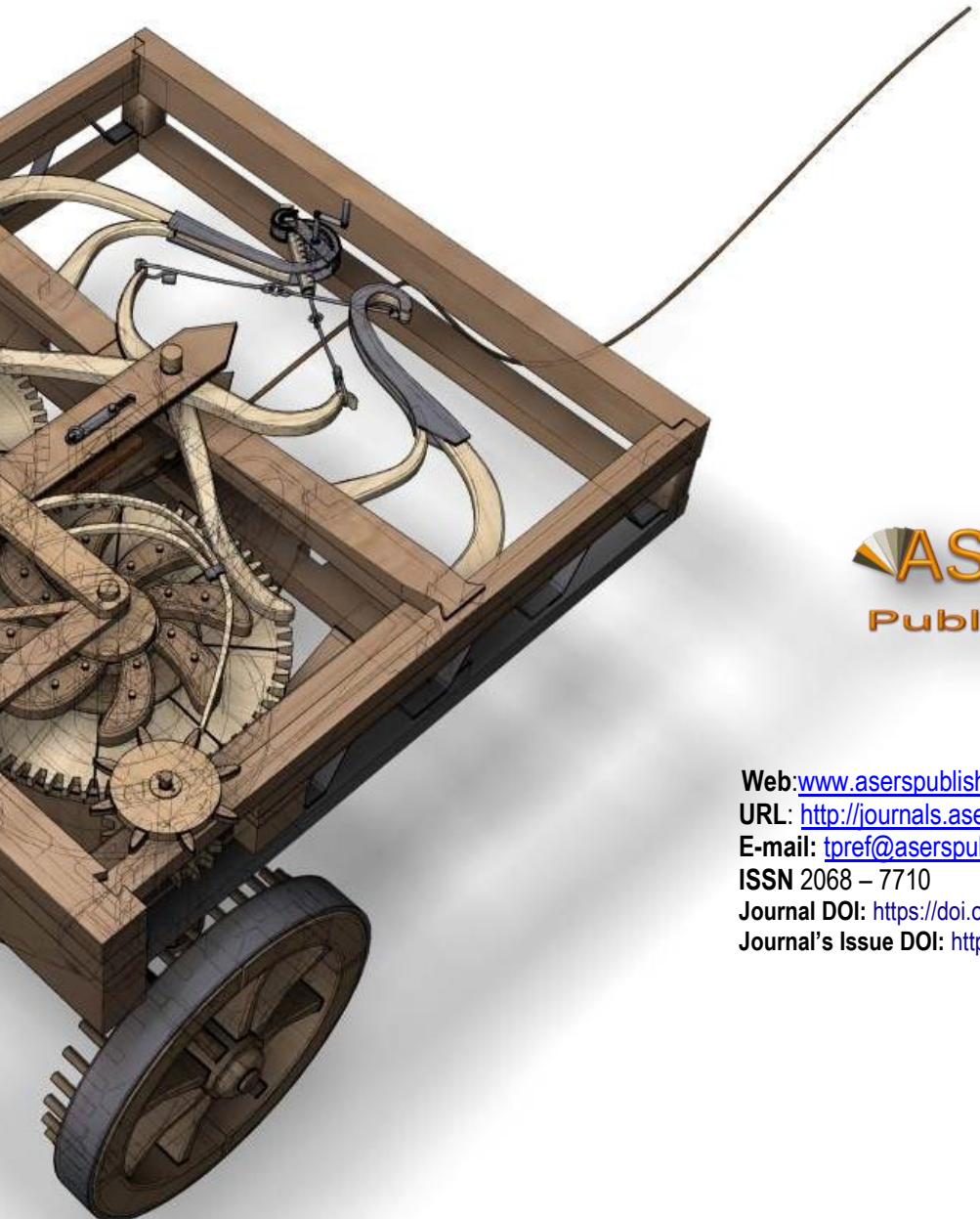

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