FINANCE: THEORY AND PRACTICE

Scientific and practical peer-reviewed journal
Published since 1997.
Former title: "Bulletin of the Financial University"

Manuscripts are submitted via the electronic editorial board on the journal's website
https://financetp.fa.ru/jour

Minimum volume of a manuscript to be submitted 4 ths words; optimal — 6 ths words.

The Editorial Board are assessment the peer-review manuscripts meticulously and executes scientific, literary and technical editing of the author's original in the journal.
More information on publishing terms is at: **https://financetp.fa.ru/jour**

CONTENTS

Central Banks Digital Currencies Issuance: Development Directions and Key Risks

V.V. Kuznetsova[a], O.I. Larina[b]
[a] Moscow State University named M.V. Lomonosova, Moscow, Russia;
[b] State University of Management, Moscow, Russia

ABSTRACT

Currently, many central banks have begun to develop, study and introduce central bank digital currencies (CBDC). Due to the lack of sufficient experience, potential problems and risks' research that can stimulate such financial innovations is relevant. The paper analyzes the projects for the creation of CBDC. The **purpose** of the paper is to identify unresolved aspects of the application of CBDC, and specific tasks include identifying the problems of the marketing of retail CBDC and the identification of the risks generated by them. The authors use general and special research **methods**, including comparative analysis and systematization. The article examines the prospects for digital ruble circulation in the Russian Federation. The use of CBDCs opens up enormous opportunities for the development of the digital economy, but their actual deployment is replete with risk. The article identifies the risks of the third form of national currency: technological (including environmental), economic, financial, social and legal. The authors consider that the widespread use of CBDC implies a transformation of the activities of national central banks, including a change in the role and functions of the national central bank, and provide several possible scenarios. The authors include among the unresolved problems that require solutions for the widespread practical use of digital securities: lack of understanding of the mechanism for transferring ownership during transfers from one user to another, clear prudential regulation, and effective management of big data analytics. Furthermore, the scope of regulation of the financial intermediation sector with regard to fintech innovations has not been defined; there is no system for exchanging data between different government agencies for a timely and more accurate assessment of potential risks; and the required number of specialists is not sufficient. The research can be important for both digital money consumers and authorities when the initiative to issue digital money in Russia is implemented.

Keywords: central bank; central bank digital currencies; digital ruble; financial innovations; development of the payment system

INTRODUCTION

National regulators initiated transforming the legal regulation of financial activity by improving various prudential requirements (Basel III) and operating standards for licensed financial institutions in response to the flaws and difficulties indicated by the global financial crisis (2007–2009). Similarly, this resulted in a decrease in their provision of financial services and products to economic organizations, and the freed-up market niche was rapidly occupied by "newcomers" — fintech and bigtech businesses. Their increased market activity, on the one hand, and demand for digital products and services by households, on the other, have contributed to the formation of new branches of financial intermediation.

In turn, the response to the indicated trends on the part of central banks (further — CB) has been a study of the opportunities, benefits and potential risks of issuing central bank digital currencies (further — CBDC) since the mid-2010s. However, in the period prior to the COVID-19 pandemic, only individual CBs (e.g. China, the UK, Uruguay) participated in the development of various CBDC projects, including bilateral and multilateral research projects[1]. The rate of digitization payments and settlements, as well as the provision of additional banking and financial products, have risen significantly during the pandemic. This showed two opposite trends: on the one hand — the "retreat" of economic entities from using cash in settlements (in 2020, by 26% in the Russian Federation and 39% in China), and on the other, an increase in demand for cash as a result of "precautionary" measures[2].

Many governments are considering the growth of digital payment infrastructure as an integral component of their industrial policies, assuming that promoting the adoption of innovative payment methods will improve the ability to regulate both inside and outside cash flows, recharge, and budgetary expenditures in order to preserve internal financial stability. Since the end of the 2010s, a number of payment methods based on innovative infrastructure, such as national card systems (e.g. the Troy systems in Turkey, Mir in Russia, Elo and Pix in Brazil), fast payment systems, and others, have grown significantly due to the focused efforts of governments and central banks[3]. Innovative upgrading of the payment sector has transformed it into a catalyst for reducing transaction costs for all operators, a stimulator of economic growth and a catalyst for the transition to the digital economy.

Over the past three years, CB has seen a so-called "race" to develop, study and introduce CBDCs. According to SWIFT, as of December 2022, the respective projects had implemented 105 CB. According to https://cbdctracker.org/ for July 2022–97 (*Fig. 1*). Individual CBs simultaneously explore the benefits and risks of different CBDC projects, such as retail or wholesale, multi-currency, technology-based, centralized or decentralized distribution and other options.

The supranational financial institutions' representatives made it evident that every country is open to expressing its own "for" and "against" opinions and preferences regarding the CBDC design. Each CB operates appropriately on its own, focusing on the goal of resolving any issues that may arise.

Due to the limited number of CBs that have implemented their retail CBDC[4], initiatives on

---

[1] See: Project Jura. Cross-border settlement using wholesale CBDC. Banque de France, Bank for International Settlements, Swiss National Bank, 2021. URL: https://www.bis.org/publ/othp44.pdf (accessed on 05.02.2023).

[2] Covid-19 accelerated the digitalisation of payments. BIS, Committee on Payments and Market Infrastructure. URL: https://www.bis.org/statistics/payment_stats/commentary2112.pdf (accessed on 15.01.2023).

[3] According to the Committee on Payment and Market Infrastructure, more than 60 fast payment systems operated under BIS as of December 2021. For example: Developments in retail fast payments and implications for RTGS systems. Committee on Payments and Market Infrastructures. URL: https://www.bis.org/cpmi/publ/d201.pdf (accessed on 25.01.2023).

[4] Retail CBDCs (sand dollars) first issued by the Bahamas in 2020. Nigeria introduced eNaira in 2021, while the East Caribbean (DCash) and China (e-CNY) initiated extensive pilot programs.
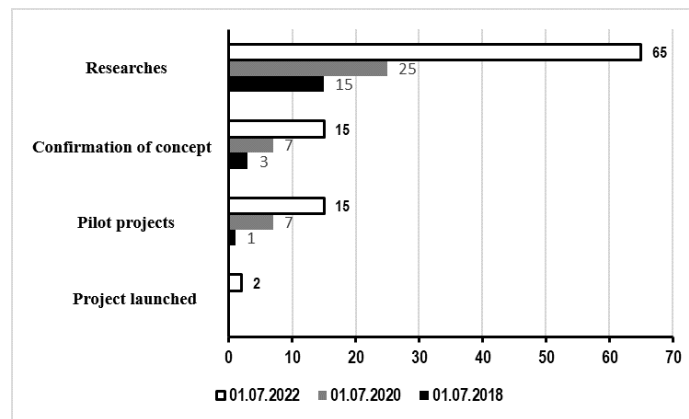
Fig. 1. **Evolution of Central Banks' Activities on the Development, Study and Introduction of the CBDC, 2018–2022**

Source: A. Stanley [1].

a large scale, any potential problems and risks that could lead to these financial innovations are still relevant because there is a lack of empirical experience. The usage of CBDCs in domestic and cross-border settlements presents a number of possible problems and risks, which are analyzed and explored in this paper. Because of technology limitations, any domestic application of a national CBDC may have significant cross-border implications.

DISCUSSION OF THE BENEFITS/LIMITS AND REFINEMENT OF CBDC' ISSUANCE

In recent years, the international flow of publications on the potential benefits (possible motives) of national CBDCs has been extensive. The most detailed CBDC typology is presented in the report of the Center for Research in Financial Technologies and the Digital Economy of Skolkovo-RES [2]. Some publications focused exclusively on listing the benefits that could be obtained from the introduction of CBDC [3][5]. In addition to discussing the potential benefits and advantages of the CBDC problem, additional materials also focus on the problems that must be resolved before their full release [4–

6]. The third direction of the publications is devoted to the analysis of potential options for the evolution of national and international payment ecosystems under the influence of the wider spread of CBDC [7][6].

Among the **advantages** of using CBDC in payment transactions, the most frequently mentioned are:

• ability to offer businesses and households more convenient, fast, cheap and efficient methods of payment;

• opportunity to promote competition between traditional payment service providers and new players (bigtech and fintech companies);

• provide a digital asset to economic entities of trust (provided by trust to the national CB);

• consumer protection;

• increase the availability of financial services, etc.[7]

---

[5] For example: Digital currencies of central banks: foreign experience. Moscow: Fintex Association. 2021, December. URL: file:///C:/Users/Aser/Downloads/Analiticheskaya-zapiska.pdf (accessed on 25.01.2023).

[6] For example: The Future of Financial Services. How disruptive innovations are reshaping the way financial services are structured, provisioned and consumed. An Industry Project of the Financial Services Community. Final Report. World Economic Forum, Deloitte. 2015. URL: https://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf (accessed on 25.01.2023); Options for access to and interoperability of CBDCs for cross-border payments. Report to the G20. Committee on Payments and Market Infrastructures, BIS 2022, July. URL: https://www.bis.org/publ/othp52.pdf (accessed on 22.02.2023).

[7] Central banks and payments in the digital era. BIS Annual Economic Report. 2020. URL: https://www.bis.org/publ/arpdf/ar2020e3.pdf (accessed on 18.02.2023).

Separate Arguments of Supporters and Opponents of the Implementation of CBDC

Arguments "For" the issue CBDC	Arguments "against" the issue CBDC
• Independent of the form CBDC allow CB to issue the national currency as a secure public good; • the advantages of crypto assets are completely exceeded by CBDCs, but the disadvantages are eliminated; • CBDCs will facilitate monetary policy implementation, including through the possibility of introducing negative interest rates; • the possibility of providing social support and distribution of transfers; • the use of CBDC increases the efficiency of internal settlements, thereby promoting economic activity	– The fact that money is issued by the government in the person of CB does not make it a public good; –the practice of operating the markets of cryptocurrencies and stablecoins leads to fragmentation and weakening of the financial system; – CBDC issue – an attempt by the government to retain its privileged positions and more control over citizens' funds; – the CBDC issue states that the central bank is entrusted with the functions of a fiscal agent of the government; – increases the volatility of the national payment system by increasing the vulnerability to cyber-attacks and banking panic ("runs on banks")

Source: Compiled by the authors.

Discussions on the subject are still ongoing, despite the fact that many publications recognize that the issuance of the third form of CB money is inevitable. The specific indications made by CBDC's supporters and detractors are presented in *Table*.

In general, publications pay much less attention to potential problems and risks than to the advantages of the development of the third form of money. However, since the CBDC issue relies on the innovative infrastructure of the payment participants and a large number of third-party players are involved in its creation and maintenance, the channels and ways of disseminating and using the new form of the national currency are changing, and this must inevitably be accompanied by the transformation of CB's own activities.

CHINA'S DIGITAL YUAN EXPERIENCE AND RUSSIANS BANK'S PLAN

Based on the data from the "Digital Ruble" report[8], the Bank of Russia plans to issue a retail CBDC, using a two-tier system of distribution. China implements a similar model of national CBDC[9]. The information released by the Bank of Russia on how the digital ruble will function does not reveal all the details. But, as a possible analogy, the features of the initial two-level digital yuan model, when only the largest national banks with government participation had access to the CBDC, could be considered (*Fig. 2*).

This model consolidates the existing two-tiered system of monetary issuance: the first level — CB, the second level — the system of commercial banks. The third level — is end users. CB issues a national digital currency, opens digital wallets to accredited commercial banks, distributes digital currencies in exchange for banks providing 100% coverage (e.g. in return for non-cash money) and keeps records of their transactions. After receiving the digital currency, banks can conduct interbank transactions, open digital wallets for clients (legal and natural persons), execute client orders, and keep records of transactions in digital currencies. Both levels

---

[8] Digital ruble. Moscow. Bank of Russia. 2020. URL: https://www.cbr.ru/StaticHtml/File/112957/Consultation_Paper_201013.pdf (accessed on 15.01.2023).

[9] Progress of Research & Development of E-CNY in China. Working Group on E-CNY Research and Development of the People's Bank of China. 2021 July. URL: http://www.pbc.gov.cn/en/3688110/3688172/4157443/4293696/2021071614584691871.pdf (accessed on 22.01.2023).
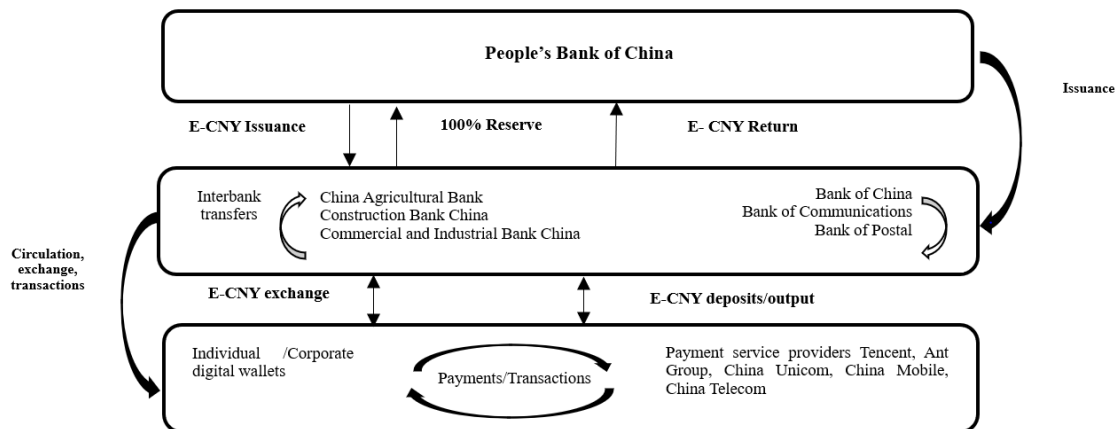
Fig. 2. **The Scheme of Functioning of the Digital Yuan**
Source: Compiled by the authors.

use centralized blockchain technology. At the same time, accredited commercial banks remain obliged to conduct due verification of clients (compliance with ALM/KYC requirements). Every level includes design elements that require advanced technological solutions, prudential consideration, and compliance supervision. For example, a number of activity areas at the CB level require significant reform (*Fig. 3*).

Even greater organizational and technological restructuring is needed at the level of commercial banks and end-users.

Large-scale preparatory work was done in China before to launch of the virtual yuan project. This work included the introduction of a system for digital evaluation of user integrity (a social credit system for individuals and legal entities), the centralization of mining, the development and approval of a unified mobile application (also known as a super API or program user interface), which allows end users to quickly access digital wallets and conduct transactions both online and offline, the identification and certification of suppliers of the necessary hardware, software, cloud storage, etc., and the implementation of numerous other preparatory measures. Furthermore, the development of a fundamental blockchain is planned to allow end users to transact with CBDC (*Fig. 4*).

The Bank of Russia is yet to release the results of its initial work. It follows that the Bank of Russia intends to establish the operational compatibility of the CBDC blockchain technology and its technical payment platform, rather than constructing a separate infrastructure for transactions with CBDC. Such a solution has its advantages (e.g. a significant reduction in initial investments) and serious constraints and risks [8]. The availability of operational compatibility between various technologies allows: a) banks and payment service providers to make payments in various systems without being direct participants in all of them; b) end users to instantly transfer money between various accounts, such as a debit card or electronic money transfer from a commercial bank account to a CBDC account.

The Bank of Russia declared in 2022 that it conducted trial projects with three significant Russian state banks[10] on the launch of the virtual ruble and its application in settlements at the start of the year. Then, 15 participating banks were added to the list. In the spring of 2023, the Bank of Russia began to test the digital ruble with clients of commercial banks[11].

---

[10] The digital ruble was piloted by state banks. Kommersant. 15.02.2022. URL: https://www.kommersant.ru/doc/5217447 (accessed on 28.01.2023).

[11] Central Bank intends to start testing digital ruble with clients of banks in 2023. Kommersant. 16.09.2022. URL: https://www.kommersant.ru/doc/5569335 (accessed on 15.01.2023).
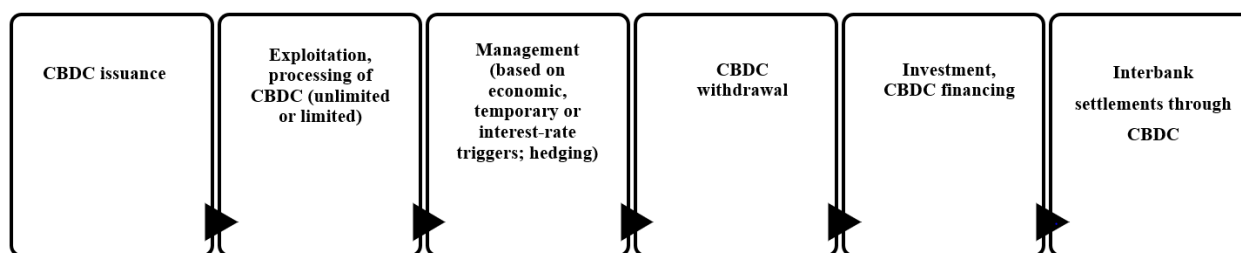
Fig. 3. **The Main Activities of the Central Banks that Require Transformation in the Introduction of the CBDC**

Source: Compiled by the authors.
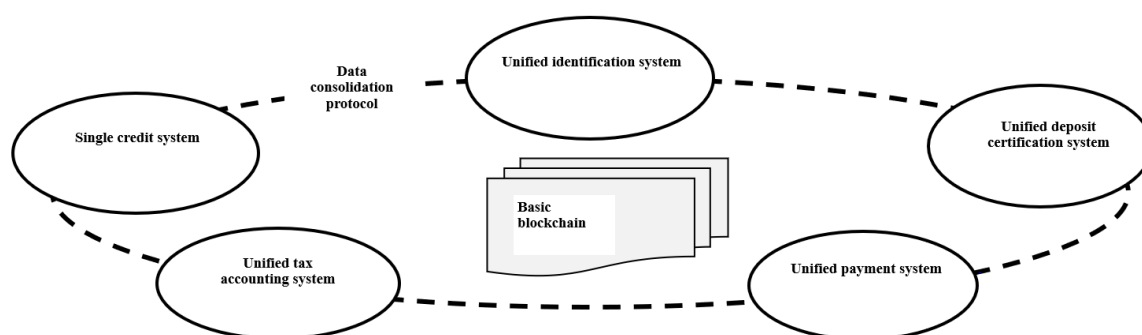
Fig. 4. **Simplified Scheme of the Basic Blockchain that Provides Transactions with the CBDC**

Source: Compiled by the authors.

CBDC' RISKS

CBDCs may result in at least a few different risk groups, including economic, financial, social, and legal risks, the ramifications of which have not yet been thoroughly investigated. These risks are in addition to the common risks associated with financial assets and technological risks (such as environmental risks) resulting from the use of innovative technologies.

Macroeconomic risks. The creation of CBDCs is a "button-click", and they can be distributed just as easily unless strict rules are set for their allocation, for example, in exchange for bank deposits, security or government bonds. In a potential case, their release may be pro-inflationary. The issuance and use of CBDCs require enormous initial and subsequent capital investments, including in the establishment and continuous upgrading of a large-scale national infrastructure. Implementation of potential mega-projects may be accompanied by an inefficient placement of capital within the national economy, which, in the context of the urgent need for modernization and development of physical infrastructure, may lead to the wasting of limited public resources.

Macro-financial risks. It is assumed that CBDCs will be a new ("third") form of modern money and will be exchanged 1:1 for current forms of money. In current circumstances, there are practical differences in exchange rates, such as non-cash to cash or on-shore to off-shore, which are exacerbated during periods of increased macroeconomic uncertainty. It is probable that CBDC rates will experience volatility in line with the volatility of private digital asset rates, albeit to a smaller degree. In this case, large-scale arbitration transactions of the game on the difference of rates, including from abroad, are possible, the consequences of which are similar to the well-known banking panics ("attacks on banks"). While various projects claim that the CBDC will be stable because they are central bank

currencies, in other words, the stability of the CDB will be determined by the economic entities' confidence in the CB as a financial institution and its policies. However, due to their immense liquidity, CBDCs may also represent serious risks to the integrity of the financial system and provide investors with refuge if operators choose to move to CBDCs in order to minimize risk in an extremely unpredictable environment. As a result, a more serious and extensive banking panic is more probable than not [9].

The introduction of CBDCs, as indicated by the Bank of England's "New Forms of Digital Money" report[12], may lead to a rise in the loan price due to a decrease in bank loans, because by acquiring CBDC in exchange for non-cash, banks are reducing the supply of the latter on the credit market, while the demand for CBDC loans may be insufficient, for example, due to the difficulties for potential borrowers to pass digital identification and more thorough verification of ALM/KYC compliance. As a result, the availability of market funding will be limited (due to low supply volumes and higher interest rates).

The introduction of CBDC increases network risks within the financial/banking systems and from third-party providers such as hardware, software, cloud storage, etc. Particularly if most financial intermediaries use the services of the same third-party providers. The high level of concentration increases the likelihood of systemic risk, including because such third parties do not disclose information and financial position data to the public.

Separate groups of macro-financial risks typical of centralized CBDC systems include cyberattacks that, even on a minor scale, can trigger a systemic financial crisis.

Social risks. The functioning of the CBDC infrastructure requires highly qualified IT and engineering professionals, which are currently

lacking in the labor market. Therefore, the Central Bank can become a serious competitor as a reliable employer for other sectors of the economy. The training of the required specialists requires a fundamental restructuring of the entire education system, which also requires huge capital investments in human capital.

CBDCs could potentially be used as a tool for government supervision and control. Every transaction with CBDC is recorded and any public authority authorized to access the CBDC registry can view all transactions. By granting access to a distributed register, public authorities may be able to monitor on the transactions of operators and initiate various measures, such as prolonging the validity of their CBDCs, restricting the amount they can hold, changing interest rates based on the entity's status, banning purchases, and enforcing automatic fines. In this instance, the implementation of CBDC could make the risk of operator digital segregation more evident.

Combining digital identity and CBDC also poses a risk of digital segregation for operators. Access and addressability are necessary for digital payments, but they are different from digital identification. In the context of programmable money, digital identity can go beyond simply providing access to the CBDC holder's assets. The use of funds in the CBDC may be subject to the characteristics of the digital identity of the entity. If an entity's funds are nominated to the CBDC, the Central Bank and the Government can directly control how entities receive and spend money.

The risks that operators can fall upon when distributing CBDCs are presented in *Fig. 5*. However, there is probably a relationship between risks and operators because of the restricted practical use of CBDC and the absence of official statistics (*Fig. 5*).

CBDC AND TRANSFORMATION OF THE ROLE OF NATIONAL CENTRAL BANK

The recognition of the identified risks of the CBDC issue is reflected in the principles

---

[12] New forms of digital money. Bank of England. 2021. URL: https://www.bankofengland.co.uk/paper/2021/new-forms-of-digital-mone (accessed on 23.02.2023).
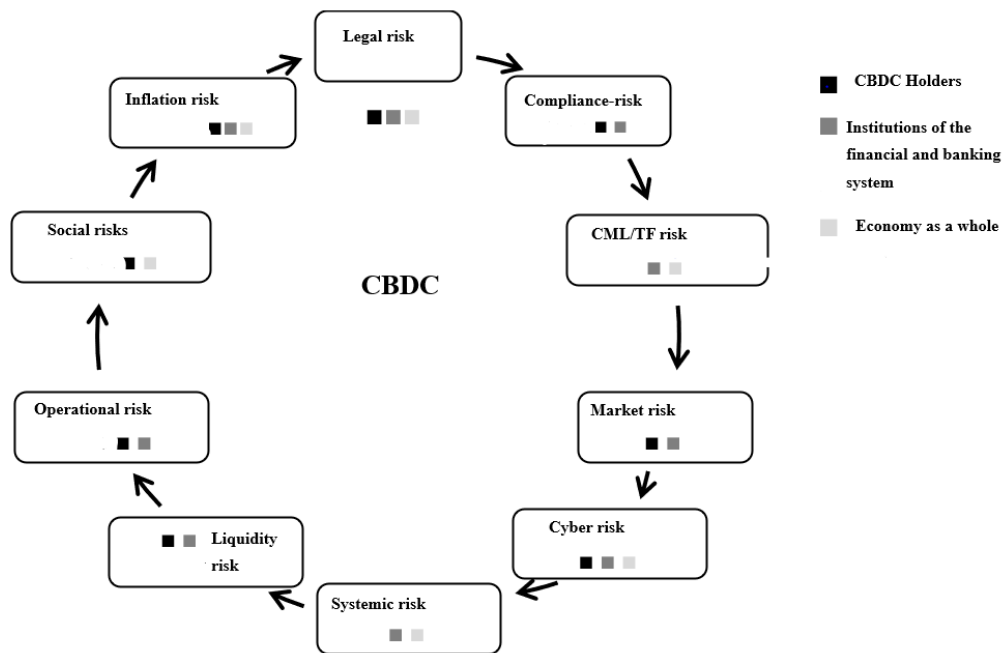
Fig. 5. **Circulation Risks CBDC for Business Entities**
Source: Compiled by the authors.

for the adjustment of digital currencies formulated by the G-7 Central Bank. The document notes that while the introduction of CBDCs will have implications for financial intermediation and financial stability that require careful consideration and analysis, they can be managed[13]. In essence, these principles represent a list of desirable characteristics of the third form of money, but do not define ways to achieve them.

As noted above, the widespread use of CBDCs entails a transformation of the activities of national central banks, which may lead to a fundamental change in the role and functions of the national central bank. There are several possible scenarios in this regard.

Scenario 1: The Central Bank is the central body for general financial regulation and control. This scenario is likely to be implemented in the case of the choice of a single-level model of

CBDC issuance, in which the central bank interacts directly with economic entities without the involvement of commercial banks and non-bank financial institutions. The Central Bank's activities have changed from being the body in responsible for formulating and implementing monetary policy to a high-tech company that sets requirements and uses pre-established algorithms to monitor compliance by all economic operators. Examples of these functions concentrated within the bank's structure include a single center for the collection and analysis of data on the movement of all financial flows, including budgetary and cross-border; distributing CBDC based on the automatic evaluation of e-KYC of economic entities, their business models, and their cost structure. Such a scenario suggests that as these functions are concentrated in the structure of the Central Bank, the current system of financial intermediation and financial markets will "die off" [10].

Scenario 2: The Central Bank — is the body to protect the role and functions of

---

[13] Public Policy Principles for Retail Central Bank Digital Currencies (CBDCs). G7, Great Britain, 2021. URL: https://www.mof.go.jp/english/policy/international_policy/convention/g7/g7_20211013_2.pdf (accessed on 05.02.2023).

traditional financial intermediaries in an environment of increasing digitalization of financial services and products. To this end, the framework of the Central Bank focuses on regulating all types and forms of financial intermediation, including the financial areas of bigtech companies, which will be subject to the prudential requirements applicable to traditional financial intermediaries, based on the principle of a functional and proportionate approach to regulation. While centralized and relatively decentralized financial systems can coexist in this case, in decentralized finance systems, centralised decisions are shifted to different levels of the new financial infrastructure [11]. In this scenario, the central bank faces the difficult challenge of finding a balance between creating an environment that supports innovation and managing associated risks for the banking system, operators and the stability of the financial system. Overly strict or conservative regulations will discourage innovation and protect the dominant positions of big businesses (excessively high market entry costs); on the other hand, insufficient rules encourage banks and operators to take inappropriate risks, which might undermine creative solutions in the CBDC [12].

Scenario 3: The Central Bank — is the body responsible for national financial sovereignty. The issuance and use of CBDCs, as well as other digital assets, are based on Internet technologies that are inherently cross-border. Maintaining national financial sovereignty with CBDCs, private stablecoins and tokenized assets will require the centralization of the functions of most ministries and departments currently in operation. Ultimately, the financial system will be nationalized and the central budget will act as the ultimate creditor.

Currently, representatives of national central banks and supranational financial institutions are looking for a new model of conducting CB business. At the June 2022 BIS General Annual Meeting, Hyun Sun Shin, the Chief Research Officer and Economic Adviser for BIS, gave a presentation on the future monetary system. Hyun Sun Shin described it as an ecosystem based on settlements made on the central bank's balance sheet and developed in accordance with established central bank rules, with the "solid tree whose solid trunk is the central bank, supporting a rich and dynamic ecosystem of services provided by private sector institutions and mechanisms" [13]. But time will show how realistic this vision of the future model of the Central Bank will be.

UNSOLVED PROBLEMS

The practical application of CBDC needs to address several important issues:

• there is no clear and unambiguous understanding of a number of legal aspects of the use of CBDCs, in particular how to fix ownership when transferred from one user to another;

• no prudential regulation of transactions with CBDCs and crypto-assets has been developed for commercial banks [14] and non-bank financial service providers, including cross-border [14];

• there are governance and disclosure requirements for big data analytics, although it is at the heart of transformational processes in many sectors of the economy and can be a source of serious risks;

• not defined "perimeter" (types of activities) of regulation of central banks of the financial intermediation sector, taking into account fintech innovations and the speed of their spread;

---

[14] Only in December 2022, the Basel Committee of Banking Supervision published a new standard for regulating the exposure of banks to the risks of crypto-assets, which should fully enter into force from 01.01.2025. For example: Prudential treatment of cryptoasset exposures. Basel Committee on Banking Supervision, 2022, Dec. URL: https://www.bis.org/bcbs/publ/d545.pdf (accessed on 15.02.2023).

• there is no system for the exchange of data, including supervisory, and harmonization of regulatory requirements between different government agencies for timely, more accurate assessment of potential risks and their integration into new regulatory models;

• insufficient training of professionals with adequate skills to understand and work with financial innovations.

Alternative possible configurations of the use of digital currencies and their consequences for economic development, monetary policy implementation and financial stability are yet to be explored.

CONCLUSION

The study identifies unresolved problems that require solutions for the broad practical application of CBDCs and presents potential scenarios for the transformation of the activities of national central banks caused by their implementation. In the future, the central bank's role as a "emission center" may be supplemented by the role of "controller of national currency circulation", if the central banks will be in charge of and maintain records of the distribution of digital currency between users, as previously noted by the authors. This is because of the development of financial technology and the Central Bank's experiments with the creation of digital national currencies [15].

The article addressed the challenges and possible consequences of the introduction of CBDC into everyday circulation. Although the priorities of CBDCs in different jurisdictions vary, for many emerging and developing countries central banks, greater financial inclusion and greater efficiency of settlement transactions are at the forefront.

At the same time, the practical use of CBDC requires a special environment and infrastructure that can create new and serious risks for both consumers and institutions in the financial system and the economy as a whole. Digital currencies issued by central banks can trigger both traditional financial risks (such as systemic risk) and new specific risks, such as the risk of digital segregation. At the initial stage of the introduction of the digital ruble, the experience of issuing the digital yuan can be utilized, as such an approach is already being implemented, which allows the achievements and limitations of the large-scale use of digital yuan's to be taken into account at the phases of validation of the concept and pilot projects.

REFERENCES

1. Stanley A. The ascent of CBDCs: More than half of the world's central banks are exploring or developing digital currencies. International Monetary Fund. Sep. 2022. URL: https://www.imf.org/en/Publications/fandd/issues/2022/09/Picture-this-The-ascent-of-CBDCs

2. Krivosheya E., Semerikova E.Digital currencies of central banks: Typology, design and Russian specifics. Skolkovo: Moscow School of Management Skolkovo; 2021.85 p. URL: https://sk.skolkovo.ru/storage/file_storage/2f8b8f7c-289b-4634–9595-e612deb07a1d/fin_%D0%9E%D1%82%D1%87%D0%B5%D1%82_%D0%A6%D0%92%D0%A6%D0%91_%D0%A4%D0%B8%D0%BD%D1%86%D0%B5%D0%BD%D1%82%D1%80_%D0%A1%D0%9A%D0%9E%D0%9B%D0%9A%D0%9E%D0%92%D0%9E_%D0%A0%D0%AD%D0%A8_after_peer_review_and_copy_edit.pdf (In Russ.).

3. Kosse A., Mattei I. Gaining momentum — results of the 2021 BIS survey on central bank digital currencies. BIS Papers. 2022;(125). URL: https://www.bis.org/publ/bppdf/bispap125.pdf

4. Sakharov D.M. Central bank digital currencies: Key aspects and impact on the financial system. *Finance: Theory and Practice.* 2021;25(5):133–149. DOI: 10.26794/2587–5671–2021–25–5–133–149

5. Sitnik A.A. Digital currencies of central banks. *Vestnik Universiteta imeni O.E. Kutafina (MGYuA) = Courier of the Kutafin Moscow State Law University (MSAL).* 2020;(9):180–186. (In Russ.). DOI: 10.17803/2311–5998.2020.73.9.180–186

6. Sinelnikova-Muryleva E. V. Central banks digital currencies: Potential risks and benefits. *Voprosy ekonomiki*. 2020;(4):147–159. (In Russ.). DOI: 10.32609/0042–8736–2020–4–147–159

7. Michel N. Central bank digital currencies and freedom are incompatible. CATO Institute. Jul. 18, 2022. URL: https://www.cato.org/commentary/central-bank-digital-currencies-freedom-are-incompatible#:~:text=The%20real%20danger%20in%20CBDCs, out%20of%E 2%80%93every%20person's%20account

8. Boar C., Claessens S., Kosse A., Leckow R., Rice T. Interoperability between payment systems across borders. BIS Bulletin. 2021;(49). URL: https://www.bis.org/publ/bisbull49.pdf

9. Vučinić M. Fintech and financial stability potential influence of FinTech on financial stability, risks and benefits. *Journal of Central Banking Theory and Practice*. 2020;9(2):43–66. DOI: 10.2478/jcbtp-2020–0013

10. Aramonte S., Huang W., Schrimpf A. DeFi risks and the decentralisation illusion. *BIS Quarterly Review*. 2021;(Dec.):21–36. URL: https://www.bis.org/publ/qtrpdf/r_qt2112b.pdf

11. Makarov I., Schoar A. Cryptocurrencies and decentralized finance. NBER Working Paper. 2022;(30006). URL: https://www.nber.org/system/files/working_papers/w30006/w30006.pdf

12. Barr M.S. Managing the promise and risk of financial innovation: Remarks at D.C. Fintech Week. Washington, DC, Oct. 12, 2022. URL: https://www.federalreserve.gov/newsevents/speech/files/barr20221012a.pdf

13. Shin H.S The future monetary system. Speech by Hyun Song Shin, Economic Adviser and Head of Research, Bank for International Settlements, on the occasion of the Bank's Annual General Meeting in Basel on 26 June 2022. Basel: BIS; 2022. 11 p. URL: https://www.bis.org/speeches/sp220626b.pdf

14. Ehrentraud J., Evans J.L., Monteil A., Restoy F. Big tech regulation: In search of a new framework. Financial Stability Institute Occasional Paper. 2022;(20). URL: https://www.bis.org/fsi/fsipapers20.pdf

15. Kuznetsova V. V., Larina O. I. The evolving role of national central banks. *Finance: Theory and Practice*. 2022;26(2):62–73. DOI: 10.26794/2587–5671–2022–26–2–62–73

ABOUT THE AUTHORS

Valentina V. Kuznetsova — Cand. Sci. (Hist.), Assoc. Prof., M. V. Lomonosov Moscow State University, Moscow, Russia
https://orcid.org/0000-0002-8698-4295
vkuz_55@mail.ru

Olga I. Larina — Cand. Sci. (Econ.), Assoc. Prof., State University of Management, Moscow, Russia
https://orcid.org/0000-0002-9841-8194
Corresponding author:
oilarina@mail.ru

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

(CC) BY 4.0

Import Substitution Impact on Growth of Production of Mineral Products and Metallurgy: Short-Term and Long-Term Forecasting of Basic Sectors of the National Economy

E.A. Fedorova[a], A.R. Nevredinov[b], K.S. Melikhov[c], A.I. Yashchenko[d]

[a, c, d] Financial University, Moscow, Russia;
[b] Bauman Moscow State Technical University, Moscow, Russia

ABSTRACT

The **purpose** of the study is to identify ways of short- and medium-term development of mineral production and metallurgy in the Russian Federation in the context of the policy of sanctions based on economic and mathematical modeling. The impact of sanctions on production in the basic sectors of the Russian economy, as well as the impact of import substitution on production in the short- and long-term is investigated. The research **methodology** includes panel regression with fixed effects and Bayesian vector autoregression (BVAR model). The sanctions index is calculated based on a sentimental analysis of the texts of news publications. This index is based on the results of computer analysis of a set of thematic texts (evaluation of the frequency of words and phrases, correlation analysis, case analysis based on the BERT neural network). The paper demonstrates the importance of an industry-specific approach to the implementation of import substitution policy in view of its time horizon. For example, for the mineral products industry, the current import substitution policy can be considered effective in terms of the production index forecast, and for the metallurgical industry, the import substitution policy needs to be revised, since a sharp decline is expected in the short-term when the baseline scenario is implemented, and in the long-term production stabilizes without showing growth. As a result, the efficiency of the import substitution policy is considered to be completely dependent on the industry in which it is implemented. Fund intensity and other factors affecting industry cycles must be considered in order to forecast policy results. Import substitution also has a long-term positive impact.

Keywords: import substitution; industry development; sanctions; economic system; economic growth; sanctions indexes; text analysis

INTRODUCTION

The Russian Federation's economic policy, as represented in real economic decisions, is significantly impacted by foreign policy and inter-state interactions. Since 2014, such development has taken form in the context of import substitution programs, which have changed into measures of national response to the sanctions policies of a number of Russian partner countries. The state's and the global inter-country system's economic development is based on integrated and sustainable economic growth [1]. This growth is achieved through foreign trade relations, enabling countries to identify the most promising areas of activity, through resource redistribution [2, 3]. The import substitution under consideration in this paper potentially involves reorientation to domestic production features, strengthening of economic autonomy and ultimate state development [4, 5]. The purpose of the study is to identify ways of short- and medium-term development of the economic system of the Russian Federation on the basis of economic and mathematical modeling of the conditions of sanctions.

REVIEW OF LITERATURE AND HYPOTHESES

Since the 1950s, serious thought has been given to the theoretical consequences of sanctions. The main formal theories of sanctions developing at the moment are based on negotiating models [6–9]. The first requires into consideration participant interactions in restricting measures in just a few of response measures. The second, on the other hand, examined interactions in terms of alternating movements (subjective forms of conduct), infinite horizon (decision-making), and completeness (reciprocal) information. With point (address) introduction, global experience shows that sanctions reduce the sanctioned country's GDP growth rate by an average of 0.5–0.9 percentage points over a seven-year period

[10]. However, the systematic effectiveness of such restrictions was disputed by a number of authors. For example, some researchers [11, 12] suggested that a reduction in international trade could stimulate the domestic markets of the target country and eliminate the impact of sanctions measures. Another reason for the ineffectiveness of restrictions is the additional costs for countries [12, 13]. In order to compare research views on sanctions restrictions, the authors compiled a scheme of the attitudes of different authors toward them (*Fig. 1*).

The presented scheme allows for the identification of diversified assessment conclusions describing the impact of the sanction. The experience of restrictive measures is different around the world, this is due to the long-term nature of the sanctions imposed against Russia, which did not always harm the economic processes of the country [14]. However, the economic development of the Russian Federation and the system of response to restrictions described by the domestic authors are completely incompatible with global research theories (*Fig. 1*). The authors of the paper are interested in looking into it, presented within the framework of a certain hypothesis, in order to reach an actual determination of the influence of sanctions on the country's economic activity.

Hypothesis 1. Sanctions imposed against the Russian economic system led to a reduction in production in its basic industries.

Import substitution as a measure of a country's response to restrictions on its economic system is seen as one of the main reasons for the ineffectiveness of sanctions. This reaction, coupled with the reorientation of production capabilities, is described in the cost-output model and models of the reorganization of economic activity in the context of market development [15, 16]. Import substitution, according to a number of researchers, contributes to the development of individual sectors of countries and economic growth
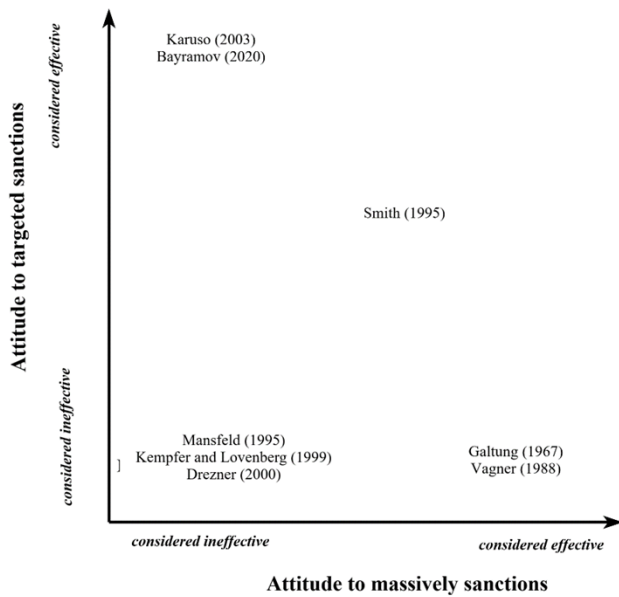
Fig. 1. **Key Theoretical Views on Sanctions Restrictions**

Source: Compiled by the authors.
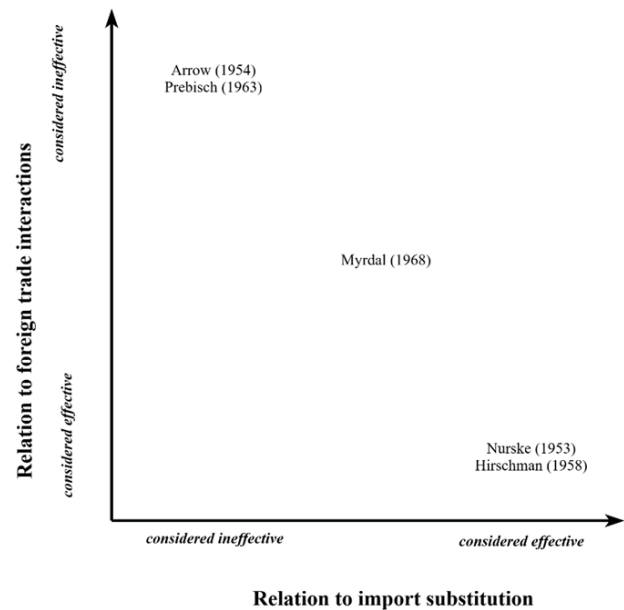
Fig. 2. **Key Theoretical Views on Foreign Economic Policy**

Source: Compiled by the authors.

[17]. At the same time, there was a strong criticism of the idea of import substitution under sanctions [4], taking into account the impossibility of obtaining additional capital from abroad if they are available. The authors' approaches to import substitution research have been analyzed in connection with free trade principles that have been extensively studied since the 1950s. A comparison of the described scientific views is presented in *Fig. 2*.

In the context of non-trade restrictions, a number of researchers noted the substantial reliance of domestic sectors of the economy on foreign equipment (particularly in the manufacturing industry), where the scale of replacement is limited [18]. However, even in the context of the structural transformation of the economic system in 2022–2023, a number of researchers positively assess the possibilities of the development of Russian import substitution [19]. The authors of this paper propose to evaluate primarily the basic sectors of the state, ensuring the systemic and continuous maintenance of the economy of the country.

Hypothesis 2: Import substitution in Russia's basic sectors affects production in those sectors.

In the framework of the system, the key impact on the domestic economic system within the work has been established for: extraction and production of mineral products (including petroleum products; sections 25–27 of the EEU classification); extraction of and processing of metals and products made of them (sections 72–83 of the EU classification). The choice of these industries is due to their high importance in the economic system of the Russian Federation. For the period 2017–2022, they accounted for an average of 37.09% of all federal budget tax revenues (or 27.96% of all budget revenues)[1] and 60.47% of total export (external trade) revenues of organizations.[2]

---

[1] Calculation of authors, for mining and processing of metals and products made of them included sections 07, 23–25; for the processing and production of mineral products sections: 05–06, 19; data from 2017 to 2021. Source: Analytical portal of the Federal Tax Service of Russia. URL: https://analytic.nalog.gov.ru/ (accessed on 21.12.2022).

[2] Calculation of authors, annual indicators of export to CIS countries and far abroad. Commodity structure of export and

The share of foreign production, competing with domestic production in such industries is at a fairly low level. As existing import substitution programs are planned for a limited period of time: 2021–(2022)–2024 (3 to 4 years), the authors have detailed their development plans with annual criteria. Data on import substitution programs for 2022 was used as retrospective information aimed at improving the accuracy of forecasting in the framework of econometric analysis. Data on export substitution scenarios is presented in *Table 1*.

The information provided in *Table 1* is based on the program of the Ministry of Trade, revised after the beginning of the structural transformation of the economic system of Russia in 2022.[3] Similar to *Table 2*, information submitted by the Ministry before the start of domestic economic restructuring 2021–2023 was developed for the industry of mining and processing of metals and products thereof.[4]

Hypothesis 3a. Import substitution in the basic industries of the Russian economy has a negative effect on the growth of production in the short-term.

Hypothesis 3b. Import substitution in the basic industries of the Russian economy has a positive effect on the growth of production in the long-term.

METHODOLOGY OF RESEARCH

The first two hypotheses will be tested on the basis of fixed-effect panel regression [15], the model specification is presented by formula (1).

$$PI_{i,t} = \alpha + \beta_1 EX_{i,t} + \beta_2 IM_{i,t} + \beta_3 SAN_t + \beta_4 USD_t + \varepsilon_{i,t}, \quad (1)$$

where $PI_{i,t}$ — production index of the i-industry in the t-period, $EX_{i,t}$ — export volume of the i-industry in the t-period, $IM_{i,t}$ — import volume of the i-industry in the t-period, SAN_t — sanction index based on sensitive analysis in the t-period, USD_t — exchange rate of the USD in the t-period, $\varepsilon_{i,t}$ — model error.

Bayesian vector autoregression (BVAR) will be the methodology for verifying the third hypothesis. The model used in the study is a five-dimensional vector auto-regression with lag 7 and using the associated normal Wishart inverse distribution, it can be represented by the formula (2).

$$\begin{bmatrix} PI_t \\ EX_t \\ IM_t \\ SAN_t \\ USD_t \end{bmatrix} = c + \sum_{j=1}^{7} \Phi_j \begin{bmatrix} PI_{t-j} \\ EX_{t-j} \\ IM_{t-j} \\ SAN_{t-j} \\ USD_{t-j} \end{bmatrix} + \varepsilon_{i,t}, \quad (2)$$

where PI_t — production index in the t-period, EX_t — export volume in the t-period, IM_t — import volume in the t-period, SAN_t — sanction index based on sensitive analysis in the t-period, USD_t — exchange rate of the USD in the t-period, c — vector constant, Φ_j — matrix of autoregression coefficients, $\varepsilon_{i,t}$ — model error vector.

The sanction index will be calculated on the basis of sentiment analysis. We used articles from the news portal lenta.ru. Between January 2014 and March 2023, more than 16 200 publications were uploaded under "economics" and "science and technology". Only those that contained the word "sanction" or "ban" were selected, with a total of 1 960 publications (of which approximately 1 700 belong to the "economics" section). We cleared the texts of stop-words and unnecessary characters and lemmatized. Our methodology for developing a sanction index included several stages of content analysis of the empirical data collected, including: evaluation of the frequency of words and phrases;

---

import. Federal Customs Service of the Russian Federation. URL: https://customs.gov.ru/folder/502 (accessed on 05.01.2023).

[3] On approval of the Plan of Measures for Import Substitution in the Chemical Industry of the Russian Federation and on Invalidation of Some Orders of the Ministry of Industry and Trade of the Russian Federation. Order of the Ministry of Industry and Trade of the Russian Federation from 15 November 2022 No. 4743. Consultant Plus: Moscow. 2023.

[4] Could be submitted on request by the authors of the article, limitation of volume of article did not allow to insert the table.

Table 1

Import Substitution Scenarios in the Mining and Production of Mineral Products

Time period (year)	Type of scenario forecast		
	Basic (realistic)	**Optimistic***	**Pessimistic****
2022	Decrease in import volume by 11% (under the conditions of restriction of export-import operations for Russia)	Reduction of imports by 4%	Growth of imports by 6%
2023	Growth of imports by 6% (with reorientation of industrial and economic activity and growth of economic activity)	Reduction of imports by 5%	Growth of imports by 8%
2024	Reduction of the volume of imports by 5% (in the context of the transition to the implementation of the program plans of the Ministry of Trade of previous years)	Reduction of imports by 7%	Growth of imports by 5%

Source: Compiled by the authors.

Note: * Planned annual indicators of the Ministry of Industry and Trade (forecast changes y/y) [Order of the Ministry of Industry and Trade];

** Forecast data on indicators of the level of the period before the introduction of import substitution programs (forecast changes y/y).

correlation analysis, in which we focus on the relationship between words and the term "sanction" in order to find the most important words for the index case analysis based on the BERT neural network [20] in order to assess the context of sanctions-related issues and to develop keywords. The first stage is the frequency analysis presented in *Table 2*.

In the second phase of text analysis, we analyzed the correlation factors, the results are presented in *Table 3*.

First and foremost, the media discussed the source, direction and nature of the sanctions (*Table 3*). They allow the development of the dictionary index along with the frequency list, but we have also chosen to perform a case analysis with the support of the neural network BERT. The resulting SAN sanctions index dictionary consists of the following words and phrases: sanction, economic sanctions, restriction, ban, blockade, block, barrier, import ban, export ban, hard sanctions, penalties, restrictive, embargo, retaliation, anti-Russian, west sanctity, sanction introduction, sanctions

EU, Washington reaction, western sanction package, sanctions list, new sanction ban, supply ban, sanctuary pressure, import bans.

The result of the evaluation of the sanction index is displayed on *Fig. 3*. The data by year is averaged for visibility.

From *Fig. 3* it can be seen that the main peaks of the imposition of sanctions fall at the beginning of the period in 2014, which is still the weakest, as well as 2018 and the end of 2021.

STUDY RESULTS

The author's study is based on available macroeconomic data on the ten basic industries of the Russian economy from 2014 to 2021 monthly — a total of 960 observations for five indicators: production index (Rosstat[5]), volume of exports and imports (FCS of Russia[6]), sanctions index, exchange rate of the US dollar (CB of

[5] Rosstat. [Industrial statistics]. URL: https://rosstat.gov.ru/enterprise_industrial (accessed on 05.03.2023).
[6] Commodity structure of exports and imports. Federal Customs Service of the Russian Federation. URL: https://customs.gov.ru/folder/502 (accessed on 05.03.2023).

Table 2

Frequency of Words and Phrases

Word	Frequency	Word	Frequency
Ban	795	Package of sanction	76
Restriction	749	Ban on import	68
Embargo	292	Delivery ban	64
Anti-russian	172	Economic sanction	61
Impose sanction	169	Export ban	42
Anti-russian sanction	153	European union sanction	41
Restrictive	142	Ruble depreciation	40
New sanction	137	Sanctions pressure	35
Restrictive measure	108	Import ban	35
Imposition of a sanction	102	Retaliation	29
Sanctions list	97	Strong sanction	28
Western sanction	90	Penalty charge	24
Bloc	84	Barrier	22
American sanction	76	Washington sanction	13
Package of sanction	76	Blockade	8

Source: Author's calculations.

Table 3

Analysis of Word Correlations with the Word "Sanction"

Word	Corr. coeff.	Word	Corr. coeff.
Against	0.887	Introduce	0.627
Relation	0.832	American	0.625
Enter	0.812	European Union	0.623
Restriction	0.807	Embargo	0.597
Intro	0.746	Threat	0.580
Anti-Russian	0.709	Ban	0.564
Party	0.702	State	0.530
New	0.696	Package	0.522
Measure	0.684	Penalty	0.495
Restrictive	0.661	Return	0.489
Response	0.650	European	0.446
Washington	0.644	Economic	0.418

Source: Author's calculations.
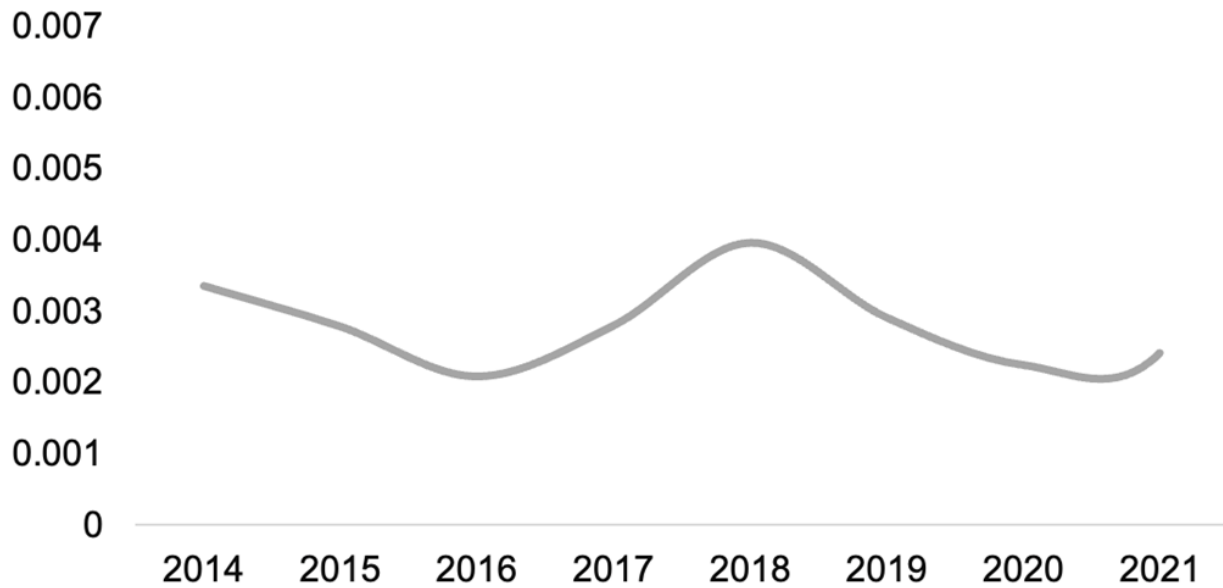
Fig. 3. **Dynamics of the Sanctions Index SAN News Portal lenta.ru for 2014–2021**
Source: Author's calculations.

Table 4

Results of the Impact Assessment of Sanctions on Production

Model variables	Economy in general	Mineral products	Metallurgy
Export volume	0.001	0.007*	−0.035
	(0.001)	(0.003)	(0.034)
Import volume	0.019***	−0.424**	0.208*
	(0.003)	(0.206)	(0.122)
Sanctions index	0.08***	0.02***	−0.01**
	(0.012)	(0.003)	(0.006)
Rate of USD	−0.003**	−0.011***	0.009**
	(0.001)	(0.000)	(0.004)
Constant	1.01***	1.513***	0.616**
	(0.056)	(0.208)	(0.289)
Adjusted R-squared	0.27	0.33	0.21

Source: Author's calculations,

Note: p-value: * < 0,1; ** < 0,05; *** < 0,01.
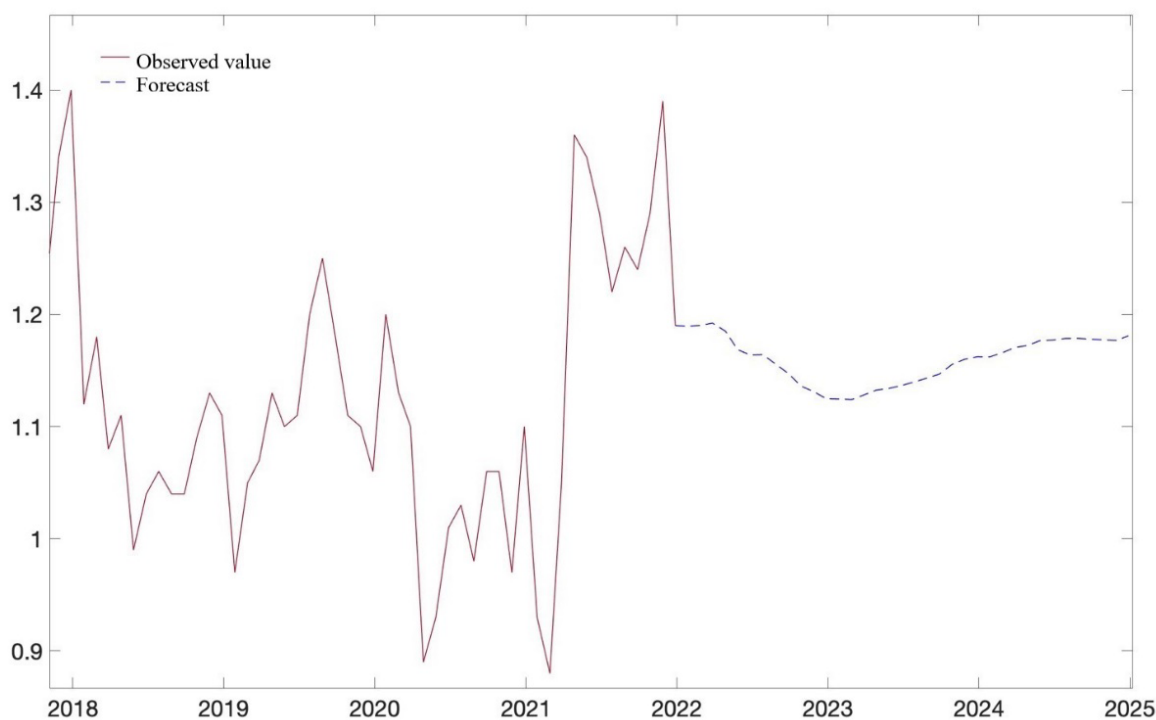
Fig. 4. **Forecast of the Production Index in the Mineral Products Industry for 2022–2024**
Source: Author's calculations.

Russia[7]). The results of the evaluation of the common model for all industries are presented in *Table 4*.

It may be assumed that the estimates of coefficients at the variable sanction index are significant both for the economy as a whole and for the industries of mineral products and metallurgical products at a level of significance of not less than 5%. At the same time, the sanctions have a positive impact on production in the economy as a whole and in the industry of mineral product production. For the metallurgical industry, the effect of sanctions is negative. The first hypothesis is confirmed for the metallurgical industry and disproved for the economy as a whole and for the mineral products industry. The second hypothesis is confirmed for the economy as a whole and for the metallurgical industry, and disproved for the mineral products industry.

To verify hypothesis 3, the authors used Bayesian vector autoregression. The forecasts obtained by applying this model to the authors' data were adjusted to the indicators provided by the import substitution scenarios in the basic sectors of the economy of the Russian Federation to verify the hypothesis of the impact of import substitutes on the growth of production in these sectors. Based on the evaluation of the BVAR model, estimates of the value of the production index for 2022–2024 for the mineral products production (*Fig. 4*) and metallurgy industries (*Fig. 5*) have been obtained.

According to the model forecast (*Fig. 4*) production in the mineral products industry will grow, and the growth rate will increase after 2023.

According to the model forecast (*Fig. 5*) the change in the production index in the metallurgy industry will be negative: in the first half of 2022, the index moves in a downward trend, then stabilizes, and by 2025, it will be approximately 1.12. Improved forecasts are adjusted to the import substitution scenario

---

[7] CBR. Large Bayesian Vector Autoregression Model for Russian Economy. URL: https://cbr.ru/Content/Document/File/16740/wps_1.pdf. (accessed on 05.03.2023).
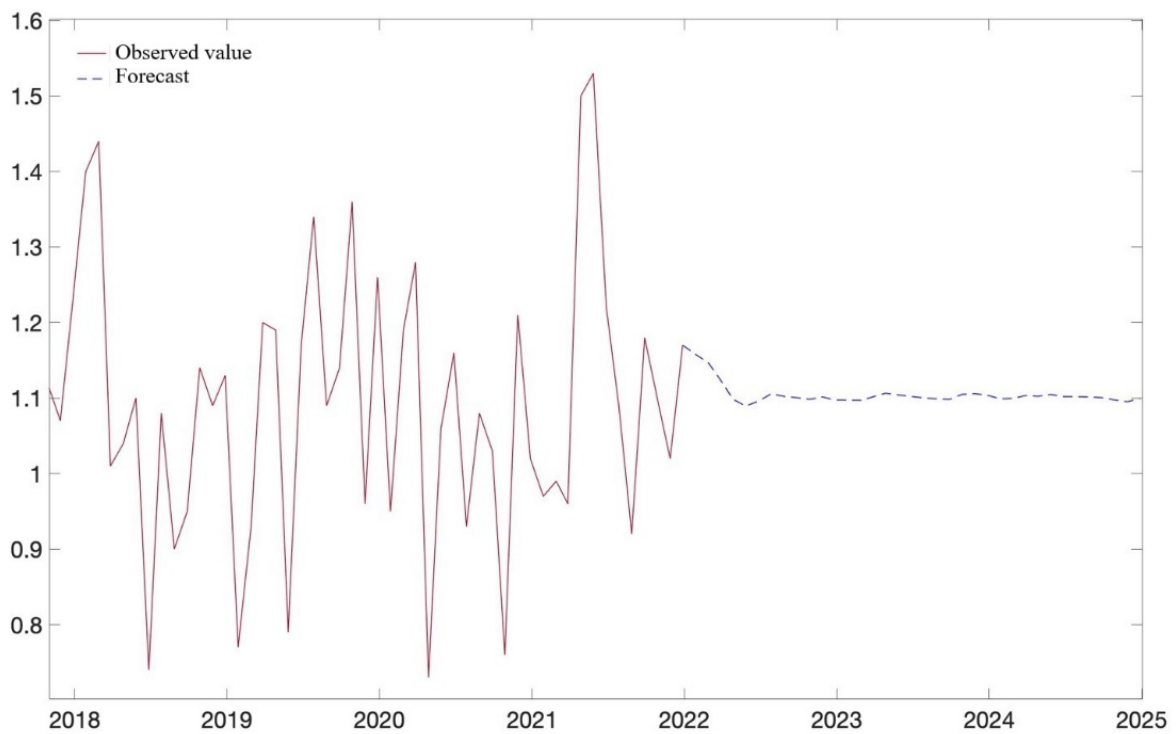
Fig. 5. **Forecast of the Production Index in the Metallurgy Industry for 2022–2024**
Source: Author's calculations.
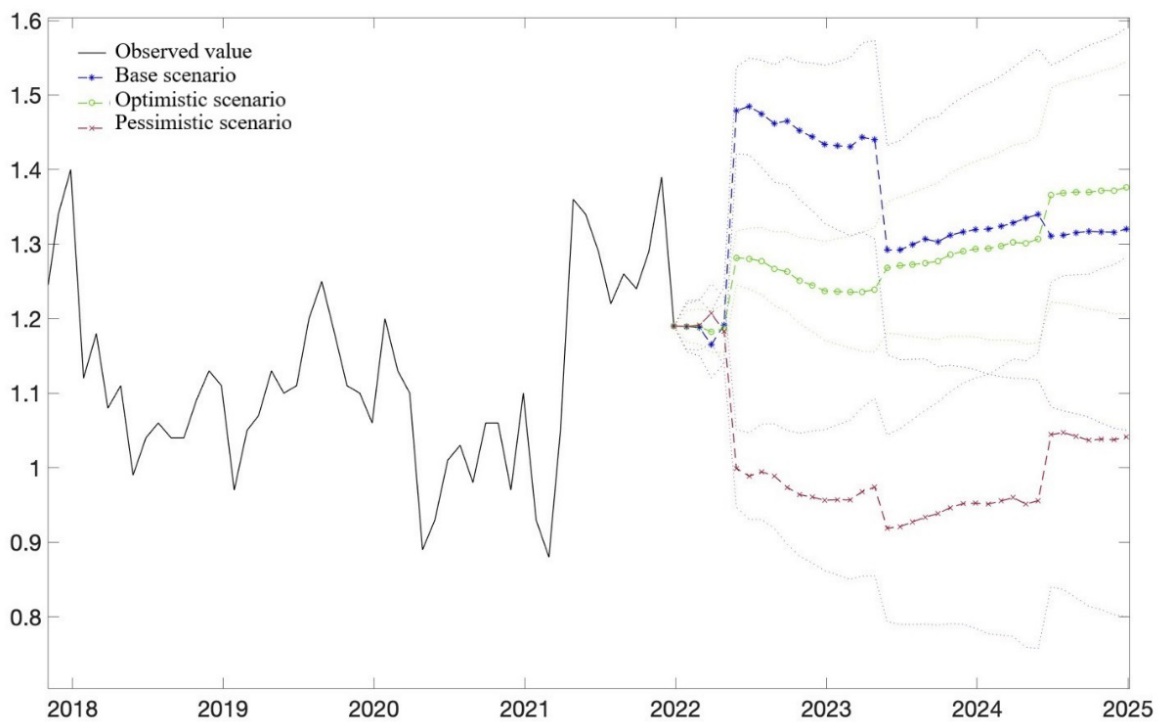
Fig. 6. **Forecast of the Production Index in the Mineral Products Industry for 2022–2024**
Source: Author's calculations.

Results of Scenario Forecasting of the Production Index in the Mineral Products Industry and Verification of Hypotheses

Production index	Import substitution scenario		
	Basic	**Optimistic**	**Pessimistic**
In the short-term (as of early 2023)	1.42	1.25	0.97
Hypothesis 3a	Disproved	Disproved	Confirmed
In the long-term (at the end of 2024)	1.31	1.37	1.04
Hypothesis 3b	Confirmed	Confirmed	Confirmed

Source: Compiled by the authors.

(basic, optimistic, pessimistic — according to the programs of the Ministry of Trade, *Table 2, 3*) and are again aimed at modeling. The results of the evaluation of the model are based on scenario data production forecasts for the mineral products industry (*Fig. 6*) and the metallurgical industry (*Fig. 7*), based on the implementation of scenarios by the Ministry of Trade.

According to the forecast (*Fig. 6*) the mineral products industry will develop within the framework of a growing trend. After the implementation of the basic scenario of the Ministry of Trade (unstable, shock reduction of imports), *Table 2*, in the short term there will be a "boom" of production in the industry; in the long-term, the index of production still remains high, but before this adjusted almost to stagnation in the period from mid-2023 to the Q2 of 2024. With the implementation of the optimistic scenario (progressive steady decline in imports) in *Table 2*, a stable positive dynamic of the production index is forecast up to 2025. In the context of the pessimistic scenario (increase in imports, depletion of import substitution), as shown in *Table 2*, a sharp decline in the production index is forecast by the middle of 2022, and subsequent stagnation means a slight recovery in production growth will

occur only by 2025. *Table 5* presents the results of the forecast of the production index and the verification of hypotheses 3a and 3b for the mineral products industry.

According to the forecast (*Fig. 7*), the metallurgical industry will be less secure, and while production will increase (on average) during the next three years, the trends in some scenarios will be disappointing.

With the implementation of the base scenario of the Ministry of Trade (unstable, shock reduction of imports), *Table 3*, in the short term there will be a sharp decline of production — the index will be in the reduction zone of production; in the long-term, the index of production will still remain at levels characteristic of reduction but will go into the zone of recovery in the middle of 2023 — early 2024, by 2025 it will stabilize in the area of unit growth (its absence). With the realization of the optimistic scenario (progressive steady decline in imports), *Table 3*, a stable negative dynamic of the production index is forecast until 2025, which is explained by the positive impact of imports on the index of production, *Table 6* (results of the assessment of the impact of sanctions on production), that is, the need for imports; by the end of 2024, the index, with this scenario, will be in the zone of reduction of production.
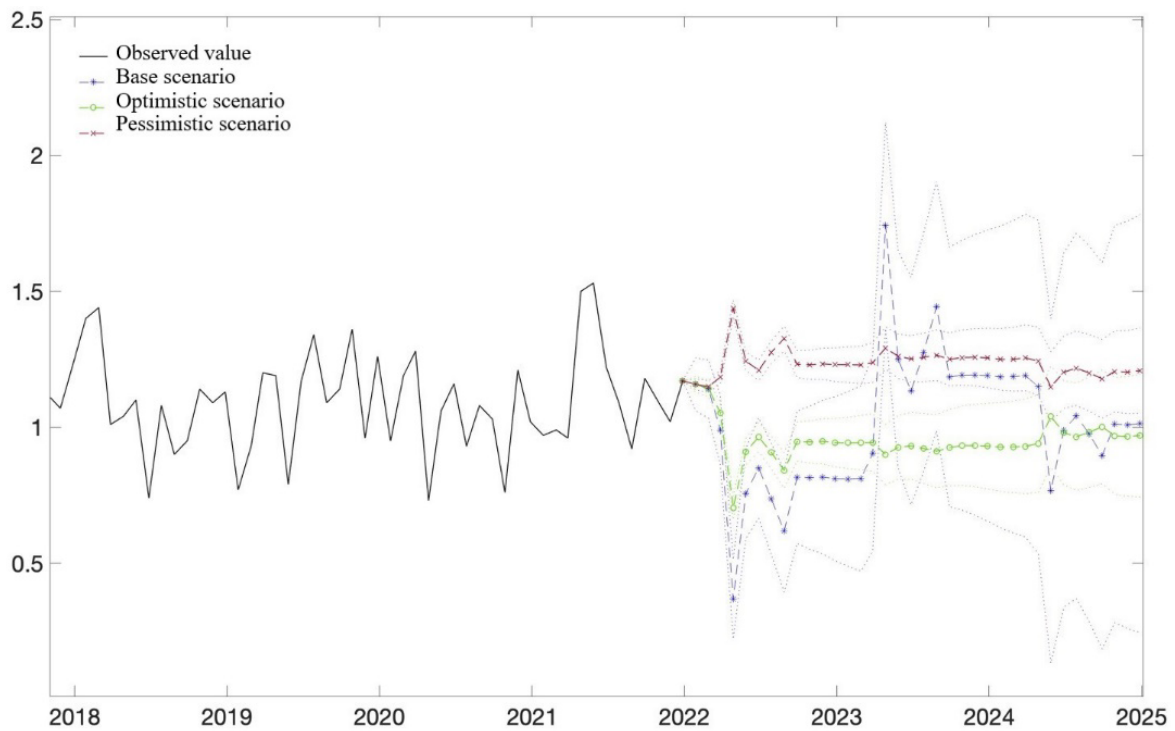
Fig. 7. **Forecast of the Production Index in the Metallurgical Industry for 2022–2024**
Source: Author's calculations.

Table 6

Results of Scenario Forecasting of the Production Index in the Mineral Products Industry and Verification of Hypotheses

Production index	Import substitution scenario		
	Basic	**Optimistic**	**Pessimistic**
In the short-term (as of early 2023)	0.84	0.96	1.21
Hypothesis 3a	Confirmed	Confirmed	Disproved
In the long-term (at the end of 2024)	1.01	0.99	1.14
Hypothesis 3b	Confirmed	Disproved	Confirmed

Source: Compiled by the authors.

In the pessimistic scenario (increased imports, no import substitution), *Table 3*, a stable high production index is forecast until 2025. *Table 6* presents the results of the forecast of the production index and the verification of hypotheses 3a and 3b for the metallurgical industry.

As a result of the assessment of the impact of sanctions on the production index in the economy as a whole and in some basic

industries, the results for different industries have been demonstrated to be ambiguous, so in the industry of mineral products, sanctions have a positive effect on the metallurgical industry — a negative. The paper demonstrates the relevance of a sector-specific approach to the implementation of the import substitution policy in view of its time horizon. For example, for the mineral products industry, the current import substitution policy can be considered effective in terms of the forecast of the production index, while for the metallurgical industry, the import replacement policy needs to be revised.

Due to the decrease in the volume of imports in 2022 by 13% in the base scenario of the Ministry of Trade, the production index will fall from 1.18 at the beginning to 0.84 at the end of 2022. As a result, in contrast to the mineral products industry, hypothesis 3a of the negative impact of import substitution on the short-term production index in metallurgy is confirmed for all scenarios, preserving the pessimistic one. In turn, hypothesis 3b of the long-term positive impact of import substitution on the output index is confirmed for the underlying and pessimistic scenarios in the mineral products industry and rejected for an optimistic scenario in the metallurgy industry.

CONCLUSION

The study's authors determine that the extent to which industries require imported components or equipment influences the effects of import substitution policy on production in these industries. With required import substitution, the industries affected must undergo structural transformations, which will be accompanied by output compression over a three-year horizon; the impact of import replacement policy on output in the underlying industries is one-way, as they often involve two interconnected phenomena. Import substitution policy parameters should be defined primarily on the basis of the industry-specific need to pursue such a policy: where the import substitute elements are structurally significant in the industry's production chain, their import substitution would involve the risk of compression of output.

Further research could include adapting stochastic models to the needs of forecasting the results of import substitution programs in order to account for the probability of describing the degree of success of the policy in specific sectors and determining the significance of changes in relevant economic indicators.

REFERENCES

1. Schumpeter J.A. Theoretical problems: Theoretical problems of economic growth. *The Journal of Economic History*. 1947;7:1–9. DOI: 10.1017/S 0022050700065189

2. Marx K. Das Kapital. Kritik der politischen Ökonomie. Bd. 1. Buch 1: Der Produktionsprocess des Kapitals. Hamburg: Verlag von Otto Weissner; 1867. 784 p. (Russ. ed.: Marx K. Kapital. Kritika politicheskoi ekonomii. Vol. 1. Bk. 1: Process proizvodstva kapitala. Kharkov: Proletarii; 1923. 610 p.).

3. Kaldor N. A model of economic growth. *The Economic Journal*. 1957;67(268): 591–624. DOI: 10.2307/2227704

4. Problems of Capital Formation in Underdeveloped Countries (1953). In R. Kattel, J. Kregel, & E. Reinert (Eds.), Ragnar Nurkse: Trade and Development (pp. 99–212). Anthem Press; 2009. DOI: 10.7135/UPO9781843318187.010

5. Goodman B. The strategy of economic development, Albert O. Hirschman. (Yale Studies in Economics: 10). New Haven: Yale University Press, 1958. Pp. xiii, 217. $ 4.50. *American Journal of Agricultural Economics*. 1959;41(2):468–469. DOI: 10.2307/1235188

6. Smith A. The success and use of economic sanctions. *International Interactions*. 1995;21(3):229–245. DOI: 10.1080/03050629508434867

7. Morgan T.C., Miers A.C. When threats succeed: A formal model of the threat and use of economic sanctions. In: Proc. Annu. meet. American Political Science Association (Atlanta, GA, September 2–5, 1999). Washington, DC: APSA; 1999:643–659.

8. Lacy D., Niou E.M.S. A theory of economic sanctions and issue linkage: The roles of preferences, information, and threats. *The Journal of Politics*. 2004;66(1):25–42. DOI: 10.1046/j.1468–2508.2004.00140.x

9. Eaton J., Engers M. Sanctions. *Journal of Political Economy*. 1992;100(5):899–928. DOI: 10.1086/261845

10. Caruso R. The impact of international economic sanctions on trade: An empirical analysis. *Peace Economics, Peace Science and Public Policy*. 2003;9(2):1–19. DOI: 10.2202/1554–8597.1061

11. Galtung J. On the effects of international economic sanctions: With examples from the case of Rhodesia. *World Politics*. 1967;19(3):378–416. DOI: 10.2307/2009785

12. Kaempfer W., Lowenberg A.D. The political economy of economic sanctions. In: Sandler T., Hartley K., eds. Handbook of defense economics. Vol. 2: Defense in a globalized world. Amsterdam: North-Holland Publishing Co.; 2007:867–911. DOI: 10.1016/S 1574–0013(06)02027–8

13. Drezner D.W. Bargaining, enforcement, and multilateral sanctions: When is cooperation counterproductive? *International Organization*. 2000;54(1):73–102. DOI: 10.1162/002081800551127

14. Bayramov V., Rustamli N., Abbas N. Collateral damage: The Western sanctions on Russia and the evaluation of implications for Russia's post-communist neighbourhood. *International Economics*. 2020;162:92–109. DOI: 10.1016/j.inteco.2020.01.002

15. Bodrunov S.D. Resource advantages of Russia — basis of high-tech economic growth. *Nauchnye trudy Vol'nogo ekonomicheskogo obshchestva Rossii = Scientific Works of the Free Economic Society of Russia*. 2015;190(1):134–154. (In Russ.).

16. Glaz'ev S. Yu. Problems and prospects of the Russian financial market in the context of structural changes in the world economy. *Finance: Theory and Practice*. 2020;24(3):6–29. DOI: 10.26794/2587–5671–2020–24–3–6–29

17. Arrow K.J. Import substitution in Leontief models. *Econometrica*. 1954;22(4):481–492. DOI: 10.2307/1907438

18. Golikova V.V., Kuznetsov B.V. Strategies of Russian industrial enterprises' importing behavior under economic sanctions. *Voprosy ekonomiki*. 2021;(7):89–106. (In Russ.). DOI: 10.32609/0042–8736–2021–7–89–106

19. Felbermayr G., Mahlkow H., Sandkamp A. Cutting through the value chain: The long-run effects of decoupling the East from the West. *Empirica*. 2023;50(1):75–108. DOI: 10.1007/s10663–022–09561–w

20. Atagün E., Hartoka B., Albayrak A. Topic modeling using LDA and BERT techniques: Teknofest example. In: Proc. 6th Int. conf. on computer science and engineering (UBMK). (Ankara, September 15–17, 2021). Piscataway, NJ: IEEE; 2021:660–664. DOI: 10.1109/UBMK52708.2021.9558988

ABOUT THE AUTHORS

Elena A. Fedorova — Dr. Sci. (Econ.), Prof., Department of Corporate Finance and Corporate Governance, Financial University, Moscow, Russia
http://orcid.org/ 0000-0002-3381-6116
Corresponding author:
eafedorova@fa.ru

Alexander R. Nevredinov — postgraduate student, Bauman Moscow State Technical University, Moscow, Russia
http://orcid.org/0000-0003-3826-1305
a.r.nevredinov@gmail.com

Kirill S. Melikhov — Master's student, Faculty of Economics and Business, Financial University, Moscow, Russia
https://orcid.org/0000-0001-5964-8029
melikhovks@yandex.ru

Alexander I. Yaschenko — Master's student, Faculty of Taxes, Audit and Business Analysis, Financial University, Moscow, Russia
https://orcid.org/0000-0002-9042-6077
yashchenko_ai@internet.ru

Authors' declared contribution:
E.A. Fedorova — general management of the research, formulation of the problem, development of the concept of the article, formation of research methodology, formulation of hypotheses, construction of model specifications and calculations.
A.R. Nevredinov — compilation of the sanctions index, construction of model specifications and calculations.
K.S. Melikhov — determination of the degree of development of the problem, data collection, formation of research methodology, formulation of hypotheses, construction of model specifications and calculations.
A.I. Yaschenko — determination of the degree of development of the problem, formulation of hypotheses, search and formulation of import substitution scenarios.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The Research of Comparative Characteristics and Functional Features of the Co-integration of Technological Innovations and Business Activity and their Impact on the Formation of Macroeconomic Dynamics

B.J. Matrizaev
Financial University, Moscow, Russia

ABSTRACTS

The **subject** of the study is the causal relationship between the co-integration of technological innovations and business activity, and their impact on the formation of macroeconomic dynamics in the short and long-term. The **purpose** of the paper is to propose a comprehensive approach to determining the conditions for the co-integration of technological innovations and business activity for their subsequent stimulation of economic growth. The practical examination of the impact of changes in the dynamics of complex indicators of creative development and commercial activity on economic growth is the research's scientific contribution and **novelty**. Using vector error correction models, modular root testing models and other econometric methods, the author demonstrated that both business activity and innovation stimulate economic growth in the long-term. In the short-term, there are strong causal relationships, but they are not always homogeneous. The main **conclusion** is the fact that the results obtained by the author confirm the correctness of using the approach of determining the order of integration and the presence/absence of co-integration between indicators of innovative development, business activity and economic growth. The summary results confirm the existence of a close long-term equilibrium relationship between innovation, business activity and economic growth.

Keywords: macroeconomic theory; economic growth; technological innovations; business activity; co-integration; macroeconomic dynamics

INTRODUCTION

A dynamic entrepreneurial culture and a strong national innovation ecosystem are key catalysts for improving the socio-economic well-being of countries around the world. There are numerous studies examining the relationship between innovation, business activity and economic growth [1]. Although there is a theoretical understanding of the basics of these three variables' interactions, research indicates that the causal relationships among them are properly complex and are supported by factors impacting them. Research on the microeconomic foundations (entrepreneurship) of macroeconomics (innovation and growth) continues to evolve, and factors that define the underlying structure of the economy continue to be the subject of discussion and research [2]. Within the framework of the new growth theory of macroeconomics, there is a popular belief that long-term economic growth is determined by technological progress supported by investments in human capital, research and innovation activity [3].

At the same time, there are also extensive studies that show that entrepreneurial culture is crucial to creating a dynamic economic environment that is capable of attracting capital, creative talent, networking and other resources to stimulate innovation and economic growth. Many important conclusions can be highlighted in which the authors examine the relationship between business activity, the national innovation ecosystem, and the increasing impact of other traditional factors of production on economic growth [3]. According to these studies, business contributes to the economy through a number of directions, including investment in resources to produce goods and services that satisfy market demands; job creation; revitalization of industrial clusters, creation of innovation accelerators and special economic regions; development and maintenance of regional trade and cooperation; investment in research; introduction of new market innovations; corporate social responsibility; increasing competition in the market, leading to improved service quality and cost structure; and continuous improvement of products and processes. The authors of the above-mentioned studies also show that large firms benefit from a well-developed network of suppliers consisting of small firms that provide cost-effective, timely and high-quality services. The interactions of these economic agents result in the formation of strong industrial clusters and economic regions, which improve the national economy's competitiveness. As noted by M. Porter [4], strong clusters are increasingly becoming an important basis for the formation of global supply chains, which contribute to improving the economic performance and competitiveness of firms, regions and states.

Based on the effective "spillover effects" of business activity, most of the world's advanced governments have invested significantly in company development and strengthening innovative ecosystems [5]. The most illustrative example here is the experience of the European Union presenting a 10-year plan in 2010,[1] to promote "smart", sustainable and inclusive economic growth in the eurozone [6]. According to this document, "smart" growth is defined as "development of a knowledge- and innovation-based economy"; sustainable growth as "contributing to a more resource-efficient, environmentally friendly and competitive economy"; and inclusive growth as "contributing to an economy with a high level of employment that provides social and territorial integration" [6, 7]. Furthermore, according to the plan, business activity and innovation are key to sustainable economic growth, job creation and an improved quality of life in Europe.

At the same time, despite numerous theoretical and empirical studies in which authors demonstrate the relationship between innovation, business activity, and economic growth, very few studies have quantified the endogenous relationship between these variables using appropriate econometric

---

[1] A Sustainable Europe by 2030. European Commission. URL: https://commission.europa.eu/publications/sustainable-europe-2030_en (accessed on 14.07.2023).

analysis, specifically to assess the direction of the cause-and-effect relationship between those variables in the short- and long-term dynamics. Consequently, the main objective of this article is to study an integrated approach to defining the conditions for the co-integration of technological innovations and business activity in order to stimulate their economic growth. Another purpose is to try to identify the macroeconomic implications of the results obtained.

THEORETICAL AND METHODOLOGICAL ANALYSIS AND HYPOTHETICAL BASES OF RESEARCH

According to macroeconomic theory, the concepts "innovation" and "business activity" have a wide range of definitions. In particular, J. Schumpeter [8, 9] identified five different types of innovation: the introduction of new products and services; the implementation of new methods that lead to process improvement; the entry into new and diverse markets; the acquisition of new sources of resources for the production of goods and services, and the establishment of new business models and industrial systems that prevent the formation of monopolistic market structures. Although the characteristics given by J. Schumpeter cover several types of innovation, the definition of innovation has not changed much during this time. Next, consider the M.D. Plessis definition [10], which describes innovation as "creating new knowledge and ideas to promote new business results aimed at improving internal business processes and structures and creating market-oriented products and services". Thus, as certain types of innovation change over time because of their very nature, the idea of innovation remains fundamentally the same.

The entrepreneur is often recognized as the primary driver of corporate activity. There are numerous definitions and explanations of entrepreneurs in macroeconomic theory. According to J. Schumpeter's definition [8, 9], an entrepreneur is defined as someone who carries out manufacturing processes using numerous possible combinations, providing him with a strategic market advantage and allowing him to generate entrepreneurial profit. Further, F. Knight [11] describes an entrepreneur as a person who assumes "assumed risks" and turns uncertain ventures into productive results. H. Leibenstein [12] characterizes entrepreneurs as "…institutions that create a dynamic corporate culture that contributes to reducing organizational entropy and inefficiency". The definition of individual modern researchers is interesting. In particular, D. Salman [13] defines an entrepreneur as "…an innovator inclined to risk, who contributes to economic growth by undertaking creative efforts to produce new products and services that will enable the enterprise to compete in international markets". In his research, R. Seymour [14] notes that entrepreneurship is often directed by professional managers, not "entrepreneurs", and that companies themselves can be entrepreneurial.

Since the introduction of the R. Solow growth model [15, 16] in the 1950s, the role of technical innovation in economic growth has received significant attention. Developing his concept and based on the theoretical model of R. Solow, P. Romer [3] introduced the endogenous growth model, which showed that investments in human capital led to the dissemination of knowledge and technological substitution, and all of this together contributes to economic growth. Later, J. Schmitz [17] improved the endogenous growth model by incorporating the role of employees and entrepreneurs in creating economic wealth. Calculations based on this model showed that the growth of entrepreneurship in the economy creates additional resources for economic growth. The J. Schmitz model was further expanded by C. Michelacci [18], who included two types of economic agents — researchers and entrepreneurs, which are necessary to stimulate innovation and economic growth. According to C. Michelacci, the primary role of researchers is to create inventions, whereas the role of entrepreneurs is to obtain commercial benefits from these inventions. C. Michelacci's model

demonstrates that supporting entrepreneurship to utilize the business value of research may increase innovation and thus economic growth. In addition, Z. Acs and S. Estrin [19] proposed a theory of knowledge distribution in their collaborative research, demonstrating that economic agents that acquire new knowledge through research and other innovative activities prefer to use opportunities to extract value from that knowledge. This theory suggests that the economic benefits of the "spillover effects of knowledge dissemination" will lead to the activation of entrepreneurship. In a number of other similar studies, the authors showed that entrepreneurship is crucial to stimulating innovation and economic growth.

ANALYSIS OF MACRODYNAMIC EVALUATION METHODOLOGY OF ENDOGENIC RELATIONS BETWEEN INVESTED INDICATORS

As noted above, although the relationship between innovation, business activity and economic growth has been studied, there is still no consensus on the causal relationship between them. Moreover, empirical studies of these relationships typically use a two-dimensional model and therefore consider only two of these variables at any given time. In the present study, an advanced two-dimensional model is used for the macrodynamic evaluation between all three variables by the author using the Granger causality panel tests. Given the simultaneous consideration of all three variables, the author's model enables two important macroeconomic aspects of economic growth to be covered: firstly, the impact of public policy aimed at stimulating innovation, in the presence (i.e. taking into consideration) business activity; secondly, influence of public policy designed to stimulate business activity when there are (i.e. taking into consideration) innovations. Furthermore, the use of long-term time series data (2000–2018) allows us to explore the short-term and longer-term interactions between the three variables. The survey is conducted for 20 eurozone countries using annual time series data from the annual

World Economic Situation and Prospects[2] and Global Entrepreneurship Monitor.[3] The following indicators are included in the model for analysis: real per capita economic growth (REG_{pc}) and seven different indicators of innovative development ($INNODEV$): number of patent applications submitted by both residents and non-residents (per thousand population) ($PATAPPL$); number of trademark applications by both residents and non-residents (per thousand population) ($TMAPPL$); number of R&D researchers (per thousand population) ($RAND$); number of publications in scientific and technical journals (per thousand population) ($PSTJ$); R&D expenditure (in percentage of GDP) ($RANDE$); volume of exports of high-tech products and services (in percentage of GDP) ($HTEX$); consolidated index of innovation development ($TIINNODEV$), which represents the weighted average of all seven innovation development indicators.

With reference to the research on the Granger causality relationship between innovation, business activity, and economic growth, the inclusion of all seven indicators in the model could indicate a representative aspect of innovation development. Similarly, the importance of individual indicators of innovation varies from study to study. For example, R. Pradhan [20] considers that the number of patent applications (release rate) and R&D expenditure (cost rate) are important in regulating long-term economic growth in high-income OECD countries, but T. Brenner [21] suspects that publications in scientific and technical journals (rule rate) and R&D expenditure (custom rate) are important in regulating long-run economic growth in the group of developed and developing countries. For business activity (BA) in this model, the author uses three indicators, expressed as a percentage of the population aged 18 to 64. Total early-stage

business activity ($TBAI$) takes into account the percentage of the population who are either start-up entrepreneurs or owners-managers of a new business. Potential business activity (PBA) is the percentage of the population that believes that they have the necessary skills and knowledge to start a business. Finally, the Local Business Activity Index (LBA) takes into account the percentage of people who believe that there are good opportunities to start a business in the area where they live. The present study examines three samples and seven cases based on three business activity indicators and seven innovation indicators. All variables are measured at constant prices of 2000 in USD. To normalize these variables, they are converted into natural logarithms. The set of dynamic panel regressions is measured according to the following equations:

$$\Delta REG_{pcit} = \mu_{1j} + \sum_{n=1}^{\delta} \psi_{1in} \Delta REG_{pc_{it-n}} + \sum_{n=1}^{\theta} {}_{1in} \Delta INNODEV_{it-n} + \\ + \sum_{n=1}^{d} \eta_{1ik} \Delta BA_{it-n} + \varphi_{1i} ECT_{it-1} + \varepsilon_{1it},$$
(1)

$$\Delta INNODEV_{it} = \mu_{2j} + \sum_{n=1}^{\delta} \psi_{2in} \Delta INNNODEV_{it-n} + \\ + \sum_{n=1}^{\theta} \rangle_{2in} \Delta REG_{pcit-n} + \sum_{n=1}^{d} \eta_{2ik} \Delta BA_{it-n} + \varphi_{2i} ECT_{it-1} + \varepsilon_{2it},$$
(2)

$$\Delta BA_{it} = \mu_{3j} + \sum_{n=1}^{\delta} \psi_{3in} \Delta BA_{it-n} + \sum_{n=1}^{\theta} \rangle_{3in} \Delta INNODEV_{it-n} + \\ + \sum_{n=1}^{d} \eta_{3ik} \Delta REG_{pcit-n} + \varphi_{3i} ECT_{it-1} + \varepsilon_{3it},$$
(3)

where Δ — first multiplier operator; i — country; t — period, and ε — random error. Innovative development $INNODEV$ is defined by the variable $PATAPPL$, $TMAPPL$, $RAND$, $PSTJ$, $RANDE$, $HTEX$, and $TIINNODEV$; and business activity (BA) is determined by variables $TBAI$, PBA and LBA. In addition, δ, θ and d are delayed durations for differential variables of corresponding equations and can be determined by the Engle-Granger equation. Equations with

delayed correction of (ECT_{it-1}) errors are derived from long-term equilibrium properties inherent in equations (1)–(3). Equations with delayed error correction (ECT) represent long-term dynamics, while differential variables represent short-term. For short-term cause-and-effect relationships, if the zero hypothesis ϱ_{1in}, ϱ_{2in} или ϱ_{3in} is rejected, then there is a Granger causality relationship directed from the $INNODEV$ variable to the REG_{pc} variable (or from REG_{pc} to $INNODEV$). If the co-zero hypothesis $\varrho_{1in} = 0$, $\varrho_{2in} = 0$ или $\varrho_{3in} = 0$ is deviant, then there is a Granger causality relationship from the variable BA to REG_{pc} (or from REG_{pc} к BA). To confirm long-term causal relations, the zero hypothesis ($\varphi_{1i} = 0$, $\varphi_{2i} = 0$ and $\varphi_{3i} = 0$) must be rejected. The above tests are performed using the Wald test.

EMPIRICAL ANALYSIS OF THE RESULTS OF THE EVALUATION OF THE INVESTIGATED INDICATORS' CO-INTEGRATION

As already mentioned, the (VECM) is used in this study to explore possible Granger causality relationships between innovation, business activity and economic growth. The first step involves determining the order of integration and the presence/absence of co-integration between the three sets of variables. For this purpose, three panel modular root tests are used, namely the Levin-Lin-Chu test, the advanced Dickey-Fuller test and the Phillips-Perron test, to determine the order of integration of variables in our panel. The summary results of these tests show that all variables are integrated in the first order (see *Appendix, Table. 1*). The results indicate the possibility of integrating innovation, business activity, and economic growth. Furthermore, the Johansen panel co-integration test is used to evaluate the hypothesis that these three sets of data have a long-term relationship. The results of this test confirm the existence of a long-term balanced relationship between innovation, business activity and economic growth in all three samples and in seven cases within each sample (see *Appendix,*

Table 2). The results confirm the correctness of using the vector error correction model to identify possible Granger causality relationships between innovation, business activity and economic growth (see *Appendix, Table 3*). This table presents the long-term results of the Granger causality relationships, which are determined by determining the statistical significance of coefficients (ECT_{it-1}). It was found that when REG_{pc} is a dependent variable, the error correction delay coefficients (ECT) are statistically significant at the level of 1%. This indicates that, as a result of developments in both innovation and business activity, economic growth is approaching its long-term balancing trajectory. It is important to note that this is true for all of the situations in this sample (see *Appendix, Table 3*).

The above arguments support the hypothesis that both innovation and business activity have a significant influence on economic growth in eurozone countries. The consequence of this unambiguous conclusion is that it is essential to promote both innovation and business to stimulate long-term economic growth. However, short-term results are not always the same (see *Appendix, Table 4*). They show the heterogeneity of the Granger causality relationships and demonstrate that the dynamics of the short-time adjustment differ in the three samples and seven cases. *Table 4 of the Appendix* on the correlation between economic growth and innovation shows that 16 out of 21 cases confirm the feedback hypothesis, whereas four cases confirm supply economy 1 and one case confirms neutrality 4. As far as the relationship between economic growth and business activity is concerned, 11 out of 21 cases confirm hypothesis 1, based on the economy of supply, six cases confirm hypothesis 2, based on the demand economy, and four cases confirm the author's researched hypothesis 3, which testifies to feedback. Finally, as far as the relationship between innovation and business activity is concerned, the results show that in six out of 21 cases hypothesis 2 based on demand economy is confirmed, in eight cases hypothesis 1 based on supply economy, in five cases

hypothesis 3 based on feedback, and in two cases, hypotheses 4 based on neutrality are confirmed.

Although short-term results are not always the same and sometimes depend on approaches to the definition of innovation and business activity, even in the short-term dynamics, important causal links between variables are revealed. In other words, hypothesis 4, which indicates neutrality, is confirmed in very few cases. This includes a short-term link between innovation and business activity, where factual evidence indicates a strong short-term link between these two variables. The general conclusion must therefore be that there are many short-term changes between variables. Moreover, all the long-term dynamics point to the same result, namely that innovation and business are key factors in economic growth. The author additionally conducted many more experiments to guarantee the reliability of the results. The formal requirements for publication greatly limit the scope of the article and do not allow full disclosure of the details of the test checks, and here are only the results. So, the results show the following. First, fully modified assessments of the least squares method (LSM) and dynamic LSM show that both innovation and business activity have a positive impact on economic growth. Secondly, the order of the vector error correction model has been changed. There were no significant changes compared to the previous results presented in *Table 3* of the *Appendix*. Thirdly, the method of generalized decomposition of forecast error dispersion (GFEVDs) based on generalized pulse characterization functions similar to Lanne-Newberg was used to verify the accuracy of the causality relationship between innovation, business activity and economic growth. The dispersion decomposition shows the expected percentage change of the dependent variable, explained by the expected percent changes of the independent variables on the forecast horizon beyond the sample period of the study. One of the greatest advantages of this approach, similar to the orthogonalized decomposition of the forecast error dispersion, is that it is insensitive

to the order of variables, since the order is unambiguously determined by the VAR system. Furthermore, the generalized decomposition approach of the forecast error dispersion assesses the simultaneous impact of shocks on variables; for example, it describes different degrees of shock caused by innovation and business activity for economic growth. The estimates obtained from this approach support the argument that in the eurozone countries, innovation and business activity will continue to influence economic growth over a long period of time.

CONCLUSION

The results of this study, based on the example of eurozone countries, show that the long-term and short-term impact of innovation and business activity on economic growth is obvious. They promote long-term economic growth despite the heterogeneity of short-term results. Although, even the short-term dynamics, there are strong endogenous links between innovation, business activity and economic growth, all three variables are closely interrelated. Thus, as a priority measure of a macroeconomic nature that the Government of the Russian Federation must take, it can be identified to stimulate innovation and business activity in order to take advantage in the short-term of the obvious causality relationships between these variables. Furthermore, regardless of how we define these variables, promoting innovation and business is a long-term strategy.

Thus, the empirical results obtained from the study of the experiences of the eurozone countries support the idea that long-term economic growth in the Russian Federation will depend on a carefully organized national innovation ecosystem that promotes both a dynamic business culture and an innovative climate in all regions. Strong support for innovation and business activity will boost the competitiveness of the economy's existing sectors, and the combination of these two variables will result in the formation of new sources of economic growth.

REFERENCES

1. Smith A. An inquiry into the nature and causes of the wealth of nations. London: W. Strahan, T. Cadel, 1776. 589 p. (Russ. ed.: Smith A. Issledovanie o prirode i prichinakh bogatstva narodov. Moscow: Sotsium, LKI; 2017. 456 p.).

2. Auzan, A.A. Innovative development of the Russian economy. Interdisciplinary interaction: Coll. pap. Moscow: Prospekt; 2016. 646 p. (In Russ.).

3. Romer P.M. Endogenous technological change. *Journal of Political Economy*. 1990;98(5.Pt.2): S 71-S 102. URL: https://web.stanford.edu/~klenow/Romer_1990.pdf

4. Porter M.E. Competitive strategy: Techniques for analyzing industries and competitors. New York, NY: The Free Press; 1998. 397 p.

5. Etemad H. Influential factors in internationalization of family firms, socially and innovatively oriented firms, and effective international activities in global E-markets. *Journal of International Entrepreneurship*. 2021;19(4):469–478. DOI: 10.1007/s10843–021–00305–8

6. Dana L.-P. Entrepreneurship in Western Europe: A contextual perspective. London: World Scientific Publishing Europe Ltd; 2017. 544 p. DOI: 10.1142/p1035. ISBN: 978–1–78326–793–4

7. Wright R.W. International business education in the global economy. In: Rugman A.M., ed. Leadership in international business education and research. Bingley: Emerald Group Publishing Ltd; 2003:269–281. (Research in Global Strategic Management. Vol. 8). DOI: 10.1016/S 1064–4857(03)08017–3

8. Schumpeter J.A. Theorie der wirtschaftlichen Entwicklung: Eine Untersuchung über Unternehmergewinn, Kapital, Kredit, Zins und den Konjunkturzyklus. München, Leipzig: Verlag von Duncker & Humblot; 1911. 369 p. Schumpeter J.A. Capitalism, socialism and democracy. New York, London: Harper & Brothers; 1942. 381 p. (Russ. ed.: Schumpeter J.A. Teoriya ekonomicheskogo razvitiya. Kapitalizm, sotsializm, demokratiya. Moscow: Eksmo; 2007. 864 p.).

9. Schumpeter J.A. Capitalism, socialism and democracy. London, New York: Routledge; 1942. 460 p.

10. Plessis M.D. What bars organisations from managing knowledge successfully? *International Journal of Information Management*. 2008;28(4):285–292. DOI: 10.1016/j.ijinfomgt.2008.02.006

11. Knight F.H. The economic organization. New Brunswick, NJ: Transaction Publishers; 2013. 208 p.

12. Leibenstein H. General X-efficiency theory and economic development. New York, NY: Oxford University Press; 1978. 200 p. (Economic Development Series).

13. Salman Abdou D.M. Mediating role of research and development on entrepreneurial activities and growth. *World Journal of Entrepreneurship Management and Sustainable Development*. 2014;10(4):300–313. DOI: 10.1108/WJEMSD-11–2013–0056

14. Seymour R., ed. Handbook of research methods on social entrepreneurship. Cheltenham: Edward Elgar Publishing Ltd; 2012. 288 p. DOI: 10.4337/9781781001059

15. Solow R.M. Technical change and the aggregate production function. *The Review of Economies and Statistics*. 1957;39(3):312–320. DOI: 10.2307/1926047

16. Solow R.M. A contribution to the theory of economic growth. *The Quarterly Journal of Economics*. 1956;70(1):65–94. DOI: 10.2307/1884513

17. Schmitz J.A., Jr. What determines productivity? Lessons from the dramatic recovery of the U.S. and Canadian iron-ore industries following their early 1980s crisis. *Journal of Political Economy*, 2005;113(3):582–625. DOI: 10.1086/429279

18. Canova F., López -Salido D., Michelacci C. On the robust effects of technology shocks on hours worked and output. *SSRN Electronic Journal*. 2006. DOI: 10.2139/ssrn.1002872

19. Acs Z.J., Estrin S., Mickiewicz T., Szerb L. Entrepreneurship, institutional economics, and economic growth: An ecosystem perspective. *Small Business Economics*. 2018;51(5):501–514. DOI: 10.1007/s11187–018–0013–9

20. Pradhan R.P., Maradana R.P., Zaki D.B., Dash S., Jayakumar M. Nexus between venture capital and economic growth in European economic area countries: The Granger causality approach. *The Journal of Developing Areas*. 2016;50(6):1–15. DOI: 10.1353/jda.2016.0142

21. Brenner T., von Ledebur S. Academic inventors decision on a transfer channel — the influence. In: DRUID 25th Celebration conf. 2008 on entrepreneurship and innovation — organizations, institutions, systems and regions (Copenhagen, June 17–20, 2008). Copenhagen: Copenhagen Business School; 2018:1–19. URL: https://www.researchgate.net/profile/Thomas-Brenner-2/publication/266218075_ACADEMIC_INVENTORS_DECISION_ON_A_TRANSFER_CHANNEL_-THE_INFLUENCE/links/54d49bbf0cf24647580606b9/ACADEMIC–INVENTORS-DECISION-ON-A-TRANSFER-CHANNEL-THE-INFLUENCE.pdf

ABOUT THE AUTHOR

Bahadyr J. Matrizaev — Cand. Sci. (Econ.), Assoc. Prof., Department of Economic Theory, Financial University, Moscow, Russia
https://orcid.org/0000-0002-6270-9002
matrizaev@mail.ru

Conflicts of Interest Statement: The author has no conflicts of interest to declare.

APPENDIX

Summary Table of Empirical Results of Levin-Lin-Chu, Dickey-Fuller, Phillips-Perron Panel Tests Between Sets of Variables of Innovative Development, Business Activity and Economic Growth

Variables name	Test results					
	Indicators of the differential of the first order			Level indicators		
	Levin-Lin-Chu test	Dickey-Fuller test	Phillips-Perron test	Levin-Lin-Chu test	Dickey-Fuller test	Phillips-Perron test
TBAI	−13.932	151.632	234.9	0.65988	11.664	21.924
PBA	−15.336	154.332	226.692	−0.5292	15.012	17.604
LBA	−11.232	115.02	166.428	0.7344	12.9276	14.0292
PATAPPL	−11.124	135.756	206.604	0.96012	26.244	26.892
TMAPPL	−8.64	125.388	181.548	−0.864	17.604	93.852
RAND	−6.7068	91.692	160.704	−0.4104	20.736	148.824
PSTJ	−4.2984	52.596	90.5904	−0.9288	11.448	137.808
RANDE	−7.2144	92.664	159.732	1.3824	18.252	49.896
HTEX	−10.0656	144.396	195.804	0.5832	17.928	65.016
INNODEV	−5.3028	78.3	46.7748	1.2636	17.064	11.556
REG_{pc}	−19.872	300.996	414.072	0.7884	22.248	30.348

Source: Author's calculations based on statistical data obtained from annual surveys on world economic development and global monitoring of business activity. World Economic Situation and Prospects. URL: https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects (accessed on 14.07.2023). Global Entrepreneurship Monitor (GEM). URL: https://www.gemconsortium.org/report/50213 (accessed on 14.07.2023).

Table 2

Summary Table of Empirical Results of the Panel Test for the Presence/Absence of Cointegration Between Individual Variables of Innovative Development, Business Activity and Economic Growth

Indicator of availability of cointegration	Case 1 ($PATAPPL$)		Case 2 ($TMAPPL$)		Case 3 ($RAND$)		Case 4 ($PSTJ$)		Case 5 ($RANDE$)		Case 6 ($HTEX$)		Case 7 ($INNODEV$)	
	Track statistics	Statistics of the maximum value	Track statistics	Statistics of the maximum value	Track statistics	Statistics of the maximum value	Track statistics	Statistics of the maximum value	Track statistics	Statistics of the maximum value	Track statistics	Statistics of the maximum value	Track statistics	Statistics of the maximum value
Sample 1: REG_{pc}, $TBAI$, $INNODEV$														
No one	139.6	122.31	108.25	105.40	122.45	107.8	149.92	123.66	110.35	95.81	179.61	149.45	139.67	108.32
Max. 1	49.23	44.68	29.52	26.17	71.33	61.76	90.09	68.04	54.32	45.64	68.92	55.87	55.43	61.34
Max. 2	25.13	25.13	18.72	18.72	39.87	39.87	52.34	52.34	35.98	35.98	41.54	41.54	44.98	45.88
Number of co-integrated vectors	2		2		3		3		3		3		3	
Sample 2: REG_{pc}, PBA, $INNODEV$														
No one	129.87	111.35	111.00	99.63	121.33	98.54	89.75	75.13	112.68	97.12	179.86	149.17	139.48	109.66
Max. 1	30.13	25.44	81.53	63.98	64.71	53.14	34.03	36.95	53.59	44.22	67.53	54.41	52.85	60.51
Max. 2	20.46	20.46	47.16	47.16	37.48	37.48	6.99	6.99	37.79	37.79	42.30	42.30	46.35	46.35
Number of co-integrated vectors	2		3		3		2		3		3		3	
Sample 3: REG_{pc}, LBA, $INNODEV$														
No one	35.78	31.07	132.95	112.77	106.80	87.54	108.24	91.82	95.02	77.60	156.31	128.78	114.61	85.24
Max. 1	22.54	20.66	52.16	46.82	71.53	57.46	74.32	70.51	64.52	60.35	68.15	59.38	60.84	50.94
Max. 2	10.56	10.56	27.98	27.98	40.36	40.36	56.27	56.27	33.87	33.87	33.98	33.98	42.28	42.28
Number of co-integrated vectors	1		3		3		3		3		3		3	

Table 3

Summary Table of Empirical Results of the Granger Causality Panel Test

Indicator of variables	Case 1 (PATAPPL)				Case 2 (TMAPPL)				Case 3 (RAND)				Case 4 (PSTJ)			
	ΔREG_{pc}	$\Delta TBAI$	$\Delta PATAPPL$	ECT_{it-1}	ΔREG_{pc}	$\Delta TBAI$	$\Delta TMAPPL$	ECT_{it-1}	ΔREG_{pc}	$\Delta TBAI$	$\Delta RAND$	ECT_{it-1}	ΔREG_{pc}	$\Delta TBAI$	$\Delta PSTJ$	ECT_{it-1}
ΔREG_{pc}	–	7.3	7.2	–0.76	–	7.3	3.9	–0.23	–	7.5	10.5	–0.23	–	6.8	35.1	–0.23
$\Delta TBAI$	0.8	–	7.8	–0.09	2.4	–	10.2	–0.08	4.01	–	2.02	–0.03	2.46	–	2.13	–0.09
$\Delta INNODEV$	2.9	4.3	–	–0.14	2.1	2.1	–	–0.16	11.2	3.68	–	–0.1	72.8	3.8	–	–0.1
Sample 2: REG_{pc} , PBA , $INNODEV$																
ΔREG_{pc}	–	12.8	15.6	–0.15	–	9.42	3.13	–0.17	–	4.2	6.34	–0.16	–	5.23	45.3	–0.22
ΔPBA	2.87	–	3.14	–0.06	2.85	–	0.52	–0.09	3.1	–	3.96	–0.05	2.01	–	4.01	–0.05
$\Delta INNODEV$	7.26	8.41	–	–0.23	3.42	1.02	–	–0.26	6.82	4.24	–	–0.08	49.4	6.95	–	–0.11
Sample 3: REG_{pc} , LBA , $INNODEV$																
ΔREG_{pc}	–	1.87	13.08	–0.10	–	2.45	4.09	–0.13	–	1.01	6.06	–0.12	–	4.12	46.7	–0.13
ΔLBA	2.87	–	2.23	–0.26	6.17	–	5.01	–0.39	4.14	–	2.11	–0.42	2.42	–	7.24	–0.06
$\Delta INNODEV$	9.13	6.02	–	–0.19	2.14	1.35	–	–0.19	9.53	4.51	–	–0.15	78.32	2.06	–	–0.19

Table 3 (continued)

Indicator of variables	Case 5 (RANDE)				Case 6 (HTEX)				Case 7 (INNODEV)			
	ΔREG_{pc}	$\Delta TBAI$	$\Delta PATAPPL$	ECT_{it-1}	ΔREG_{pc}	$\Delta TBAI$	$\Delta TMAPPL$	ECT_{it-1}	ΔREG_{pc}	$\Delta TBAI$	$\Delta RAND$	ECT_{it-1}
ΔREG_{pc}	–	2.99	27.5	–0.09	–	5.7	6.62	–0.23	–	5.31	8.15	–0.21
$\Delta TBAI$	1.97	–	3.92	–0.08	3.12	–	3.86	–0.09	1.02	–	5.75	–0.14
$\Delta INNODEV$	9.65	2.13	–	–0.03	5.91	2.9	–	–0.2	6.62	5.97	–	–0.32
Sample 2: REG_{pc}, PBA, $INNODEV$												
ΔREG_{pc}	–	7.25	8.09	–0.14	–	14.3	11.7	–0.15	–	7.54	14.7	–0.12
ΔPBA	9.05	–	0.91	–0.16	7.94	–	3.03	–0.17	5.05	–	3.36	–0.11
$\Delta INNODEV$	24.7	6.08	–	–0.09	5.96	2.84	–	–0.08	40.5	5.16	–	–0.68
Sample 3: REG_{pc}, LBA, $INNODEV$												
ΔREG_{pc}	–	3.12	7.68	–0.09	–	3.05	6.17	–0.10	–	2.23	11.87	–0.09
ΔLBA	6.26	–	5.09	–0.41	5.01	–	2.1	–0.40	5.91	–	4.98	–0.19
$\Delta INNODEV$	28.31	3.26	–	–0.13	3.39	2.03	–	–0.10	39.04	2.04	–	–0.69

Summary Table of Results of Granger's Short-Term Causal Relationship

Sample number	Sequence of cases	Directions of interaction between variables		
		$INNODEV$ and BA	$INNODEV$ and REG_{pc}	BA and REG_{pc}
1	1	$PATAPPL \leftrightarrow TBAI$	$PATAPPL \rightarrow REG_{pc}$	$TBAI \rightarrow REG_{pc}$
	2	$TMAPPL \rightarrow TBAI$	$TMAPPL \rightarrow REG_{pc}$	$TBAI \rightarrow REG_{pc}$
	3	$RAND \leftarrow TBAI$	$RAND \leftrightarrow REG_{pc}$	$TBAI \rightarrow REG_{pc}$
	4	$PSTJ \leftarrow TBAI$	$PSTJ \leftrightarrow REG_{pc}$	$TBAI \rightarrow REG_{pc}$
	5	$RANDE \rightarrow TBAI$	$RANDE \leftrightarrow REG_{pc}$	$TBAI \rightarrow REG_{pc}$
	6	$HTEX \leftrightarrow TBAI$	$HTEX \leftrightarrow REG_{pc}$	$TBAI \rightarrow REG_{pc}$
	7	$TIINNODEV \leftrightarrow TBAI$	$TIINNODEV \leftrightarrow REG_{pc}$	$TBAI \rightarrow REG_{pc}$
2	1	$PATAPPL \leftarrow PBA$	$PATAPPL \leftrightarrow REG_{pc}$	$PBA \leftrightarrow REG_{pc}$
	2	$TMAPPL \varnothing PBA$	$TMAPPL \varnothing REG_{pc}$	$PBA \rightarrow REG_{pc}$
	3	$RAND \leftrightarrow PBA$	$RAND \leftrightarrow REG_{pc}$	$PBA \rightarrow REG_{pc}$
	4	$PSTJ \leftrightarrow PBA$	$PSTJ \leftrightarrow REG_{pc}$	$PBA \rightarrow REG_{pc}$
	5	$RANDE \leftarrow PBA$	$RANDE \leftrightarrow REG_{pc}$	$PBA \leftrightarrow REG_{pc}$
	6	$HTEX \leftarrow PBA$	$HTEX \leftrightarrow REG_{pc}$	$PBA \leftrightarrow REG_{pc}$
	7	$TIINNODEV \leftarrow PBA$	$TIINNODEV \leftrightarrow REG_{pc}$	$PBA \leftrightarrow REG_{pc}$
3	1	$PATAPPL \leftarrow LBA$	$PATAPPL \leftrightarrow REG_{pc}$	$LBA \leftarrow REG_{pc}$
	2	$TMAPPL \rightarrow LBA$	$TMAPPL \rightarrow REG_{pc}$	$LBA \leftarrow REG_{pc}$
	3	$RAND \leftarrow LBA$	$RAND \leftrightarrow REG_{pc}$	$LBA \leftarrow REG_{pc}$
	4	$PSTJ \rightarrow LBA$	$PSTJ \leftrightarrow REG_{pc}$	$LBA \rightarrow REG_{pc}$
	5	$RANDE \rightarrow LBA$	$RANDE \leftrightarrow REG_{pc}$	$LBA \leftarrow REG_{pc}$
	6	$HTEX \varnothing LBA$	$HTEX \rightarrow REG_{pc}$	$LBA \leftarrow REG_{pc}$
	7	$TIINNODEV \rightarrow LBA$	$TIINNODEV \leftrightarrow REG_{pc}$	$LBA \leftarrow REG_{pc}$

Source: Author's calculations based on statistical data obtained from annual surveys on world economic development and global monitoring of business activity. World Economic Situation and Prospects. URL: https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects (accessed on 14.07.2023). Global Entrepreneurship Monitor (GEM). URL: https://www.gemconsortium.org/report/50213 (accessed on 14.07.2023).

Treatment of Missing Market Data: Case of Bond Yield Curve Estimation

M.S. Makushkin, V.A. Lapshin
National Research University Higher School of Economics, Moscow, Russia

ABSTRACT

Missing observations in market data is a frequent problem in financial studies. The problem of missing data is often overlooked in practice. Missing data is mostly treated using ad hoc methods or just ignored. Our **goal** is to develop practical recommendations for treatment of missing observations in financial data. We illustrate the issue with an example of yield curve estimation on Russian bond market. We compare three **methods** of missing data imputation — last observation carried forward, Kalman filtering and EM–algorithm — with a simple strategy of ignoring missing observations. We **conclude** that the impact of data imputation on the quality of yield curve estimation depends on model sensitivity to the market data. For non-sensitive models, such as Nelson-Siegel yield curve model, final effect is insignificant. For more sensitive models, such as bootstrapping, missing data imputation allows to increase the quality of yield curve estimation. However, the **result** does not depend on the chosen data imputation method. Both simple last observation carried forward method and more advanced EM–algorithm lead to similar final results. Therefore, when estimating yield curves on the illiquid markets with missing market data, we **recommend** to use either simple non-sensitive to the data parametric models of yield curve or to impute missing data before using more advanced and sensitive yield curve models.

Keywords: yield curve; term structure of interest rates; bond market; Nelson-Siegel method; liquidity level; missing data; emerging markets

INTRODUCTION

Missing data is a common problem in many empirical studies. It is also found in finance, especially when it comes to emerging, low-liquidity markets. The presence of gaps in the data complicates the assessment of financial models and may distort conclusions. Market data gaps can arise for a variety of reasons, for example, due to low liquidity of the instrument, data censoring, or the filtering of outliers.

In liquid developed markets, the problem of missing data is generally ignored because missing observations are not frequent. Researchers focus more on model specification rather than on data quality issues.

In less liquid markets, missing observation are more frequent. Simply removing gaps in data can lead to the loss of important information. Therefore, researchers often pre-process the data. The choice of the method for missing data treatment is usually made ad-hoc, and the processing of the data itself is an auxiliary step

on the way to answering the main research questions.

In the paper, we explore the treatment of missing observations in market data in more detail in relation to the task of estimating the bond yield curve. Our goal is to develop practical recommendations on how to deal with gaps in market data when estimating the term structure of interest rates.

To illustrate the problem and its possible solutions in practice, we use data on the trading of Russian Federal Loan Bonds (further — FLBs). We investigate how filling gaps in the trading data affects the estimation quality of the yield curve. This is an important topic subject since yield curve estimation in emerging markets is sometimes negatively impacted by gaps in market data [1].

The novelty of the paper is the application of statistical tools from the field of incomplete data analysis to the tasks of financial engineering. We show that the issues of data quality and

completeness in emerging markets require no less attention than the questions of financial model choice.

LITERATURE REVIEW

In statistical science, there is a separate area dedicated to the formal analysis of missing data [2–4]. Data gaps are dangerous for two reasons. First, they can lead to shifted estimates of model parameters. Second, they increase the standard error of model coefficients and reduce the power of statistical tests [5].

One can safely remove the gaps from the analysis only if they are completely random, i.e. they are not dependent on their own non-observed values or on the values of other observations. If missing observations are simply random, i.e. they do not depend on their own missed value, but on the values of other parameters, then missed data can be restored by means of conditional imputation. If gaps are not random, then to fill them, you need to know the process that generates the gaps [3].

Gaps in market data can be both random and non-random. Non-random gaps can arise, for example, when trade in a stock or bond stops due to an unexpected decline in the price of the stock or bond (for example, suspension of trading in the Russian market in February–March 2022). Such cases must be examined independently, with special emphasis on the reasons behind missing observations.

With random missing data, on the contrary, you can work effectively. There are two ways to do this. The first option is to adapt the model to address data gaps. This is a more correct way, but it complicates the model, depends on its properties and specifications, and is not universal. Please refer to [6–8] for the description of missing data treatment in yield curve estimation tasks.

The second option to work with gaps is to pre-fill gaps in the data. The advantages of the approach are its ability to retain a simple original model, as well as to use the processed data for other purposes. As part of our study, we are considering this more general option.

In practice, the most common solution to the problem is to remove gaps [9]. This is a simple solution, but it leads to the loss of some important information. In some situations, it may be useful to impute the missing data. A general overview of possible data imputation methods is presented in the papers [10, 11]. With regards to financial problems, both advanced methods of filling gaps in the data are used (EM-algorithm [12, 13], Bayesian model with Markov chain Monte Carlo [14]), as well as simpler methods (last observation carried forward [15] and the last weighted value [16]). In the cited examples methods for missing market data treatment are chosen without much of justification. There is usually no description of how the strategy used to fill gaps influences the results achieved. Data imputation is mentioned only as an intermediate step towards answering key research questions. In this regard, it is important to address the problem of missing market data in greater detail and to compare the methods of processing them for financial objectives.

METHODOLOGY
Yield curve estimation models

We illustrate the importance of the problem of processing gaps in market data with an example of constructing a yield curve in a bond market. The yield curve shows the relationship between interest rates and maturity. It has multiple practical uses ranging from macroeconomic forecasting to risk management and pricing of financial instruments. In emerging markets, estimation of the yield curve is often complicated by gaps in market data [1]. Therefore, the task of implying the yield curve from the data with missing observations seems important and relevant.

There are many models for yield curve estimation. All of them are based on the general principle that information about the unobserved yield curve is derived from observed market information, for example, from the prices of coupon bonds. An overview of yield curve models can be found in the paper [17].

When choosing the current interest rate term structure model, the quantity and quality

of data available for calibration must be taken into account [18]. The model should be as complex and accurate as the available data allows. Where the number of available data is limited, conservative assumptions and simpler models should be used. Therefore, for market data with gaps, it is advisable to consider two models of the yield curve with varying degrees of data quality sensitivity. We select a very simple but stable Nelson-Siegel yield curve model [19] and a more flexible but less stable interest-rate bootstrapping method [20].

The Nelson-Siegel model in the factor specification [21] describes the yield $y(\tau)$ for maturity τ with the following equation:

$$y(\tau)=\beta_1+\beta_2\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right)+\beta_3\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}-e^{-\lambda\tau}\right)+\varepsilon(\tau), \quad (1)$$

where $\theta=\{\beta_1,\beta_2,\beta_3,\lambda\}$ — model parameters vector, and; $\varepsilon(\tau)$ — error.

In fact, the rate of $y(\tau)$ in the model is the weighted sum of three factors, where factors are weighted by β_1,β_2,β_3. These weights can be interpreted as the level, slope and curvature of the yield curve. The fourth parameter λ describes the relative position of the curvature on the chart.

The Nelson-Siegel model captures quite well the empirically observed shapes of the yield curve. Therefore, it is used some way by many financial institutions.[1] In particular, the model of the G-curve of the Moscow Stock Exchange[2] is based on the Nelson-Siegel variation of the yield curve. The model is also popular in emerging markets and low-liquidity markets, as it has only four parameters that can be conveniently calibrated to a small set of market data available [22, 23].

Estimation of model parameters can be done by minimizing the average square error of revaluation of bond yields, or directly from the bond prices. A description of technical details

behind the yield curve estimation can be found, for example, in paper [24]. We choose to calibrate the yield curve model directly to the coupon bond prices, because zero-coupon yields on the FLB market are not observed directly.

If the vector P, of coupon bond prices is given, the task of estimating the parameters of the yield curve is described by the following equations:

$$\hat{\theta}=\arg\min_{\theta}\sum_{i}^{N}(\hat{P}_i(\theta)-P_i)^2, \quad (2)$$

$$\hat{P}_i=\sum_{j=1}^{J_i}CF_{ij}e^{-y(\tau_{ij})\tau_{ij}}, \quad (3)$$

where j — serial number of cash flow; J — total number of cash flows, and; $y(\tau_{ij})$ — zero-coupon rate, corresponding to the time τ_{ij} till payment of CF_{ij} on the bond i. In fact, the model is estimated as a classical regression, so all data instabilities are smoothed at the calibration stage.

Bootstrap is a more data-sensitive method. It is based on the idea of sequential calculation of the zero-coupon rate in order of increasing the maturity of bonds. Given the values of bonds at various maturities, you may iteratively find zero-coupon interest rates using the bootstrap. The produced curve is an exact fit to the original market data.

Formally, the bootstrap logic can be written as follows. Suppose we have a set of bonds $P_i, i\in 1...N$ at with maturities $\tau\in 1...J$. Then the price of each bond can be represented as the sum of its discounted future streams:

$$\begin{cases} \hat{P}_1=CF_{11}e^{y(\tau_{11})\tau_{11}} \\ \hat{P}_2=CF_{21}e^{y(\tau_{21})\tau_{21}}+CF_{22}e^{y(\tau_{22})\tau_{22}} \\ \dots \\ \hat{P}_N=CF_{N1}e^{y(\tau_{N1})\tau_{N1}}+CF_{N2}e^{y(\tau_{N2})\tau_{N2}}+\dots+CF_{NJ}e^{y(\tau_{NJ})\tau_{NJ}} \end{cases} \quad (4)$$

The system of equations (4) can be solved by the iterative method by replacing the found zero-coupon yields from the first equations in the subsequent equations.

In reality, the set of available bond prices P is limited. An assumption of the form of the yield curve is required at the intervals between the

[1] Bank of International Settlements. Zero-coupon yield curves: Technical documentation. BIS Papers. 2005;(25).

[2] MOEX (2021). Zero-coupon Yield Curve for Sovereign Bonds. https://www.moex.com/a3642 (accessed on 09.11.2022).

maturities of the available securities. We use the basic assumption of a piecewise constant form of the yield curve, but we can also assume more complex dependencies [25].

A bootstrapped yield curve $y(\tau)$ depends on each point of market data and ideally reproduces the initial data. Any noise in the source data can significantly distort the shape of the curve, and gaps in the data will make it less smooth [26]. Bootstrap is commonly used in developed liquid markets where enough bonds are traded and structural market inefficiencies are minimized.

Methods for missing data imputation

We examine two strategies of dealing with missing data: simply remove the gaps in data and fill gaps. The first option serves as a benchmark strategy, as it is most commonly found in financial research that deals with missing data. The second option is more advanced. It is less common in the literature, but sometimes it allows to improve the quality of model evaluation. We explore how the gap filling strategy improves the quality of yield curve estimation compared to the gap removal strategy.

We have chosen three methods for filling gaps: 1) a simple heuristic method of filling in the last value (last observation carried forward); 2) a Kalman filter that takes into account the previous dynamics of observations; 3) an EM-algorithm that takes into account the aggregate dynamics. This selection of methods makes it possible to compare how much the complexity of missing data imputation method impacts the quality of the evaluation of the curve.

The easiest way to fill a gap is to fill it with the last value. This method is simple to implement, but it uses the strong assumption that in the absence of data, a previous observation is the best estimate of a missing value.

The Kalman filter is a more advanced option for filling gaps. When filling the gaps, this method takes into account the historical dynamics of a data point. Based on noisy observations, the Kalman filter evaluates the unobserved state of the system. The system state can then be used to estimate the possible values

for the missed observations. Technical aspects of the method are presented in the paper [27].

In contrast to Kalman filter, EM-algorithm considers the dynamics of not just one data point, but of the entire dataset. It takes into account the dynamics of other observations and the covariation structure of the data. This is an iterative algorithm consisting of two steps. In the E-step, the expected value (expectation) of the vector of non-observed variables is calculated on the basis of the first approximation of the model coefficients estimated using available information. The M-step solves the problem of maximization and is the next approximation of the vector of the model parameters. It is then used to estimate non-observed values, and the process repeats. [28].

Comparison of estimation quality

We compare the quality of the yield curve estimation using cross-validation. The idea of the method is that all observations are used for tests. This is useful when available data sets are small. An observation is excluded from the training dataset, the model is evaluated without this observation, and then the error is calculated for the excluded test observation. The procedure is performed iteratively for each observation in the sample, and the result is then averaged [29].

When calculating cross-validation errors, we use only real observations. The imputed data is thus only needed for a more accurate estimation of the curve. It does not need to be taken into account in the calculation of error, as the ultimate goal is to improve the quality of reproduction of real observations rather than recovered observations.

DATA

We use closing prices of standard FLB with fixed coupon in the period from May 2012 to December 2015 (approximately 1000 observations). We do not include amortizing, floating and inflation-linked FLBs in the sample, as their pricing principles differ from standard FLB coupons [30]. Prices were obtained from the Finam analytical platform.

More up-to-date data on FLB trades up to 2022 was also collected and studied. However, the percentage of gaps in the data sample is small, so they would not be representative for the study. In this regard, we are restricted to looking at older data.

An alternative could be to generate data gaps, but this approach involves an artificial, exogenous missing data generating process that may distort the conclusions of the study. That is why we compromise data speed in return for an actual and non-distorted gap structure. This method doesn't reduce the practical value of the produced results. They can still be applied to other bond markets where data gaps are still a problem — to the corporate debt market, as well as to less liquid sovereign — obligation markets, where data gap is still a common phenomenon.

The average share of missing data in the collected sample is 10%. There were more missing observations in the beginning of the sample (around 30% in 2012). The share of gaps has then fallen down to 20%. By the end of 2015 there are almost no gaps in the sample. A large number of gaps are concentrated around weekends and public holidays (New Year's Eve, May Holidays). Gaps are distributed relatively randomly by individual securities. Long series of gaps are rare. Usually, their length does not exceed two to five days. Some securities are more "prone" to gaps, but generally they don't stand out much from the sample.

We rearrange the data as follows. From the closing prices we calculate coupon yields. Next, we fill the gaps in yields using data imputation methods described earlier. Then we go back from processed returns again to bond prices. The yield curve is then calibrated to new price data sample. For observations with no gaps, such a transition has no effect because yield and price are inseparable. As a result, all valid observations are preserved, while missed observations are recovered.

A transition from price to yield and backwards is necessary to take into account the pull-to-par effect (the convergence of the bond value to the nominal as it approaches repayment data). In addition, some methods of filling gaps, such

as EM-algorithm, require normally distributed data. Yields distribution is closer to normal than distribution of bond prices.

To apply the EM-algorithm, we additionally calculate the average arithmetic yield on all securities for each day. This is necessary because the size of the sample is not fixed. Some securities are expired, others, on the contrary, are issued. As a result, estimating the covariance between the yields of various securities is difficult. This issue can be avoided by calculating the covariance between yield of a particular bond and an average yield, rather than the covariance matrix of yields. Of course, this simplification leads to the loss of some information. In fact, when filling gaps with the EM-algorithm, we only take into account the relationship of observation with the overall "level" of the yield curve. However, this simplification is acceptable, as parallel shifts explain most of the yield curve dynamics [31].

RESULTS

On the basis of the methodology described, gaps in data on bond trading were filled. A graphical comparison of different ways of filling gaps in yields and prices is shown on below on the example of FBL 25065 (*Fig. 1, 2*).

When the gaps in returns are filled, the results may vary greatly. Filling with the last value (shaped dots) looks most inaccurate. It creates long, constant sections in the data. Filling with the Kalman filter (cross) is slightly more effective. Because the model reads from previous yield dynamics, the constant areas are replaced by sloping ones. When using the EM-algorithm (plus), the results are quite close to expectations. In fact, the average yield dynamics of all securities is applied to the yield of a bond with missing prices.

As we transition from yields to prices, the difference between the methods of filling gaps becomes less noticeable. This is due to the fact that as the maturity decreases, the bond's sensitivity to the change in yield also decreases, and its price tends to par.

For data with filled gaps, we then constructed the yield curves using the Nelson-Siegel and
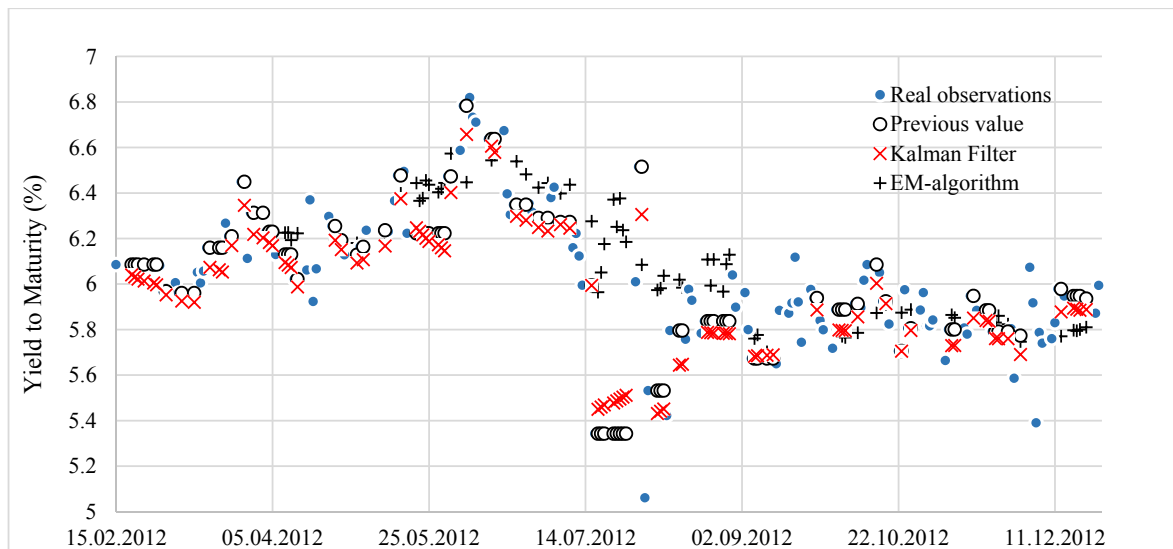
Fig. 1. **An Example of Processing Yields Gaps for FLB 25065**

Source: Author's calculations.
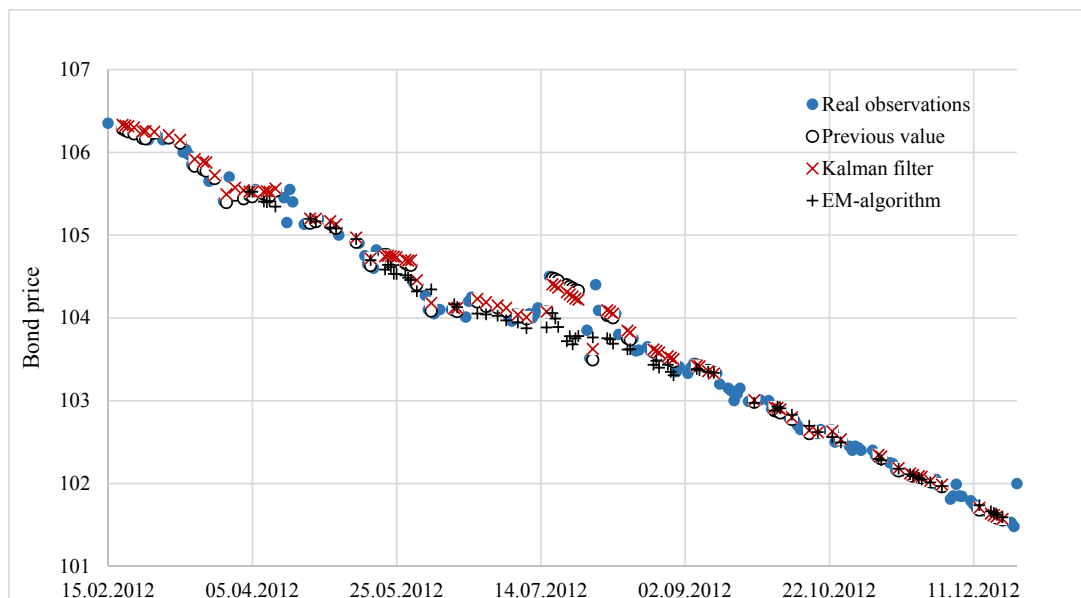
Fig. 2. **An Example of Processing Prices Gaps for FLB 25065**

Source: Author's calculations.

bootstrap models and calculated the average absolute fitting error with cross-validation. By comparing the error values, we counted the percentage of days when missing data imputation improved the quality of yield curve estimation compared to the simple deletion of the gaps. Only the days with recorded gaps were considered.

The gap filling strategy improves the fitting quality of the bootstrapped yield curve compared to the simple gap removal strategy (*Table*). The share of the days when data imputation has improved quality is approximately 65%. This is slightly higher for the EM-algorithm imputation, but generally speaking, the differences between the imputation methods are insignificant. The quality improvement resulting from the filling of gaps is statistically significant at a 95% confidence level.

For the Nelson-Siegel parametric model, missing data imputation does not significantly

Percentage of the Days when Processing Data Gaps Provides a Better Yield Curve Fit than Simple Removal Processing of Gaps

	Bootstrapping		Nelson-Siegel Mode	
	Removal of gaps	**Missing data imputation**	**Removal of gaps**	**Missing data imputation**
Last value	35%	65%	52%	48%
Kalman filter	34%	66%	59%	41%
EM-Algorithm	31%	69%	49%	51%

Source: Author's calculations.
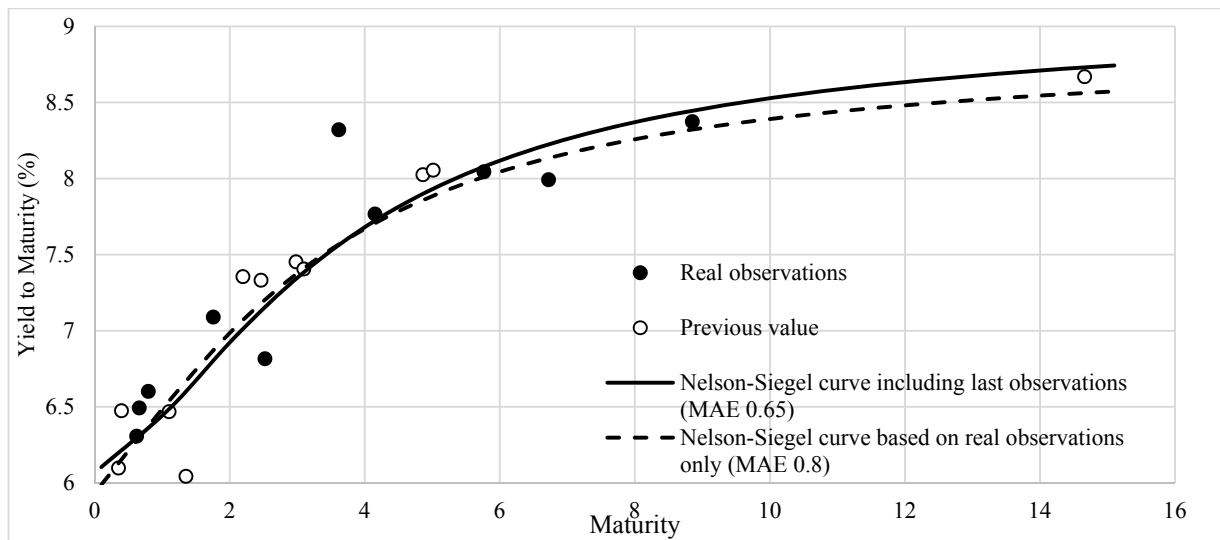
Fig. 3. **Nelson-Siegel Yield Curve for Russian FLB Constructed Using Only Real Data and Using Both Real and Gaps Data as of June 9, 2022**
Source: Author's calculations.

improve the quality of the curve estimation. The share of days when data imputation helped improve the quality of the estimation and the days when the curve is better to evaluate only on the available data are roughly equal.

The difference in the impact of missing data imputation on the quality of the yield curve estimation using the Nelson-Siegel model and bootstrapping can be explained by the different sensitivity of the models to market data. The Nelson-Siegel model has only 4 parameters. They can be estimated quite well from available observations. Adding two or three more recovered points to the 16 real points will not have a significant impact on the outcome. Bootstrap, on the contrary, depends on each point of market data. Adding even one observation makes the yield curve more smooth.

An example of the improvement in the quality of the estimation of the yield curve is shown in *Fig. 3–4* based on the trade data for 9 June 2012. It's a pre-holiday day, so trading activity was lower and there were more gaps in the data. The yield curve was first calibrated only to real observations and then to a combination
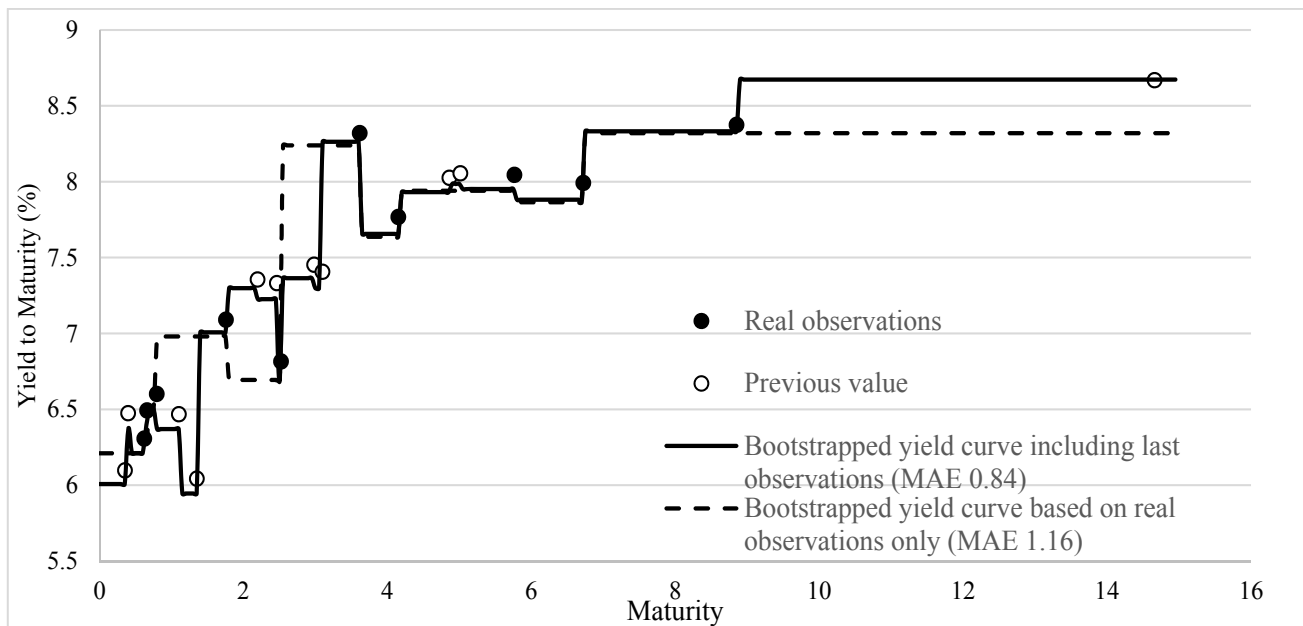
Fig. 4. **Bootstrapped Zero-Coupon Yield Curve for Russian FLB Constructed Using Only Real Data and Using Both Real and Gaps Data as of June 9, 2022**

Source: Author's calculations.

of real data and data with filled gaps. Both for the Nelson-Siegel model (*Fig. 3*), and for the bootstrap (*Fig. 4*) missing data imputation allowed to describe more accurately the term structure of interest rates, especially at the far end. The average absolute error on cross-validation was significantly reduced (the error values are shown in figures).

CONCLUSION

A comparison of different methods for missing market data imputation was carried out. The results are illustrated by an example of yield curve estimation in the Russian bond market. We have shown that ignoring gaps can lead to distorted estimates of the yield curve model. On the contrary, missing data imputation could improve the quality of estimating the yield curve compared to removing missed observations from the sample.

The effect of filling gaps in the data on the quality of estimation of the yield curve depends on the selected curve model. For the Nelson-Siegel parametric model, the positive effect of filling gaps is minimal. For bootstrapping, a statistically significant improvement in

evaluation quality is recorded when filling gaps in the data. The observed differences are related to the degree of sensitivity of yield curve models to market data. The Nelson-Siegel parametric model can be efficiently calibrated even when only a small number of data points is available. For bootstrap, however, every additional observation is important.

In practice, when selecting an approach for missing data pre-processing, we propose evaluating the financial model's sensitivity to market data. It will be useful to pre-fill gaps in data if data-sensitive models are used. The specific method of dealing with gaps in relation to the task of yield curve estimation is less significant. Both simple last observation carried forward method, and more sophisticated methods of filling gaps based on the Kalman filter or EM-algorithm give a similar result. If it is not possible to fully process data gaps, then it is necessary to use simpler and less data-sensitive models.

The paper findings can be useful for yield curve estimation in low-liquidity markets and for other financial studies that deal with incomplete market data.

REFERENCES

1. Makushkin M., Lapshin V. Yield curve estimation in illiquid bond markets. *Ekonomicheskii zhurnal Vysshei shkoly ekonomiki = The HSE Economic Journal*. 2021;25(2):177–195. (In Russ.). DOI: 10.17323/1813–8691–2021–25–2–177–195

2. Haitovsky Y. Missing data in regression analysis. *Journal of the Royal Statistical Society. Series B (Methodological)*. 1968;30(1):67–82. DOI: 10.1111/j.2517–6161.1968.tb01507.x

3. Rubin D.B. Inference and missing data. *Biometrika*. 1976;63(3):581–592. DOI: 10.1093/biomet/63.3.581

4. Little R.J.A. Missing-data adjustments in large surveys. *Journal of Business & Economic Statistics*. 1988;6(3):287–296. DOI: 10.1080/07350015.1988.10509663

5. Newman D.A. Missing data: Five practical guidelines. *Organizational Research Methods*. 2014;17(4):372–411. DOI: 10.1177/1094428114548590

6. Cortazar G., Schwartz E.S., Naranjo L.F. Term-structure estimation in markets with infrequent trading. *International Journal of Finance & Economics*. 2007;12(4):353–369. DOI: 10.1002/ijfe.317

7. Poghosyan K., Poghosyan A. Yield curve estimation and forecasting in Armenia. *Armenian Journal of Economics*. 2019;(4):1–19. URL: https://www.aea.am/files/papers/a2019_1.pdf

8. Nagy K. Term structure estimation with missing data: Application for emerging markets. *The Quarterly Review of Economics and Finance*. 2020;75:347–360. DOI: 10.1016/j.qref.2019.04.002

9. Kofman P., Sharpe I.G. Using multiple imputation in the analysis of incomplete observations in finance. *Journal of Financial Econometrics*. 2003;1(2):216–249. DOI: 10.1093/jjfinec/nbg013

10. Briggs A., Clark T., Wolstenholme J., Clarke P. Missing… presumed at random: Cost-analysis of incomplete data. *Health Economics*. 2003;12(5):377–392. DOI: 10.1002/hec.766

11. Graham J.W. Missing data analysis: Making it work in the real world. *Annual Review of Psychology*. 2009;60:549–576. DOI: 10.1146/annurev.psych.58.110405.085530

12. Warga A. Bond returns, liquidity, and missing data. *Journal of Financial and Quantitative Analysis*. 1992;27(4):605–617. DOI: 10.2307/2331143

13. Zhu H. An empirical comparison of credit spreads between the bond market and the credit default swap market. *Journal of Financial Services Research*. 2006;29(3):211–235. DOI: 10.1007/s10693–006–7626-x

14. Kos'yanenko A.V. Missing market data imputation using Bayesian inference. Financial engineering, risk management and actuarial science. Preprint WP16/2007/02. Moscow: SU HSE; 2007. 32 p. (In Russ.).

15. Teplova T., Budanova D. Pricing effectiveness at the Russian corporate bonds market. *Vestnik Moskovskogo universiteta. Seriya 6: Ekonomika = Moscow University Economics Bulletin*. 2017;(4):3–28. (In Russ.). DOI: 10.38050/01300105201741

16. Khakimzhanov S., Mustafin Y., Kubenbayev O., Atabek D. Constructing a yield curve in a market with low liquidity. *Russian Journal of Money and Finance*. 2019;78(4):71–98. DOI: 10.31477/rjmf.201904.71 (In Russ.: *Den'gi i kredit*. 2019;78(4):71–98. DOI: 10.31477/rjmf.201904.71).

17. Lapshin V., Tereshchenko M. The choice of the model of the term structure of interest rates on the basis of its properties. *Korporativnye finansy = Journal of Corporate Finance Research*. 2018;12(2):171–187. (In Russ.). DOI: 10.17323/j.jcfr.2073–0438.12.2.2018.171–187

18. Kurbangaleev M., Lapshin V. An analysis of the risk-free term structure estimation requirements posed by various financial problems. *Upravlenie finansovymi riskami = Financial Risk Management Journal*. 2015;(1):50–60. (In Russ.).

19. Nelson C.R., Siegel A.F. Parsimonious modeling of yield curves. *The Journal of Business*. 1987;60(4):473–489. DOI: 10.1086/296409

20. Fama E.F., Bliss R.R. The information in long-maturity forward rates. *The American Economic Review*. 1987;77(4):680–692.

21. Diebold F.X., Li C. Forecasting the term structure of government bond yields. *Journal of Econometrics*. 2006;130(2):337–364. DOI: 10.1016/j.jeconom.2005.03.005

22. Zoricic D., Orsag S. Parametric yield curve modeling in an illiquid and undeveloped financial market. *UTMS Journal of Economics*. 2013;4(3)234–252. URL: https://www.utmsjoe.mk/files/Vol.%204%20No.%203/1–1B-Zoricic-Orsag_-_Croatia.pdf

23. Chou J.-H., Su Y.-S., Tang H.-W., Chen C.-Y. Fitting the term structure of interest rates in illiquid market: Taiwan experience. *Investment Management and Financial Innovations*. 2009;6(1):101–116. URL: https://www.researchgate.net/publication/288118114_Fitting_the_term_structure_of_interest_rates_in_illiquid_market_Taiwan_experience

24. Wahlstrøm R.R., Paraschiv F., Schürle M.A Comparative analysis of parsimonious yield curve models with focus on the Nelson-Siegel, Svensson and Bliss versions. *Computational Economics*. 2022;59(3):967–1004. DOI: 10.1007/s10614–021–10113-w

25. Hagan P.S., West G. Interpolation methods for curve construction. *Applied Mathematical Finance*. 2006;13(2):89–129. DOI: 10.1080/13504860500396032

26. Avdeeva O., Tsyplakov A. A method for adaptive estimation of the term structure of interest rates. *Ekonomicheskii zhurnal Vysshei shkoly ekonomiki = The HSE Economic Journal*. 2015;19(4):609–639. (In Russ.).

27. Kalman R. A new approach to linear filtering and prediction problems. *Transactions of the AMSE. Journal of Basic Engineering*. 1960;82(1):35–45. DOI: 10.1115/1.3662552

28. Dempster A.P., Larid N.M., Rubin D.B. Maximum likelihood estimation from incomplete data via the EM algorithm. *Journal of the Royal Statistical Society. Series B (Methodological)*. 1977;39(1):1–22. DOI: 10.1111/j.2517–6161.1977.tb01600.x

29. Lapshin V., Sohatskaya S. Choosing the weighting coefficients for estimating the term structure from sovereign bonds. *International Review of Economics & Finance*. 2020;70:635–648. DOI: 10.1016/j.iref.2020.08.011

30. Kurbangaleev M., Lapshin V., Shepeleva I. Consistency of Russian sovereign bond prices. *Upravlencheskii uchet i finansy = Management Accounting and Finance Journal*. 2016;(1):40–51. (In Russ.).

31. Falkenstein E., Hanweck J. Minimizing basis risk from non-parallel shifts in the yield curve. Part II: Principal components. *The Journal of Fixed Income*. 1997;7(1):85–90. DOI: 10.3905/jfi.1997.408199

ABOUT THE AUTHORS

Mikhail S. Makushkin — postgraduate student, Department of Financial Market Infrastructure, National Research University Higher School of Economics, Moscow, Russia
https://orcid.org/0000-0002-3491-1561
Corresponding author:
mikhailmakushkin@gmail.com

Victor A. Lapshin — Cand. Sci. (Phys.-Math.), Assoc. Prof., Financial Engineering and Risk Management Laboratory, School of Finance, National Research University Higher School of Economics, Moscow, Russia
https://orcid.org/0000-0002-9396-4161
vlapshin@hse.ru

Effect of Underwriter's Reputation on Performance of Small Business IPOs

P. Siwach[a], P.R. Kumar[b], V. Gupta[c]
[a] National Institute of Food Technology Entrepreneurship and Management, Kundli, India;
[a] Amity University, Punjab, India; [b] National Institute of Food Technology Entrepreneurship and Management, Kundli, India; [b] University of Hyderabad, Hyderabad, India; [c] O.P. Jindal Global University, Sonipat, India

ABSTRACT

The purpose of the study is to determine the impact of the underwriter's reputation on shaping the short- and long-term IPO success of small businesses. The paper uses IPO data from 2012 to 2020, three reputable proxy and event-time **methodologies** to analyze the company's performance through market-adjusted excess returns, cumulative abnormal returns and buy & hold returns. Similarly, to mitigate common predispositions, use the calendar-time methodology, Fama-French three-factor model and Carhart four-factor model with high and low reputational groups. The study revealed a significant positive impact of underwriters' reputations on first-day returns and long-term performance. Overall, the results indicate that, in the long-term, IPOs of Indian small and medium-sized enterprises are over efficient with regard to reputation signals. On the contrary, the calendar-time method and multifactor model indicate the low long-term IPO effectiveness of the SME. According to the authors' **conclusion**, this is the first study to assess the impact of underwriter reputation on business performance using several reputation indicators, the calendar time methodology, and the multi-factor model on the ICP's Indian IPO platform.
Keywords: SMEs; underwriter reputation; calendar time portfolio; underpricing; emerging market

INTRODUCTION

Small business ventures are the backbone of any nation, as they contribute directly to the economy by providing employment, production and trade that further improve the people's standard of living and provide resources to the governments to run smoothly. Small business ventures continuously look for high-stake capital infusions to achieve their growth targets and expand their businesses. Therefore, the consistent fund requirement for small business ventures results in the establishment of alternative stock exchanges worldwide. On the contrary, these small ventures also suffer an identity crisis in the capital market. They face a lack of investor attention due to information asymmetry and high market uncertainty. Thus, underwriters contribute significantly by handling IPOs, signaling IPO quality, mitigating information asymmetry, and promoting IPOs to assure better performance.

In emerging economies, the capital market for small-medium enterprises (SMEs) suffers heavily due to a lack of investor attention, larger lot sizes, high volatility, ex-ante uncertainty and relaxed disclosure for SME IPOs. It further causes information asymmetry for investors and issuers. Small businesses thus leverage the underwriter's reputation to communicate the quality of the IPO to stakeholders. While literature on underwriter reputation has received wide academic attention, much less is known in contrast with the performance of SME IPOs in emerging markets. In international literature, researchers used event studies to capture IPO performance. However, using event time methodology (ETM) brings along new listing bias, resampling bias, skewness bias and potential issue of cross-sectional dependency of the returns during performance assessment. Hence, previous studies used the calendar-time portfolio approach to mitigate these biases and have robust results [1, 2].

In India A. Bhattacharya [3] examined the IPO performance of 106 SME IPOs from 2012 to 2015 and found that well-timed IPOs and underwriter reputation affect long-term success. However, study employed BSE small caps to determine the

UDP of the sample IPOs. N. Arora and B. Singh [4] covered this gap by using BSE SME IPOs as benchmark proxy and found long-term IPO overperformance using cumulative abnormal returns (CAR) and buy & hold abnormal returns (BHAR). They recommended utilising the calendar-time portfolio methodology to calculate long-term performance in future research. Thus, the study contributes to the literature by using calendar-time portfolio and multifactor models to examine the long-term performance of SME IPOs. Similarly, we calculated MAER, CAR, and BHAR from 2012 to 2020. We are using MAER and one-year BHAR to measure short-and long-run performance. Additionally, we are using multiple reputational proxies, such as registered capital (RPP1), market share based on IPO managed (RPP2) and market share based on capital raised (RPP3) to test the impact on long-run performance.

THE INSTITUTIONAL ENVIRONMENT OF THE INDIAN SME IPO PLATFORM

The Indian platforms provided a capital infusion to small businesses from the primary market. Multiple listing conditions and differences of these platforms are presented in *Table 1*.

DATA COLLECTION AND RESEARCH FRAMEWORK
Model Description

The study sample involves 383 IPOs listed on the BSE SME and NSE Emerge platforms from 2012 to 2020. The data has been collected based on variables used in hypothesis formation. The data was collected from the Indian SME exchange, Ace Equity, and prospectuses.

Table 2 provides an overview of IPOs from 2012 to 2020 for their initial return (IR) and market-adjusted excess return (MAER). The IR is computed as the percentage difference between the initial day offer and the close price. Similarly, the MAER is calculated by the difference between the offer price and the closing price of the first day in percentage and then adjusted with the market return of the benchmark of the same day. The market benchmark for BSE and NSE started from 2013 and 2017, respectively.

Measuring IPOs performance
Event Time Method

The study uses ETM for evaluating the IPO's performance and computes post-issuance 1 to 36 months BHARs with the exclusion of IR. Following J.R. Ritter [5], month includes 21 consecutive trading days, with month-1 encompassing trading days 2–22, month-2 encompassing trading days 23–43, and so on. Therefore, the event year consists of 252 trading days and $BHAR_{i,t}$ for IPO i is described as:

$$BHAR_{i,t} = \left[\prod_{t=1}^{T}\left(1+R_{i,t}\right)-1\right]-\left[\prod_{t=1}^{T}\left(1+R_{m,t}\right)-1\right]. \quad (1)$$

In equation (1), $R_{i,t}$ indicates daily returns of the stock i and $R_{m,t}$ denotes the market return of the benchmark for time t, respectively. Similarly, the average $\overline{\left(BHAR_t\right)}$ of the portfolio is as follows:

$$\overline{BHAR_t} = \frac{1}{N_t}\sum_{i=1}^{N_t}BHAR_{i,t}. \quad (2)$$

The long-run returns can have a high potential for suffering from skewness bias. Therefore, to control this bias, J.D. Lyon et al. [6] suggested using bootstrapped skewness-adjusted test statistics, which can be computed as follows:

$$t\overline{\left(BHAR_t\right)} = \sqrt{N_t}\left(S+\frac{1}{3}\hat{\gamma}S^2+\frac{1}{6N_t}\hat{\gamma}\right), \quad (3)$$

$$\text{where } S = \frac{BHAR_{i,t}}{\sigma\left(BHAR\right)} \quad (4)$$

$$\text{and } \hat{\gamma} = \frac{\sum_{i=1}^{N_t}\left(BHAR_{i,t}-\overline{BHAR_t}\right)^3}{N_t\sigma\left(BHAR_t\right)^3}, \quad (5)$$

where $\hat{\gamma}$ denotes the coefficient of skewness, N_t is the number of IPOs and $\sigma\left(BHAR\right)$ denotes the cross-section variation of yields in the sample [4].

THE CALENDAR TIME METHODOLOGY

We calculated the average abnormal monthly return for a diversified portfolio and further employed the E.F. Fama and K.R. French [7] three-factor and M.M. Carhart [8] four-factor models for evaluating the long-term returns and their time-series significance.

Table 1

Regulatory Framework of Indian SME IPO Platform

Particulars	BSE SME	NSE Emerge	Main Board
Face Value (aftermarket paid-up capital)	Less than INR 250 million.	Less than INR 250 mil	More than INR 100 mil.
Underwriting	Should be underwritten 100%, with a minimum of 15% of IPO on the books of underwriters	Should be underwritten 100%, with a minimum of 15% of IPO on the books of underwriters	Mandatory (an exception to a condition where QIBs have been offered more than 50% of IPO)
IPO Gradation	Not required	Not required	Required
Size of issue	No restriction	No restriction	No restriction
Market making	Required	Required	Not required
DRHP scrutiny	Exchange	Exchange	Security Exchange Board of India
Reporting	6 monthly	6 monthly	Quarterly
Track record	3 years	3 years	Avg. operating profit of INR 150 mil. (pre-tax) each for any 3 years out of 5 years

Source: Indian SME Exchange.

Table 2

IPOs Distribution by Listing Year and Market-Adjusted Returns

Year	S&P BSE SME IPO			NSE SME Emerge			Full market		
	N	IR, %	MAER, %	N	IR, %	MAER, %	N	IR, %	MAER, %
2012	1	2.8	0.00*	0	0.00*	0.00*	1	2.80	0.00*
2013	19	21.63	23.68	3	−0.12	8.91*	22	10.76	23.68
2014	17	11.45	13.09	2	−10.17	5.47*	19	0.64	13.09
2015	36	5.5	4.87	2	2.17	3.26*	38	3.84	4.87
2016	40	5.95	5.15	8	6.61	4.13*	48	6.28	5.15
2017	43	4.18	4.71	37	8.23	9.29	80	6.21	7.00
2018	62	3.63	3.47	92	7.33	7.5	154	5.48	5.49
2019	53	4.23	3.39	53	5.12	4.43	106	4.68	3.91
2020	19	16.53	16.3	6	2.39	2.34	25	9.46	9.32
Full sample	290	8.43	9.33	203	2.70	5.67	493**	5.57	9.06

Source: Compiled by the author.

Note: * Indicates absence of SME benchmark index. Thus, for 15 firms the index return of BSE SME IPO is undertaken; ** Out of 493 IPOs, 110 issuing firms had either shifted to the mainboard or delisted.

$$R_{p,t} - R_{f,t} = \alpha_i + \beta_i\left(R_{m,t} - R_{f,t}\right) + s_i SMB_t + h_i HML_t + \varepsilon_{i,t} \quad (6)$$

In equation (6), $R_{p,t}$ denotes monthly portfolio gains and $R_{f,t}$ indicates a risk-free rate for the month t, respectively. Similarly, $R_{m,t}$ is the market return of index and $\left(R_{m,t} - R_{f,t}\right)$ signifies the market risk premium. Therefore, the multifactor model includes: $s_i SMB_t$, which is the return difference of large and small-size portfolios, $h_i HML_t$ denotes the difference in monthly portfolio returns concerning high and low B/M (book to market) portfolios.

$$R_{p,t} - R_{f,t} = \alpha_i + \beta_i\left(R_{m,t} - R_{f,t}\right) + \\ + s_i SMB_t + h_i HML_t + m_i MOM_t + \varepsilon_{i,t}. \quad (7)$$

In equation (7), $m_i MOM_t$ denotes the momentum factor, where momentum signifies difference in portfolio returns of winner and loser stocks. Similarly, α is the intercept to captures long-run performance. Thus, after controlling for $\left(R_{m,t} - R_{f,t}\right)$, $s_i SMB_t$, $h_i HML_t$ and $m_i MOM_t$, if α_i is different from zero, it indicates abnormal returns. Similarly, a positive and negative α_i can be interpreted as overperformance and underperformance in long-run.

Measuring Underwriter Reputation

The study uses three underwriter proxies to capture the different aspects of an underwriter's reputation. Following R. Michaely and W.H. Shaw [9], the study presumes that the scale of an investment bank can be associated with its reputation. Therefore, we use registered capital of the underwriters as RPP1. All 56 underwriters that managed at least one IPO were ranked into eight groups based on their registered capital. The underwriter with the highest registered capital is given a rank of 1, while the underwriter with the least registered capital is given a rank of 8. The RPP2 is based on the assumptions of C. Su and K. Bangassa [2]. They presume that underwriters who handle more IPOs are well-known in the market and have a better reputation. Thus, we assign one point for each IPO undertaken, and if multiple underwriters are involved, one point is distributed in equal proportion. Further, ranks are assigned from 1 to 8 based on issue counts, where rank 8 is given to underwriters with higher issue counts and rank 1 is given to underwriters with lesser IPO counts. Following W.L. Megginson and K.A. Weiss [10], we believe that higher capital raised by underwriters will result in a better market reputation. Thus, in RPP3, we use the ratio of each underwriter's gross proceeds to total gross proceeds.

Model Framework

We established MAER and 12-month BHAR as the dependent variables, whereas RPP1, RPP2, and RPP3 are used as independent variables with 8 control variables.

Issue size (SIZE$_i$). We computed the issue size based on the market offering of the IPOs. Prior literature shows a higher degree of ex-ante uncertainty for small-size IPOs compared to big-size issues due to the higher opacity of information [5, 11]. Therefore, we expect a positive association between an issue's size and the IPO's performance in the long term.

Initial returns (IR): Initial returns are unadjusted first-day raw returns of the IPOs. Prior literature stated the need to separate the first-day benchmark adjusted excess return and long-term performance from the initial returns, according to S. Song *et al*. [13]. S. Dhamija and R.K. Arora [14] find a positive association between IR and UDP and vice versa. Thus, we are assuming a positive association between IR and IPO performance in the long-run.

Firm Size (SIZE$_f$): Small firms publish little operating history, have low sales, high volatility, and low reputational underwriters, which creates higher information asymmetry and speculation and causes long-run underperformance [3, 5, 15]. So, we presume a positive association between firm size and IPO performance.

Total Subscription (T_SUB): The total subscription is computed as the subscription rate of the IPO by the investors. According to fad theory, over-optimism may also cause investor overreaction and speculation that can lead to lower long-run performance [4, 16]. Thus, the study assumes a negative relationship among

total subscriptions and IPO performance in the long term.

Earnings per share (EPS): F. Allen and G.R. Faulhaber [17], through signaling theory, state that good quality companies differentiate themselves from bad quality firms through underpricing the IPO. Hence, the study includes EPS to measure firm quality, operating performance and expects a positive relationship with long-run performance.

Debt ratio (DA): The debt ratio indicates the issuing company's leverage and the firm's overall financial risk [12]. Therefore, a higher ratio causes a higher risk, resulting in long-run underperformance and vice versa. We expect a negative association between debt ratio and IPO performance.

EBITDA to asset ratio (EBITDA$_A$): The EBITDA to asset ratio is the profitability measure of the firm. This ratio includes the overall income of the firm in place of operating income, thus providing a clearer picture of the earnings [12]. The higher EBITDA$_A$ ratio indicates a firm's better profitability position, thus resulting in better long-run performance. Therefore, we assume a positive relationship between the EBITDA$_A$ ratio to long-run performance.

Market Condition (MKTCD): Following N. Arora and B. Singh [4] and P. Jaskiewicz et al. [18], we explained the hot market by creating a dummy variable. The managers take advantage of favourable market conditions and try to time their IPOs accordingly, creating investor overvaluation that further leads to higher first-day returns but lower returns in the long term. Therefore, we expect a negative association between the hot market and IPO performance.

Table 3 presents descriptive statistics and a correlation matrix for selected variables. Similarly, analysing the cross-sectional association of MAERs and one-year BHARs with the selected variables is described in the following equation:

$$MAER = \alpha + \beta_1 \left[all\ reputational\ proxies \right] + \beta_2 SIZE_i +$$
$$+ \beta_3 IR + \beta_4 SIZE_f + \beta_5 TSUB + \beta_6 DA + \beta_7 EBITDA_A + \quad (8)$$
$$+ \beta_8 EPS + \beta_9 MKT + \varepsilon,$$

$$BHAR_{12m} = \alpha + \beta_1 \left[all\ reputational\ proxies \right] + \beta_2 SIZE_i +$$
$$+ \beta_3 IR + \beta_4 SIZE_f + \beta_5 TSUB + \beta_6 DA + \beta_7 EBITDA_A + \quad (9)$$
$$+ \beta_8 EPS + \beta_9 MKT + \varepsilon.$$

Hypothesis 1:
H$_1$: The reputation of underwriters has a positive impact on MAERs of the Indian SME IPOs.
Hypothesis 2:
H$_1$: The reputation of underwriters has a positive impact on one-year BHARs of the Indian SME IPOs.

DATA INTERPRETATION AND DISCUSSIONS
Analyzing Long-Run Performance Using Event Time Methodology

The ETM uses CARs and BHARs to evaluate the IPO's performance in the long term. *Table 4* presents the values of CAR and BHAR for event time t in columns 3 and 5, respectively, from 1 to 36 months. Although a negative value indicates IPO underperformance, a slight improvement can be seen from the 1st month to the 24th month. Similarly, MAERs shows −0.25% return for first month, which further increases by 61.37%, to 209% from 3 to 36 months.

In *Table* 5, we classify MAERs and 12m BHARs with respect to RPP1, RPP2, RPP3 and divide them into groups of high and low reputations. Panel A exhibits that low-reputation underwriters had a more significant rate of UDP than reputed underwriters. The result can be explained by a lack of quality signals among less reputed underwriters and concern for lower subscription levels [19]. Additionally, the average one-year BHARs are comparatively higher for less reputed underwriters. A similar trend is exhibited in panel B, where high and low reputational measure is based on issues managed by underwriters. Hence, underwriters managing more than 4% of the IPOs are categorized as having a high reputation and lower reputation otherwise. In panel C, underwriters with more than 7% of total proceeds indicate a strong reputation. The MAERs for RPP3 is 6%, identical to the mean of whole sample, and the same is reflected in case of one-year BHARs.

Table 3

Correlation Matrix and Descriptive Statistics

	RPP1	RPP2	RPP3	$SIZE_i$	IR	$SIZE_f$	T_SUB	DA	$EBITDA_A$	EPS	MKTCD
Panel A: Descriptive statistics											
N	383	383	383	383	383	383	383	383	383	383	383
Mean	4.5	3.32	7.43	12.18	−0.072	42.73	9.76	0.25	0.07	43.03	0.67
Min.	1	0	0.04	1.17	−28.5	0.6	0.07	0	−4.23	−530.56	0
Max.	8	7	19.8	92.74	30.28	696.13	263.09	2.97	4.42	7779.54	1
Std. Dev.	2.09	1.85	6.51	11.86	5.82	75.57	29.69	0.25	0.34	417.6	0.47
Panel B: Correlation matrix											
RPP1	1										
RPP2	0.151***	1									
RPP3	0.220***	.218***	1								
$SIZE_i$	−0.008	.142***	0.094	1							
IR	−0.004	−0.061	0.009	−0.007	1						
$SIZE_f$	−0.173***	0.054	0.010	.354***	0.010	1					
T_SUB	0.127**	−0.047	0.004	0.025	−0.093	−0.065	1				
DA	0.008	−0.032	.128**	0.010	−0.079	−0.041	0.023	1			
EBITDA_A	0.105**	−0.004	−0.038	0.061	0.048	0.071	−0.003	−.384***	1		
EPS	−0.020	0.023	.124**	−0.025	−0.016	−0.029	0.012	−0.070	0.015	1	
MKTCD	0.099	0.093	0.083	.216***	−0.036	−.102**	.193***	−0.025	.135***	0.040	1

Source: Compiled by the authors.
Note: *10% significant level, **5% significant level, ***1% significant level.

The Post-Issue CARs and BHARs for the Event Months

Event time (t)	N_t	CAR_t	t (CAR_t)	$BHAR_t$	t ($BHAR_t$)
1 month	383	−0.0731	1.794	−0.0025	17.169***
3 months	383	−0.0571	2.526***	0.6137	8.691***
6 months	324	−0.0424	3.214***	0.9503	7.761***
9 months	281	−0.0358	1.734	1.2571	4.922***
12 months	240	−0.0342	3.091***	1.3787	5.203***
15 months	191	−0.0305	2.739***	1.6467	5.545***
24 months	107	−0.0295	4.297***	1.9002	1.611
36 months	29	−0.0436	3.005***	2.0951	5.002***

Source: Compiled by the authors.

Note: * 10% significant level, ** 5% significant level, *** 1% significant level.

The Measure of Reputational Estimates to Market-Adjusted Excess Return and One-Year BHARs

Reputational Proxies	Benchmark adjusted returns							
	MAER				12-months BHARs			
	N	$\bar{X}$	Median	σ	N	$\bar{X}$	Median	σ
Panel A: Reputational estimate of RPP1								
High (RPP1 > 60 mil INR)	219	5.222	3.120	10.950	146	1.301	1.151	1.280
Low (RPP1 < 60 mil INR)	164	7.091	1.620	23.790	94	1.500	1.360	1.118
Panel B: a reputational estimate of RPP2								
High (RPP2 > 4%)	266	5.949	3.355	12.349	166	1.315	1.166	1.281
Low (RPP2 < 4%)	117	6.190	1.100	25.958	74	1.522	1.522	1.068
Panel C: a reputational estimate of RPP3								
High (RPP3 > 7%)	183	6.052	3.740	9.769	129	1.426	1.356	1.256
Low (RPP3 < 7%)	200	5.996	1.650	22.576	111	1.324	1.224	1.180
Full Sample	383	6.023	2.200	17.657	240	1.379	1.238	1.223

Source: Compiled by the authors.

Results of Cross-Sectional Regression

Table 6 exhibits the results of multivariate cross-sectional OLS regression based on equations 8 and 9. In panel A, the empirical results indicate that RPP1 and RPP3 statistically impact MAER. However, RPP2 is found to be inconsequential in row 2. The results are coherent when we are regressing the same reputational proxy for the entire dataset in row 4. The results are consistent with those of N. Arora and B. Singh [20] and J. Gao et al. [21]. The argument behind the positive relationship can be the behaviour of reputed underwriters to manage the IPOs of low-risk firms to avoid negative listing and lack

Table 6

The Outcome of Cross-Sectional OLS Regression

	Intercept	RPP1	RPP2	RPP3	$SIZE_i$	IR	$SIZE_f$	T_SUB	DA	$EBITDA_A$	EPS	MKT	Adj. R^2
Panel A: MAERs used as a dependent variable for Indian SME IPOs													
(1)	0.945	0.148			−0.165	0.654	0.217	0.464	0.169	−0.050	0.178	0.037	0.614
		(1.98)**			(2.67)***	(15.05)***	(3.15)***	(10.49)***	(2.56)***	(0.73)	(4.23)***	(0.750)	
(2)	2.010		0.072		−0.159	0.652	0.203	0.473	0.168	−0.041	0.176	0.032	0.609
			(0.94)		(2.55)***	(14.92)***	(2.92)***	(10.74)***	(2.53)***	(0.61)	(4.14)***	(0.65)	
(3)	0.973			0.176	−0.159	0.636	0.187	0.487	0.146	−0.053	0.151	0.512	0.629
				(3.26)***	(2.63)***	(14.83)***	(2.79)***	(11.29)***	(2.25)***	(0.81)	(3.58)***	(0.61)	
(4)	2.937	0.358	0.160	0.240	−0.080	0.735	0.02	0.106	3.340	−1.005	0.147	0.452	0.641
		(2.61)***	(0.97)	(4.11)***	(2.92)***	(14.96)***	(3.21)***	(11.09)***	(2.21)***	(1.02)	(3.55)***	(0.68)	
Panel B: 12 months Buy & Hold Abnormal Return used as a dependent variable for the sample of Indian SME IPOs													
(5)	2.442	0.186			−0.291	0.182	−0.005	−0.223	0.372	0.238	0.043	−0.154	0.332
		(2.94)***			(3.28)***	(2.98)***	(−0.05)	(3.62)***	(4.22)***	(2.48)***	(0.745)	(1.96)***	
(6)	2.955		0.246		−0.314	0.141	0.058	−0.261	0.358	0.239	0.066	−0.162	0.352
			(3.78)***		(3.59)***	(2.34)***	(0.654)	(4.31)***	(4.12)***	(2.54)***	(1.14)	(2.09)***	
(7)	2.128			0.092	−0.308	0.173	0.045	−0.235	0.377	0.217	0.043	−0.134	0.306
				(1.24)	(3.40)***	(2.78)***	(0.49)	(3.75)***	(4.19)***	(2.22)***	(0.71)	(1.16)	
(8)	3.475	0.08	0.29	0.14	−0.31	0.149	0.01	−0.241	0.33	0.247	0.15	−0.16	0.389
		(2.27)***	(4.33)***	(1.81)	(3.63)***	(2.53)***	−0.14	(4.08)***	(3.96)***	(2.70)***	(3.55)***	(−2.07)...	

Source: Compiled by the authors.

Note: *10% significant level, **5% significant level, ***1% significant level.

of subscription by the investors. Furthermore, the higher investor demand can be reflected in the elevated closing price as well as higher UDP levels [22]. Similarly, the reputed underwriters used UDP to avoid insolvency risk and signal IPO quality [23].

Panel B of *Table* 7 exhibits the regression results of reputational proxies on one-year BHARs, where the individual regression outcome of reputational measures is shown in rows (5), (6), (7), the whole sample is shown in row (8). The result shows a significant positive impact of RPP1 and RPP2 on one-year BHARs. Similarly, RPP3 shows a positive but insignificant impact on long-run performance. The results align with the studies of H. Anderson

et al. [24], N. Arora and B. Singh [25], S. Dhamija and R.K. Arora [26] and C. Su and K. Bangassa [2]. It indicates that the underwriters use their expertise to undertake quality IPOs and avoid riskier issues.

The positive IPO performance can also be attributed to reduced information heterogeneity among investors due to efficient IPO estimation and signalling the accurate market value of the firm by the underwriters [25]. Conclusively, the regression results accept hypothesis 1 (H_1) that the underwriter's reputation positively impacts the MAERs of the Indian SME IPOs. Furthermore, the results also accept hypothesis 2 (H_1) that the underwriter's reputation positively impacts the one-year BHARs of the Indian SME IPOs.

Regression Results Using the Calendar-Time Approach

	Full Sample	RPP1		RPP2		RPP3	
		High	Low	High	Low	High	Low
Panel A: Results of the Fama–French three–factor Model							
Intercept	−0.115	−0.114	−0.116	−0.113	−0.118	−0.088	−0.115
t−stat	(54.74) ***	(43.01) ***	(34.06) ***	(44.06) ***	(33.11) ***	(35.50) ***	(36.83) ***
Rm−Rf	0.135	0.140	0.129	10.268	0.158	0.130	7.837
t−stat	(13.05) ***	(10.32) ***	(8.05) ***	(0.13)	(8.31) ***	(9.95) ***	(0.14)
SMB	0.138	0.136	0.142	11.797	0.126	0.069	11.202
t−stat	(13.57) ***	(10.17) ***	(8.99) ***	(0.31)	(6.72) ***	(5.35) ***	(0.11)
HML	−0.030	−0.019	−0.045	−2.171	−0.046	0.051	−3.055
t−stat	(3.17) ***	(1.54)	(3.04) ***	(0.03)	(2.58) ***	(4.15) ***	(0.02)
Adj.R^2	0.050	0.052	0.047	0.049	0.052	0.037	0.052
Panel B: Results of Carhart four–factor Model							
Intercept	−0.114	−0.113	−0.115	−0.112	−0.117	−0.087	−0.113
t−stat	(53.95) ***	(42.27) ***	(33.67) ***	(43.40) ***	(32.66) ***	(35.27) ***	(36.24) ***
Rm−Rf	0.154	0.163	0.143	0.146	0.176	0.155	0.133
t−stat	(14.21) ***	(11.45) ***	(8.53) ***	(11.29) ***	(8.84) ***	(11.22) ***	(8.59) ***
SMB	0.160	0.162	0.157	0.165	0.146	0.091	0.184
t−stat	(14.76) ***	(11.39) ***	(9.42) ***	(12.80) ***	(7.35) ***	(6.75) ***	(11.80) ***
HML	0.005	0.023	−0.019	0.012	−0.011	0.093	−0.009
t−stat	(0.48)	(1.57)	(1.05)	(0.86)	(0.53)	(6.48) ***	(0.55)
MOM	0.078	0.093	0.058	0.079	0.074	0.092	0.071
t−stat	(5.81) ***	(5.27) ***	(2.81) ***	(4.97) ***	(3.01) ***	(5.56) ***	(3.71) ***
Adj.R^2	0.053	0.056	0.048	0.052	0.055	0.041	0.054

Source: Compiled by the authors.

Note: *10% significant level, **5% significant level, ***1% significant level.

Estimating the IPO Performance in the Long-Term Using Calendar-Time Methodology

We are using the calendar-time portfolio to overcome the biases that emerge from event-time returns. Therefore, a diverse portfolio is being created for every calendar month from 2012 to 2020. However, companies that issued IPOs in the last 36 months are included in the final portfolio. And tested with FF3 and CF4 models. Concerning to calendar-time portfolio, our null hypothesis assumes that the mean monthly abnormal returns are equal to zero. Therefore, a subsequent multifactor regression intercept is employed to test our null hypothesis. Panels A and B of *Table* 7 show the calendar time regression results using the FF3 model and CF4 model, respectively.

Consequently, RPP1, RPP2, RPP3 are categorized into high and low reputational groups. The result shows an abnormally significant long-term IPO performance. Although the positive abnormal returns using ETM imply overperformance, the negative intercept from *Table* 7 indicates the long-run underperformance of the firms. A similar trend of significant negative intercept can be observed in underwriters' reputational measures that are further categorized into high and low reputational groups. The results indicates that the intercept significantly differs from zero in panels A and B.

The result shows the significant abnormal performance of the IPOs in the long-run. However, the exhibited long-run overperformance based on ETM is converted into underperformance while using the multifactor model. The negative intercept indicate that Indian SME IPOs are performing similarly to international evidence [2, 27, 28].

The model suggests a strong impact of the underwriter's reputation on the long-run performance of the firms. However, the small

Table 8

Endogeneity Testing Using Two-Stage Least Square Regression

Dependent	Intercept	Instrument	$\widehat{RPP}1$	$SIZE_i$	IR	$SIZE_f$	T_SUB	DA	$EBITDA_A$	EPS	MKT	R^2
First–stage regression:												
RPP1	11.177	1.746		−0.165	0.019	−0.008	0.014	0.112	0.313	0.011	0.644	0.507
		(4.81)***		(1.09)	(0.47)	(2.57)***	(2.09)**	(0.13)	−0.73	0.33	1.03	
Second–stage regression:												
MAER	14.459		−0.351	−0.914	−0.318	0.002	0.104	−1.857	5.761	0.002	−2.92	0.151
			(0.56)	(3.28)***	(2.98)***	0.15	(3.44)***	(0.48)	(1.96)***	0.69	(1.41)	
$BHAR_{12m}$			0.073	0.073	0.067	0.058	0.061	0.474	0.175	0.066	−0.381	0.605
			(2.97)***	1.24	0.41	0.31	(2.81)***	1.49	(2.54)***	0.32	(2.90)***	

Source: Compiled by the authors.

Note: * with parenthesis denotes white heteroscedastic-consistent t-stat, * 10% significant level, ** 5% significant level, *** 1% significant level.

adjusted R^2 indicates the minimal data variance explained by the model. Therefore, the fluctuations in performance using multifactor models and ETM support the arguments of P.A. Gompers and J. Lerner [29] and J.R. Ritter and I. Welch [30] that these deviations can be observed due to the sample selection criteria, time selection and methodology adopted to evaluate the IPO performance in the long run. We can infer that if investors are using ETM to assess returns, they will expect abnormal returns in long-term. However, in the case of a calendar-time portfolio, investors cannot expect similar abnormal returns in the long term.

Robustness Test

Multiple studies have suggested that the reputation of an underwriter can be an endogenous variable and therefore needs to be checked against the problem of endogeneity [2, 25, 31, 32]. Thus, we are using a two-stage least squares regression (2SLS) to check the robustness of our cross-sectional OLS regression and validate the results. Hence, we are constructing a new instrument variable based on the geographic difference between the issuer firm and the underwriting firm. We presume that due to the lower information cost, the underwriters with the shortest distance to the issuing firm have a higher probability of getting the opportunity to handle an IPO.

We used the address information of all the underwriters and issuing firms to create the instrument variable and confirmed the distance using Google Maps of India. In the case of an IPO underwritten by two or more underwriters, we use the distance of the leading underwriter to the issuing firm. At the first stage of the 2SLS model, we regress the instrument variable with the RPP1 using the same control variable that we used in the *Table 6* using the following equation:

$$RPP1 = \alpha + \beta_1[INSTRUMENT] + \beta_2 SIZE_i + \\ + \beta_3 IR + \beta_4 SIZE_f + \beta_5 TSUB + \beta_6 DA + \\ + \beta_7 EBITDA_A + \beta_8 EPS + \beta_9 MKT + \varepsilon. \quad (10)$$

In the second stage of the 2SLS model, we generated the variable $\widehat{RPP}1$ from the regression coefficient of the first stage. Furthermore, we are using the predicted value of $\widehat{RPP}1$ instead of the value of reputational proxies used in sections (1) and (5) in *Table 6*.

$$MAER/BHAR = \\ \alpha + \beta_1 \widehat{RPP}1 + \beta_2 SIZE_i + \beta_3 IR + \beta_4 SIZE_f + \\ + \beta_5 TSUB + \beta_6 DA + \beta_7 EBITDA_A + \\ + \beta_8 EPS + \beta_9 MKT + \varepsilon. \quad (11)$$

Table 8 presents the two-stage least square regression to check for endogeneity issues

and avoid issues with biased estimators in our regression results. The first stage regression of our instrument variable shows a significantly positive impact on UDP. The higher value of Wald f-statistics from its critical values shows the strength of instrument variable to explain the endogenous variable. Similarly, the explanatory power of these variables can be reflected through the McFadden R^2 of 50.70. The result supports positive impact of underwriter reputation on the IPO performance in long-run. This also suggests that Indian underwriters benefit the issuing firms and investors by providing better long-run performance.

<h2 style="text-align:center">CONCLUSION</h2>

Most studies on Indian SME IPO platforms majorly used ETM with a single reputational measure (market share) to draw conclusions [4, 25, 33, 34]. Since the reputation of an underwriter can be based upon various indicators, we have taken three different reputational proxies to test the impact of the underwriter's reputation on the first day and long-run performance of the firms. The results suggest that due to the lack of investor attention and higher cost of investor entry, the reputed underwriters play a substantial role in signalling IPO quality and shaping better long-run performance.

Furthermore, the calendar time regression exhibits a statistically significant negative intercept that indicates a long-run underperformance of SME IPOs. However, the lower coefficient value of intercept and adjusted R^2 of the multifactor model shows an inadequate power to explain the impact of underwriter reputation on long-run performance. These conflicting results are aligned with the previous studies of P.A. Gompers and J. Lerner [29], J.R. Ritter and I. Welch [30] and C. Su and K. Bangassa [2] that the evaluation of long-term IPO performance immensely hinges on the selection criteria, sample period selection and methodology adopted by the investors. Similarly, in the absence of a standardized long-run performance measure, the previous literature also directs inconsistent results and differs based on firms and regulatory environments. Thus, we conclude that the argument that an underwriter's reputation has a significant positive impact on MAER's long-run performance holds true. Since there is no single accepted method to measure long-run performance, future studies may explore this considerable gap to come up with unique long-run measures to evaluate the firm's performance.

<h2 style="text-align:center">REFERENCES</h2>

1. Barber B.M., Lyon J.D. Detecting long run abnormal performance. *Journal of Financial Economics*. 1997;43(3):341–372. DOI: 10.1016/S 0304–405X(96)00890–2
2. Su C., Bangassa K. The impact of underwriter reputation on initial returns and long-run performance of Chinese IPOs. *Journal of International Financial Markets, Institutions and Money*. 2011;21(5):760–791. DOI: 10.1016/j.intfin.2011.06.002
3. Bhattacharya A. Innovations in new venture financing: Evidence from Indian SME IPOs. *Global Finance Journal*. 2017;34:72–88. DOI: 10.1016/j.gfj.2017.02.001
4. Arora N., Singh B. The long-run performance of SME IPOs in India: Empirical evidence from Indian stock market. *Journal of Asia Business Studies*. 2020;15(1):88–109. DOI: 10.1108/JABS-10–2019–0305
5. Ritter J.R. The long-run performance of initial public offerings. *The Journal of Finance*. 1991;46(1):3–27. DOI: 10.1111/j.15406261.1991.tb03743.x
6. Lyon J.D., Barber B.M., Tsai C.-L. Improved methods for tests of long-run abnormal stock returns. *The Journal of Finance*. 1999;54(1):165–201. DOI: 10.1111/0022–1082.00101
7. Fama E.F., French K.R. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*. 1993;33(1):3–56. DOI: 10.1016/0304–405X(93)90023–5

8. Carhart M.M. On persistence in mutual fund performance. *The Journal of Finance*. 1997;52(1):57–82. DOI: 10.1111/j.1540–6261.1997.tb03808.x

9. Michaely R., Shaw W.H. The pricing of initial public offerings: Tests of adverse-selection and signaling theories. *The Review of Financial Studies*. 1994;7(2):279–319. DOI: 10.1093/rfs/7.2.279

10. Megginson W.L., Weiss K.A. Venture capitalist certification in initial public offerings. *The Journal of Finance*. 1991;46(3):879–903. DOI: 10.1111/j.1540–6261.1991.tb03770.x

11. Beatty R.P., Ritter J.R. Investment banking, reputation, and the underpricing of initial public offerings. *Journal of Financial Economics*. 1986;15(1–2):213–232. DOI: 10.1016/0304–405X(86)90055–3

12. Wadhwa K., Neupane S., Syamala S.R. Do group-affiliated firms time their equity offerings? *Pacific-Basin Finance Journal*. 2019;54:73–92. DOI: 10.1016/j.pacfin.2019.02.004

13. Song S., Tan J.S., Yi Y. IPO initial returns in China: Underpricing or overvaluation? *China Journal of Accounting Research*. 2014;7(1):31–49. DOI: 10.1016/j.cjar.2013.12.001

14. Dhamija S., Arora R.K. Initial and after-market performance of SME IPOs in India. *Global Business Review*. 2017;18(6):1536–1551. DOI: 10.1177/0972150917713081

15. Miller E. Long run underperformance of initial public offerings: An explanation. Department of Economics and Finance Working Papers, 1991–2006. 2000;(16). URL: https://scholarworks.uno.edu/cgi/viewcontent.cgi?article=1015&context=econ_wp

16. Aggarwal R., Rivoli P. Fads in the initial public offering market? *Financial Management*. 1990;19(4):45–57. DOI: 10.2307/3665609

17. Allen F., Faulhaber G.R. Signaling by underpricing in the IPO market. *Journal of Financial Economics*. 1989;23(2):303–323. DOI: 10.1016/0304–405X(89)90060–3

18. Jaskiewicz P., González V.M., Menéndez S., Schiereck D. Long-run IPO performance analysis of German and Spanish family-owned businesses. *Family Business Review*. 2005;18(3):179–202. DOI: 10.1111/j.1741–6248.2005.00041.

19. Álvarez-Otero S., López-Iturriaga F.J. Does corporate governance affect the valuation of Spanish IPOs? The role of ownership structure and the board of directors. *Revista Espanola de Financiacion y Contabilidad = Spanish Journal of Finance and Accounting*. 2018;47(2):214–241. DOI: 10.1080/02102412.2018.1429556

20. Arora N., Singh B. Impact of auditor and underwriter reputation on underpricing of SME IPOs in India. *Management and Labour Studies*. 2019;44(2):193–208. DOI: 10.1177/0258042X19829285

21. Gao J., Cong L.M., Evans J. Earnings management, IPO underpricing, and post-issue stock performance of Chinese SMEs. *The Chinese Economy*. 2015;48(5):351–371. DOI: 10.1080/10971475.2015.1067085

22. Sundarasen S.D., Khan A., Rajangam N. Signalling roles of prestigious auditors and underwriters in an emerging IPO market. *Global Business Review*. 2018;19(1):69–84. DOI: 10.1177/0972150917713367

23. Liu X., Ritter J.R. Local underwriter oligopolies and IPO underpricing. *Journal of Financial Economics*. 2011;102(3):579–601. DOI: 10.1016/j.jfineco.2011.01.009

24. Anderson H., Chi J., Wang Q.S. IPO performance on China's Newest Stock Market (ChiNext). *The Chinese Economy*. 2015;48(2):87–113. DOI: 10.1080/10971475.2015.99321524

25. Arora N., Singh B. Do prestigious underwriters shape the performance of SME IPOs in India? *Global Business Review*. 2020. DOI: 10.1177/0972150920963216

26. Dhamija S., Arora R.K. Determinants of long-run performance of initial public offerings: Evidence from India. *Vision*. 2017;21(1):35–45. DOI: 10.1177/0972262916681243

27. Thomadakis S., Nounis C., Gounopoulos D. Long-term performance of Greek IPOs. *European Financial Management*. 2012;18(1):117–141. DOI: 10.1111/j.1468–036X.2010.00546.x

28. Wadhwa K., Neupane S., Syamala S.R. Do group-affiliated firms time their equity offerings? *Pacific-Basin Finance Journal*. 2019;54:73–92. DOI: 10.1016/j.pacfin.2019.02.004

29. Gompers P.A., Lerner J. The really long-run performance of initial public offerings: The pre-Nasdaq evidence. *The Journal of Finance*. 2003;58(4):1355–1392. DOI: 10.1111/1540–6261.00570

30. Ritter J.R., Welch I. A review of IPO activity, pricing, and allocations. *The Journal of Finance*. 2002;57(4):1795–1828. DOI: 10.1111/1540–6261.00478

31. Fernando C.S., Krishnamurthy S., Spindt P.A. Are share price levels informative? Evidence from the ownership, pricing, turnover and performance of IPO firms. *Journal of Financial Markets*. 2004;7(4):377–403. DOI: 10.1016/j.finmar.2004.01.001

32. Habib M.A., Ljungqvist A.P. Underpricing and entrepreneurial wealth losses in IPOs: Theory and evidence. *The Review of Financial Studies*. 2001;14(2):433–458. DOI: 10.1093/rfs/14.2.433

33. Gupta V., Singh S., Yadav S.S. Disaggregated IPO returns, economic uncertainty and the long-run performance of SME IPOs. *International Journal of Emerging Markets*. 2021. DOI: 10.1108/IJOEM-09–2020–1098

34. Dhamija S., Arora R.K. The long-run performance of graded IPOs in the Indian capital market. *Global Business Review*. 2014;15(2):317–337. DOI: 10.1177/0972150914523597

ABOUT THE AUTHORS

Parveen Siwach — Research Scholar, National Institute of Food Technology Entrepreneurship and Management, Kundli, India; PhD, Assist. Prof., Amity University, Punjab, India
https://orcid.org/0000-0002-2770-2251
siwach.parveen23@gmail.com

Prasanth R. Kumar — PhD, National Institute of Food Technology Entrepreneurship and Management, Kundli, India; Assoc. Prof., University of Hyderabad, Hyderabad, India
https://orcid.org/0000-0001-5299-7701
Corresponding author:
prasanth@uohyd.ac.in

Vikas Gupta — PhD, Assist. Prof., O.P. Jindal Global University, Sonipat, India
https://orcid.org/0000-0002-5601-8432
vgupta@jgu.edu.in

Authors' declared contribution:
P. Siwach — Problem statement, literature review, data analysis, interpretation, conclusion, and references.
P.R. Kumar — Idea formation, Proof-reading, results discussion, conclusion, manuscript improvements.
V. Gupta — Proof-reading, results interpretation, literature suggestions, manuscript improvements.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 28.09.2022; revised on 21.10.2022 and accepted for publication on 26.10.2022. The authors read and approved the final version of the manuscript.

Impact of Institutional Environment on Banks' Non-Performing Loans: Evidence from BRICS Countries

S. Goyal[a], N. Singhal[b], J.M. Prosad[c], N. Mishra[d]
[a] Amity Law School, AUUP, Noida, India; [b] IIMT University, Meerut, India;
[c] Fortune Institute of International Business, Delhi, India; [d] Linkoping University, Linkoping, Sweden

ABSTRACT

The drivers of non-performing loans (NPL) and the possible effects of the institutional and business environments on the credit risk exposure of banks in the panel of BRICS countries and segregated models are analyzed in this paper. The **purpose** of the study is to identify the relationship between banking, macroeconomic and institutional factors of non-performing loans of banks at the BRICS level for the period 1996–2020. The panel ARDL approach is used for this purpose. The Panel Granger causality test is applied to verify the hypothesis of the relationship between economic development and NPLs. Panel co-integration tests examine the existence of a long-term link between the same two variables. The results of the study demonstrated that a decrease in the proportion of NPLs results from boosting performance metrics like the Z-score. Because the banking industry has more resources as a result of higher financial development and/or financial intermediation, the amount of NPLs is reduced. Finally, our study demonstrates how important the institutional environment is for raising the quality of bank credit. It was concluded that the low level of NPLs in BRICS countries was largely linked to more effective anti-corruption management, robust regulatory standards, increased application of the rule of law, freedom of speech and accountability.
Keywords: non-performing loans; NPLs; institutional environment; panel granger causality test; PCA; panel ARDL

INTRODUCTION

NPLs are a sign of banks' loan portfolios with declining quality, which raises risk and has an impact on the stability and profitability of banks. According to the 90-day rule used by the BRICS nations, loans are considered non-performing if the principle or interest is not paid for three consecutive months. NPLs cause a loss in real economic activity in addition to having a negative impact on the banking system's financial soundness and profitability. Additionally, because of their detrimental impact on the financial system and economic activities, several experts have referred to NPLs as "financial pollution". Banks are regarded as the primary generators of the economy and any disturbance in banks generates ripple effects in the economy as well. One of the fundamental responsibilities of the central bank or any other banking regulatory authority is the preservation of a trustworthy and efficient financial system that safeguards the interests of all participating agents. Financial stability is supported by a robust banking system that efficiently transfers funds between savers and borrowers. When it comes

to prudential banking oversight, bank stress tests are the most useful. Therefore, to restore overall banking stability and a sound banking system, the central banks and international regulatory bodies adopt a variety of policies and advice to reduce NPLs. However, a fuller understanding of the underlying causes of the NPL problem is necessary before any policy response by banking regulatory agencies can be made.

The BRICS economies have stood out during the past two decades by contributing significantly to the global economy. As a diverse group of emerging nations, the BRICS will account for over 23 percent of global GDP, over 48 percent of the world's geographical area, and almost 45 percent of the world's agricultural value added by the year 2020 (world development indicators). The BRICS nations can be identified by a wide range of characteristics and have enormous development potential. On the other hand, macroeconomic factors like the nation's growth rate, inflation, taxation, unemployment, etc. also have an impact on banks and the profitability of the banking industry.

This article aims to investigate the effects of particular macroeconomic factors and the strength of

the institutional environment on the NPLs of the BRICS nations. Brazil, Russia, India, China, and South Africa are known collectively as the BRICS (Brazil, Russia, India, China, and South Africa) bloc. This bloc gained prominence after the 2003 publication of a report by Goldman Sachs describing the BRICS as one of the world's emerging blocks that will significantly contribute to the global economy and trade by the year 2050 [1]. This study evaluates the impact of both institution-specific environmental variables and bank-specific economic environments on BRICS country NPLs. In the paper [2] also show that crises appear to be more likely to occur in nations with wet banking systems, as evidenced by the financial crisis of 2008 and several domestic financial collapses in countries around the world. The structural dependence of the economic system on banking and its interconnection may have negative implications for the stability of the banking sector. In view of these issues and the flimsy governance structures in emerging nations, it is vital to ascertain the causes of non-performing loans in those nations.

Our study differs from past ones in that it primarily focuses on the BRICS countries and that we are more interested in overall outcomes than the performance of single banks. We focus on the connection between credit risk and governance indicators to better understand the effect of institutional quality on banking NPLs in the BRICS countries. Among the explanatory variables we used were factors affecting bank performance, financial structure variables, macroeconomic variables, and institutional and governance quality indicators. We can identify NPL determinants for the countries of the BRICS region using this technique.

We provided two significant contributions to the literature. First of all, our research advances earlier studies on banking stability and regulation [2]. These studies try to identify the root reasons of the financial system's vulnerability as well as potential stabilizing elements. We contribute to the corpus of literature by examining the case of the BRICS countries. We show how the significance of NPL's drivers in the BRICS region varies depending on the choice of the banking stability proxy. Second, from a policy viewpoint, the information gleaned from our study can help bank regulators or/and supervisors in BRICS and other developing nations comprehend the importance of assessing more than only credit loss protection and insolvency risk in the banking system. Additionally, it examines how institutions' quality and the effects of similar occurrences and institutions would affect the stability of the financial system in the BRICS nations.

LITERATURE REVIEW

So far, the literature on NPLs focuses extensively on macroeconomic and bank-level determinants of non-performing loans with little or no focus on the question of whether certain financial development structures/characteristics drive aggregate non-performing loans.

Macroeconomic Factors

The literature on NPLs focuses on the macroeconomic and bank-level determinants of NPLs with little or no focus on the institutional environment in the persistence of NPLs. In the paper [3], we analyse NPL factors in the Greek banking sector and show that management quality, GDP, unemployment, interest rates, and public debt all have a substantial impact on NPLs.

In previous literature, because NPLs tend to be smaller during economic booms and greater during recessions, GDP growth is frequently linked to variations in the magnitude of NPLs [4]. Also, because high unemployment might damage borrowers' ability to repay loans, high unemployment is linked to high NPLs. In the literature, the effect of inflation on NPLs is equivocal, with mixed results. NPL persistence may also be influenced by global risk factors [5]. In the paper [6], bank type, risk-taking behaviour of banks, bank ownership, bank concentration, leverage and credit quality of banks and macroeconomic variables (GDP, effective interest rate, inflation, and foreign exchange rate) are responsible for variation in the NPLs of Chinese banks.

Bank-level Determinants

A country's degree of financial development is essential, and since NPLs are a measure of bank performance, a link between financial development and NPLs can be formed. However, the literature on the relationship between firm/bank performance and financial development has not looked into the impact of financial development levels on the persistence of NPLs; as a result, our understanding of how financial sector development influences NPLs is unclear. For example, the paper [7] argues that financial development is significant because it can influence the severity of a

financial or economic crisis, as well as the domestic mobilization of resources required to address a country's current crisis.

Few studies have tried to establish a link between NPLs and banking liberalization. For instance, in the paper [8], it was deduced that presence of foreign participation from developed economies; higher credit growth rates and positive loan loss provisions help in downsizing the level of NPL in host countries. The authors' paper [9] emphasized that foreign-owned banks have some important bank practices that systematically help them to have lower NPLs than domestic banks.

When it comes to bank-specific NPL determinants, [10] revealed that adequate capitalization, low credit quality, high liquidity risk, and lower cost efficiency tend to increase NPL, whereas greater bank profitability results in lower NPLs through examining determinants of NPLs for commercial banks and savings institutions in 50 US states and the District of Columbia.

Institutional Factor

According to some research, institutional quality can impact a nation's banking system's stability, and a nation's governance quality can impact banking regulation and supervision aimed at influencing bank behavior [11]. The institutional environment includes the legal and judicial framework, political stability, and the degree of corruption control. Although a well-functioning government system is known to influence the performance of the financial system, there is little evidence linking well-functioning institutions and good governance to banks' financial outcomes, such as NPL [12]. These factors appear to be important in determining cross-country differences in credit quality. For instance, in many developing countries, banks suffer from the significance of NPL. These countries are most characterized by inefficient judicial systems, corrupt bureaucracies or political institutions.

These features hinder either the process of extending credit or the process of control and recovery once the loan is granted. More specifically, the existence of corruption negatively impacts the degree of market competitiveness and thus leads to inefficient loan offers. In the paper [13] suggests that in societies with few democratic traditions and civil discipline, decision-makers are exposed to informal connections and other pressures from groups seeking unjustified or illegal economic rents. In this context, loan decisions are affected by the intensity of pressure from political lobbying by various interest groups. Loans will thus be gained by enterprises with solid political connections but could be of lower quality (even in severe distress). Furthermore, internal control tends to decrease in countries with corrupt civil societies.

Our study, however, differs from previous research in that it departs from it to look at the relationship between NPLs and institutional, macroeconomic, and financial sector development.

DATA SOURCES AND METHODOLOGY
Data

To determine how certain financial sector development, economic growth, and institutional/governance variables relate to NPLs, In the current study's panel ARDL approach, time series data from Brazil, Russia, India, China, and South Africa (BRICS) were employed for the period 1996–2020. Data is retrieved for analysis from the World Bank's archived global financial development database, which is available. As a result, the final sample of 5 BRICS nations was chosen based on the availability of data. The World Bank gathered data on macroeconomic variables from global development indicators. The World Governance Indicators created by [14] provide information on the institutional environment at the national level. Based on 276 unique variables collected from 37 data sources created by 31 various organizations, this database is specifically, this database is utilized in the literature to examine how institutions influence economic results. In this study, we try to explore the relationship between stated variables by employing the given empirical model form:

$$NPL = \alpha_0 + \beta_1 PCREDIT_{it} + \beta_2 ZSCORE_{it} + \\ + \beta_3 LOG\_GDP_{it} + \beta_4 INF_{it} + \\ + \beta_5 PCA\_INST_{it} + u_{it},$$

where in the entire above model the explanation of the variables are as follows: NPL_{it} = Gross NPLs to Gross Advances Ratio of bank i at time t; $PCREDIT_{it}$ = private credit by domestic banks to GDP ratio of country i at time t; $ZSCORE_{it}$ = Banks stability of country i at time t; LOG_GDP_{it} = Gross Domestic Product of country i at time t; INF_{it} = Inflation, consumer prices (annual%) of

country *i* at time *t*; PCA_INST_{it} = PCA of 6 Institutional factors of country *i* at time *t*; u_{it} = the error term for a country *i* at time *t*.

Variable under Study

The NPL to Gross Advances Ratio (NPLR) is a dependent variable in the present study that reflects the credit quality of banks. According to banks for international settlements, a default or nonperforming asset is considered to occur in respect of a specific borrower if borrowing is overdue for more than 90 days on any kind of bank credit to any type of banking institution.

Private credit by domestic banks to GDP ratio (PCGDP), which measures the depth and breadth of the banking sector in an economy's financial system, is used to quantify the level of financial intermediation. A large banking sector should be more stable than a small banking sector if a strong systemic risk regulatory framework is in place; thus, a negative correlation between banking NPLs and banking sector size should be expected [4].

The Z-score index, which is defined as the ratio of the return on assets plus the capital ratio divided by the standard deviation of the return on assets in the literature, is frequently used to gauge banking stability [15]. As expected, a strong banking system should have fewer NPLs, and a greater Z-score indicates stronger banking stability, suggesting an adverse connection between NPL and Z-score.

Finally, we control for macroeconomic factors affecting the banking sector's stability. Inflation (INF) is used to control for macroeconomic factors influencing NPLs [16]. During inflationary periods, banks are able to charge higher prices for banking and financial services offered to customers. Banks can benefit from higher price margins during inflationary periods to increase their profitability, which contributes to greater banking stability; therefore, we anticipate a negative correlation between the NPLs in the banking sector and inflation.

Economic growth (GDP) is another macroeconomic factor that can potentially influence the stability of the banking sector. Loan defaults typically lower during periods of high economic growth, which consequently has positive effects on banking sector stability [16]; therefore, we expect a negative relationship between NPLs and economic growth.

Institutional quality is assessed using perception measures that are assigned values; higher values indicate stronger economic governance. Since excellent governance is linked to fewer NPL creations, it is reasonable to anticipate a negative relationship between NPL and institutional quality (PCA INST).

Descriptive Statistics

Appendix Table 1 shows the results of the descriptive statistics for the variables under study. According to summary results, NPLs have increased at an average rate of 5.88% of gross loans with a standard deviation of 5.03%. Maximum NPLs were recorded at a level of 29.8% for the given sample of BRICS economies.

To illustrate the strength and direction of correlations amongst some of the potential determinants and to assess if there is any problem with multicollinearity across independent variables, *Appendix Table 2* includes a Pearson's correlation matrix. As a general rule, the correlation value below 0.70 indicates that there is no issue with multicollinearity between the variables. The greatest correlation of the study's variables, 0.4262*, is found between GDP and Z-Score.

Appendix Table 3 shows the Pairwise Correlation Matrix of world governance indicators that indicate a problem of multicollinearity among different governance variables. To address this problem, a single institutional quality variable (PCA_INST) is created through principal component analysis. *Appendix Table 4* indicates that PCA_INST explains 64.52% of all six variables. *Appendix Table 5* demonstrates Eigen vectors for the same.

Our analysis has adopted two steps: firstly, we applied the panel unit root test for the variables investigated. We have also employed Principal Component Analysis (PCA) in order to develop an institutional factor, index for analysis. Based on both results, the study has employed the Pooled Mean Group Autoregressive Distribution Model (ARDL) to capture short-run and long-run effects.

Econometric Techniques
Unit Root Test

To select the best model and conduct the necessary analysis to look at the order of the variables' integration, we used the Fisher ADF unit root test. Numerous panel unit root tests have been carried out to prevent the bogus regression issue. In the analysis, various panel unit root tests based on individual effects and combination effects have been carried out in order to evaluate the integration and unit root among the variables.

Pooled Mean Group (PMG) Panel ARDL Model

After determining whether a unit root exists in the data for our investigation, we move on to specifying the dynamic panel model. Panel Auto Regressive Distributed Lag (ARDL) is best used when few variables are stationary at levels and some of the first differences.

Homogeneous long-run coefficients are what the panel ARDL model anticipates. The PMG model presupposes that the error terms are serially uncorrelated and distributed independently of the repressors. The big sample size (N) and short-term (T) dynamic panels differ from the large sample size (N) and long-term panels in several ways (T). The use of fixed- or random-effect models, fixed-effect estimators, and instrumental-variable estimators, such as the generalized method-of-moments (GMM) approach, is required for panel estimation based on tiny T. These methods call for pooling distinct groups and allowing only the intercept to vary across the groupings. In any case, it is important to note that the large N and large T results show that it's generally incorrect to assume that the slope parameters are homogeneous. In the paper [14] have all made this point. An alternate Pooled Mean Group (PMG) estimator was provided by Pearson and Shin (1999) to address this issue. An intercept, short-run coefficients, and co-integration term are included in the advanced panel settings of the model, which has the ARDL basic form. Because each of the variables in the ARDL model stands as a standalone equation, the likelihood of endogeneity is relatively low [15, 16].

Panel Co-integration Test and Panel Granger Causality Test

We also applied the panel Granger causality test to check the long-held proposition of causality between NPLs and economic growth. We use the IPS test to test stationary data. While the alternative hypothesis proposes that the data are stationary, the null hypothesis of the IPS test asserts that the data include a unit root. Tests of panel co-integration look for a long-term link between the two variables. The Panel Co-integration test outcomes for Kao and Johansen There is no indication of co-integration between NPLs and economic growth factors, according to panel co-integration tests. So, in the absence of co-integration, we now examine the short-run causality between NPLs and economic growth. To observe short-run causation between the two, the Panel Granger causality test was

used in conjunction with the Vector Autoregressive (VAR) framework.

RESULTS AND DISCUSSION

This section looks at the relationship between NPLs and economic expansion. The IPS test unit root test was utilized to test the stationary of the data. The unit root test's findings indicate that our variables are stationary at the first difference (see *Table 1*).

After establishing that all variables are stationary at the initial difference, we can use the Kao panel co-integration test and the Johansen panel co-integration test to examine the co-integration between the NPL and economic growth. There is no co-integration between NPL and economic development, as shown by the results of the Kao panel co-integration test, which are provided in *Table 2*.

Test of Panel Co-integration Given that both Kao co-integration test results in *Table 2* accepted the null hypothesis that the variables are not co-integrated and that the P-values are greater than 5%, we can infer that the variables for BRICS, or Brazil, Russia, China, and India, do not have a long-term association with one another. In contrast, South Africa and Brazil have significant ADF test data. We now use a Vector Autoregressive (VAR) framework to test the short-run causality between the two.

The panel Granger causality test result, which looked for a short-run relationship between the NPL and economic growth, is shown in *Table 3*.

From *Table 3*, it can be deduced that there is a presence of unidirectional causality running from GDP to NPL for BRICS, Brazil, India and South Africa. Higher economic growth often leads to increased income and stability in different manufacturing and service sectors. So, the tendency of bad loans decreases during an economic boom, leading to a low level of NPLs in economies. But there is significant causality running from NPL to GDP for Brazil and South Africa. So, it can be deduced that NPL does significantly impact real economic growth in the same countries. The panel co-integration test only discusses the long-term relationships between variables; it does not give precise information regarding the relationship between the independent and dependent variables. To be more precise, the Granger causality test and PMG-ARDL model are employed to obtain these estimations because co-integration analysis does not provide any information regarding the postulated signs and magnitudes of the coefficients.

Panel Unit Root Test Results

Countries	BRICS		Brazil		Russia		India		China		South Africa	
Variables	Im, Pesaran, Shin IPS test		Im, Pesaran, Shin IPS test		Im, Pesaran, Shin IPS test		Im, Pesaran, Shin IPS test		Im, Pesaran, Shin IPS test		Im, Pesaran, Shin IPS test	
	Level	First Difference	Level	First Difference	Level	First Difference	level	First Difference	Level	First Difference	Level	First Difference
NPL	0.188	0.000***	0.114	0.000***	0.627	0.000***	0.084*	0.000***	0.157	0.001***	−2.890*	0.022**
PCREDIT	0.058*	0.000***	0.060	0.000***	0.971	0.000***	0.061*	0.000***	0.117	0.001***	−1.070	0.007***
ZSCORE	0.060*	0.000***	0.766	0.000***	0.054*	0.049**	0.644	0.014**	0.124	0.045**	−1.684*	0.000***
LOGGDP	0.050*	0.000***	0.110	0.000***	0.077*	0.000***	0.451	0.000***	0.061*	0.003**	2.861	0.000***
INFL	0.058*	0.021**	0.197	0.045**	0.822	0.000***	0.000***	0.000***	0.000***	0.000***	−3.874	0.000***
PCA INST	0.188	0.000***	0.106	0.000***	0.400	0.002***	0.406	0.000***	0.018**	0.000***	−1.368	0.000***

Source: Authors' calculation.

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

Kao Panel Co-Integration Test Results

Countries	Null Hypothesis (No Co-integration)	P (Value)	Test Statistics
BRICS	ADF	0.1202	−3.60
Brazil	ADF	0.034	−2.656*
Russia	ADF	0.167	4.78
China	ADF	0.0645	−3.89
India	ADF	0.0897	−1.78
South Africa	ADF	0.0567	−1.67*

Source: Authors' calculation.

Note: * denotes significance at 5% level.

Table 4 presents the outcomes of the PMG-ARDL model. Economic growth (GDP) and inflation (INF), two independent variables, are positively and statistically significant in the BRICS panel and other nations, according to the panel results for the long term. NPLs are inversely related to the long-run coefficients of financial development (PCREDIT) and financial stability. The institutional quality long-run coefficients, however, are negative, as predicted. The examined variables' negative coefficients imply that when institutional quality improves in Brazil and India, a greater proportion of students will be considered nonperforming.

Whereas in *Table 5*, the panel results for the short run show that the independent variables, i.e. economic growth (GDP) are statistically negatively significant and inflation (INF) is statistically insignificant in BRICS countries and other models. The long-run coefficients of financial development (PCREDIT) and Financial Stability are negatively associated with NPLs for the BRICS panel and other models.

Domestic credit provided by the home country (PCGDP) is a proxy of financial development and its coefficient is negatively associated with NPLs in long run as well as in the short run. This reflects that the depth and breadth of the financial sector in an economy result in a low level of NPLs. The long-run coefficients of financial development (PCREDIT) are negatively associated with NPLs. This finding countered the finding in the paper [7]

Results of Panel VAR Granger Causality Test

Countries	TIP/GDP	
	Dependent variable: NPL	Dependent variable: GDP
BRICS	19.67***	28.78
Brazil	17.98***	8.95**
Russia	3.56	2.78
India	9.75***	8.74
China	7.56	6.93
South Africa	9.87***	10.95**

Source: Computed by the authors.

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

Long Run PMG ARDL Estimation

Countries	BRICS	Brazil	Russia	India	China	South Africa
Short run	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
PCREDIT	−0.1125***	−0.038**	−0.217	−0.086**	0.086	−0.046***
ZSCORE	−0.1437*	−0.353**	−3.461**	−0.105**	−0.105	0.137
LOGGDP	−7.9687***	3.038	−4.871***	−6.018**	−10.018**	9.387***
INFL	−0.53503***	−0.112***	−2.452*	0.567	−0.875**	−0.733*
PCA_INS	−0.1516	−0.073*	3.907	−0.547*	.876	−0.367

Source: Computed by the authors.

Note: Critical value at the 1%, 5% and 0% significance level denoted by*, ** and ***respectively.

Short Run PMG ARDL Estimation

Countries	BRICS	Brazil	Russia	India	China	South Africa
Short run	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
PCREDIT	−0.03333***	−0.060***	−0.119	−1.125*	−0.0389	1.966
ZSCORE	−0.30938***	−1.23**	−18.75*	0.187	−0.767***	1.817
LOGGDP	−5.71646**	0.036	−1.241**	0.086	−7.748*	0.437
INFL	−0.15397	−0.444*	1.184	0.241	−0.5365	−1.362*
PCA_INS	−0.818252**	0.064	−3.713**	−2.072***	−.76478**	−1.179

Source: Computed by the authors.

Note: Critical value at the 1%, 5% and!0% significance level denoted by*, ** and ***respectively.

on the link between financial sector development and NPL. This finding supported the hypothesis that a large banking sector should be more stable than a small banking sector if a strong systemic risk regulatory framework is in place [12].

The coefficient of GDP shows a positive correlation between real economic activities and NPLs. It implied that NPLs were lower during the economic boom due to increased financial activities and stability. Likewise, the coefficient of inflation shows a positive relationship between the banking sector's NPLs and inflation in the long-run but in the short run, inflation is negative but insignificant and associated with NPLs. In order to boost lending during prosperous economic times, banks lowered loan-screening standards and used loose lending criteria. This increased the probability of rising NPLs when unforeseen circumstances occurred that affected borrowers' capacity to repay [7].

Institutional quality variables (PCA_INST) coefficient shows a negative but insignificant link between NPL and governance indicators in the long-term. The (PCA_INST) coefficient is significantly negatively associated with NPLs. That proves the findings of the paper [2], which pointed out that crises are more likely to occur in nations with lax institutional controls and systemic reliance on banks in the financial system. They cited the 2008 global financial crisis as well as numerous national banking crises in various nations around the world.

However, the short-run coefficients of INFLATION are negative, which is the opposite of long-run estimation. Finally, the institutional environment index is negative but statistically significantly associated with NPLs, which clearly indicates countries with a better institutional environment are more likely to have lower amounts of NPLs.

CONCLUSION AND IMPLICATION OF STUDY

The causes of NPLs in the BRICS countries are investigated in this paper. Prior research without a focus on the institutional setting of the BRICS countries has shown the importance of systemic risk and bank-specific shocks to the stability of the financial system. Our findings suggest that the size of the banking sector, GDP, and inflation rates are important long-term predictors of financial stability in BRICS nations. In contrast, the size of the banking sector, the Z-score, and the levels of institutional quality indicators are important short-term predictors of financial stability in BRICS nations. Although there is a causal relationship between the GDP and NPLs.

Institutional quality has arguably been recognized as one of the most important drivers of GDP development in research on institutional economics. By imposing contextual controls, institutions create and enforce norms and regulations in front of the public. In general, strategies adopted by domestic institutions to establish the legal and cultural contexts for socioeconomic activities are connected with institutional quality. Consequently, this demonstrates the government's capacity to develop and implement laws and policies that support business, enhance contract execution quality, safeguard property rights, uphold a robust legal system, and ensure that institutions are independent of political influence. On the other hand, ineffectual institutions support the private sector inefficiently, which results in corruption, an inefficient bureaucracy, and lax environmental restrictions.

Our literary work will help society in two different ways. First, our analysis adds to the research on NPLs in banking and regulation that has already been done [2]. These studies make an effort to pinpoint the causes of financial system fragility as well as prospective influences on NPLs in banking. By examining the cases of developing and developed economies, we contribute to this body of scholarship. Investigating the effect of economic and stock market volatility on banking stability in various areas might be a valuable area for future research. Finally, as a follow-up to papers [6, 12, 13], future research might also look at how digital finance affects banking stability globally. Second, from the perspective of policy, this study will assist governments, policymakers, bank regulators, and supervisors in developing and underdeveloped countries to understand the significance of assessing not only credit loss protection and insolvency in the banking system but also the impact of institutional quality and the impact that such events would have on the NPLs of emerging economies. In order to protect societal interests, it will assist the government in gaining knowledge about policy-making, advice, and regulation in regard to non-performing and banking stability. This study will also examine how NPLs and banking instability impact a country's actual economy, assisting policymakers in understanding how these factors affect economic growth so that they can develop plans accordingly.

REFERENCES

1. Singh A.K., Shrivastav R.K. Evaluating the impact of the global financial crisis on the stock markets of BRICS countries. *Indian Journal of Finance*. 2018;12(7):7–27. DOI: 10.17010/ijf/2018/v12i7/129967

2. Brunnermeier M., Crockett A., Goodhart C.A., Persaud A., Shin H.S. The fundamental principles of financial regulation. Geneva Reports on the World Economy. 2009;(11). URL: https://www.princeton.edu/~markus/research/papers/Geneva11.pdf

3. Kudinova M.M. Monetary policy transformation of major central banks during the COVID-19 pandemic. *Finance: Theory and Practice*. 2022;26(1):41–54. DOI: 10.26794/2587–5671–2022–26–1–41–54

4. Umar M., Sun G. Determinants of NPLs in Chinese banks. *Journal of Asia Business Studies*. 2018;12(3):273–289. DOI: 10.1108/JABS-01–2016–0005

5. Naudé W. The financial crisis of 2008 and the developing countries. WIDER Discussion Paper. 2009;(01). URL: https://www.econstor.eu/bitstream/10419/84665/1/659524139.pdf

6. Boudriga A., Taktak N.B., Jellouli S. Banking supervision and NPLs: A cross-country analysis. *Journal of Financial Economic Policy*. 2009;1(4):286–318. DOI: 10.1108/17576380911050043

7. Beaton M.K., Myrvoda M.A., Thompson S. NPLs in the ECCU: Determinants and macroeconomic impact. IMF Working Paper. 2016;(229). URL: https://www.imf.org/external/pubs/ft/wp/2016/wp16229.pdf

8. Artemenko D.A., Zenchenko S.V. Digital technologies in the financial sector: Evolution and major development trends in Russia and abroad. *Finance: Theory and Practice*. 2021;25(3):90–101. DOI: 10.26794/2587–5671–2021–25–3–90–101

9. Beltratti A., Stulz R.M. The credit crisis around the globe: Why did some banks perform better? *Journal of Financial Economics*. 2012;105(1):1–7. DOI: 10.1016/j.jfineco.2011.12.005

10. Kaufmann D., Kraay A., Mastruzzi M. The worldwide governance indicators: Methodology and analytical issues. *Hague Journal on the Rule of Law*. 2011;3(2):220–246. DOI: 10.1017/S 1876404511200046

11. Goyal S., Singhal N., Mishra N., Verma S.K. The impact of macroeconomic and institutional environment on NPL of developing and developed countries. *Future Business Journal*. 2023;9(1):45. DOI: 10.1186/s43093–023–00216–1

12. Ozili P.K. Banking stability determinants in Africa. *International Journal of Managerial Finance*. 2018;14(4):462–483. DOI: 10.1108/IJMF-01–2018–0007

13. Goyal S., Prosad J.M., Mishra N., Singhal N. Non-performing assets and institutional quality indicators: Evidence from developing countries. *Vision: The Journal of Business Perspective*. 2023. DOI: 10.1177/097226292211458

14. Singhal N., Goyal S., Singhal T. Insurance-growth nexus: Empirical evidence from emerging Asian markets. *Transnational Corporations Review*. 2020;12(3):237–249. DOI: 10.1080/19186444.2020.1756170

15. Singhal N., Goyal S., Singhal T. The relationship between insurance and economic growth in Asian countries: A regional perspective. *Macroeconomics and Finance in Emerging Market Economies*. 2022;15(3):301–322. DOI: 10.1080/17520843.2021.1957599

16. Maslennikov V.V., Fedotova M.A., Sorokin A.N. New financial technologies change our world. *Finansy: teoriya i praktika = Finance: Theory and Practice*. 2017;21(2):6–11. (In Russ.).

ABOUT THE AUTHORS

Shikha Goyal — PhD, Assist. Prof, Amity Law School, AUUP, Noida, India
https://orcid.org/0000-0002-7634-4403
Corresponding author:
shikhagoyal.sg94@gmail.com

Nikita Singhal — PhD, Assist. Prof., School of Commerce and Management, IIMT University, Meerut, India
https://orcid.org/0000-0002-0700-8086
nikitagoyal.nikki@gmail.com

Jaya Mamta Prosad — PhD, Assist. Prof., Fortune Institute of International Business, Delhi, India
https://orcid.org/0000-0001-9520-9859
jmprosad@amity.edu

Nandita Mishra — PhD & CMA, Universitets lektor — Språk, Department of Management and Engineering, Linkoping University, Linkoping, Sweden
https://orcid.org/0000-0001-9725-9761
saanvinandita@gmail.com

Authors' declared contribution:
S. Goyal — conceptualization of research idea and research methodology.
H. Singhal — defining the aim, objectives, approaches and methodology of the study, development of action plan.
D.M. Prosad — peer review of the main idea of the study, literature review.
N. Mishra — literature review, validation of the study, conclusions.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 01.09.2022; revised on 15.09.2022 and accepted for publication on 26.09.2022.
The authors read and approved the final version of the manuscript.

APPENDIX

Table 1

Descriptive Analysis

Variable	Mean	Std. Dev.	Min	Max
NPL	5.889267	5.037413	0.953674	29.8
PCREDIT	76.51994	42.41389	16.83777	182.8681
ZSCORE	15.03053	4.611557	6.215393	24.11201
LOGGDP	2.05E + 12	3.01E + 12	1.29E + 11	1.47E + 13
INFLATION	7.245868	9.177997	−1.40147	85.74649
PCA_INST	−0.23371	0.363133	−0.85587	0.470056

Source: Author's calculation.

Table 2

Pairwise Correlation Matrix

Variable	PCREDIT	ZSCORE	LOGGDP	PCA_INST	PCA_INST
PCREDIT	1				
ZSCORE	0.3827*	1			
LOGGDP	0.4998*	0.5262	1		
INFLATION	−0.5143	−0.346*	−0.2185*	1	
PCA_INST	0.2427*	0.3375*	−0.2631*	−0.2152	1

Source: Author's calculation.

Note: *denotes significance at 5% level.

Table 3

Result of Pairwise Correlation Matrix of World Governance Indicators

	COC	GE	PS	RQ	ROL	VAC
COC	1					
GE	0.7556*	1				
PS	0.6382*	0.4995*	1			
RQ	0.8265*	0.6578*	0.7073*	1		
ROL	0.7746*	0.6113*	0.2744*	0.5203*	1	
VAC	0.5762*	0.2032	0.1337*	0.5224*	0.7*	1

Source: Author's calculation

Note: *denotes significance at 5% level.

Result of Principal Component Analysis

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.87118	2.76994	0.6452	0.6452
Comp2	1.10124	0.505796	0.1835	0.8287
Comp3	0.595441	0.338036	0.0992	0.928
Comp4	0.257404	0.157352	0.0429	0.9709
Comp5	0.100053	0.0253677	0.0167	0.9876
Comp6	0.074685	.	0.0124	1

Source: Author's calculation.

Principal Components (Eigenvectors)

Variable	Comp1	Unexplained
Control of Corruption	0.4891	0.07385
Government effectiveness	0.4029	0.3716
Political stability	0.3446	0.5402
Regulatory quality	0.4518	0.2097
Rule of Law	0.4119	0.3433
Voice and accountability	0.3254	0.5902

Source: Author's calculation.

Three Objectives of International Banking Regulation: Analysis of Their Interrelationship and Issues

E.P. Dzhagityan[a], O.R. Mukhametov[b]
[a, b] HSE University, Moscow, Russia;
[b] Financial Research Institute of the Ministry of Finance of the Russian Federation, Moscow, Russia

ABSTRACT

In response to the Global Financial Crisis of 2008–2009, international financial regulators tightened the regime of banking supervision in order to minimize systemic risks, strengthen banking sector resilience and ensure financial stability. Given the increased level of credit risks and the issue of liquidity in the banking sector, as well as the role of banks in promoting the dynamics of the macro-environment, the objectives of banking regulation, through their interrelationship, may conflict with one another, and the research of this phenomenon is the **subject** of this article. The academic literature excludes research that provides definitive evidence on whether post-crisis banking regulation reform has achieved each of the abovementioned goals, determining the **relevance** of our study. The **scientific novelty** is attributed to the principally different approach proposed by the authors in assessing the effectiveness of the post-crisis model of international banking regulation, which is based on the analysis of the interaction and contradictions of the objectives of modern regulatory policy. The **purpose** of the study is to identify the extent to which the objectives of the post-crisis regulatory model were achieved and to what extent regulatory efforts contribute to the reduction of systemic risks. To achieve the research objectives, the authors applied methods of statistical and comparative analysis, synthesis of factors underlying the post-crisis regulatory mechanism, systematization, generalization and forecasting. The authors analyzed the main elements of the regulatory reform, examined the dynamics of the banking sector, and assessed the impact of the reform on systemic risks and economic growth. The research **results** show that tighter supervisory standards strengthened bank stress resilience, reduced systemic risks, and had a limited impact on economic growth. The article **concludes** that the objectives of banking regulation actively interact, but do not conflict: a consistent transition to the new Basel III standards allows each objective to be achieved.

Keywords: banking regulation and supervision; Basel III; credit risks; systemic risks; liquidity; systemically important banks; financial stability; economic growth

INTRODUCTION

Objectives of the Post-Crisis Regulatory Model

The Global Financial Crisis of 2008–2009 demonstrated the inevitability of an international reform of banking regulation (further — reform), aimed at reduction of risks in the banking sector to the level necessary to maintain financial stability regardless of the macroeconomic crises and external shocks. The microprudential regulation segment developed by the Basel Committee on Banking Supervision (further — BCBS), known as Basel III, aims at stress resilience of banks by minimizing their credit (and, consequently, systemic) risks, and ultimately — to restore their contribution to financial stability and economic growth.

The adoption of Basel III rules by BCBS member states has increased the resilience of the banking industry. This is demonstrated by the fact that despite non-economic origin of the COVID-19 pandemic, banks in most countries continued to perform their function of financial intermediation,[1] although a crisis mitigation and extra-soft monetary policy has also contributed to ensuring sufficient liquidity in the banking sector. While banks have largely successfully adapted to Basel III, its minimum capital adequacy requirements pose certain restriction on lending, which could decelerate economic growth. However, the decrease of GDP and the cost to the economy because of financial crises that may have arisen in the absence of reform would have been greater and more likely to have negative long-lasting effects.

In these conditions, the reform concentrated on banks' intermediation function with strong supervisory criteria, as well as banks' role as open market liquidity providers. However, along with higher level of banks' stress resilience the reform may have a negative effect on their credit capacity, thus adversely affecting economic growth. This situation, in our opinion, determines the three regulatory policy objectives, the achievement of which will determine financial stability and economic growth:

• minimization of credit risks as a contribution to consistency of banking performance;
• minimization of systemic risks as a contribution to higher stress resilience of banks;
• adaptation of banks to the post-crisis regulatory model.

Based on the reform objectives, our paper explores the interplay: how the reform affects each of the objectives and whether there are contradictions among them. Conclusions on increasing the efficiency of banking supervision and further improvement of banking regulation are based on the summary of research results and the examination of primary data. We are confident that, in the context of the contemporary risk management approaches, these findings will improve knowledge of the risks and their sources, which will allow financial regulators to optimize the search for the new risk mitigation tools while also evaluating the extent of the effect of the measures applied in the financial sector.

CREDIT RISKS OF BANKS

Approaches to Credit Risk Assessment

By the time the Global Financial Crisis struck, imbalances had accumulated in the banking sector between assets and off-balance sheet liabilities, assets and banks' own funds, as well as a growing deficit in banking sector liquidity.[2] As a source of risk, these imbalances, along with financial deregulation policies, could not help but become a "time bomb" for the financial sector.

---

[1] Bank for International Settlements (2020) Implementation of Basel standards: A report to G20 Leaders on implementation of the Basel III regulatory reforms. November. URL: https://www.bis.org/bcbs/publ/d510.pdf (accessed on 21.03.2022).

[2] Basel Committee on Banking Supervision. (2008). Comprehensive strategy to address the lessons of the banking crisis announced by the Basel Committee. URL: https://www.bis.org/press/p081120.htm (accessed on 21.02.2022).

Since credit assets are a core element of banking activities, the reform mainly focused on credit risks. The reform measures introduced a dependence of the minimum capital adequacy on the amount of risk-weighted assets (further — RWA). While assets are evaluated based on credit, market, and operational risk, credit risk has the greatest impact on RWA, given that credit assets account for at least 60–70% of bank assets. Accordingly, the stress resilience of the bank and its viability depend on credit risk, which is actually the essence of the main block of the reform. On the other hand, the degree to which the RWA methodology affects the comparability of capital adequacy and investor confidence in credit risk indicators will be determined by the cost of capital and other operating costs, which will contribute to a fair competitive environment in the banking sector. As competition increases, the level of credit risk will decrease [1], and a higher level of investor awareness of the financial position of banks will open up new opportunities for attracting capital at a relatively low cost.

Capital Buffers as a Means of Credit Risk Management

A fair assessment of the RWA is necessary not only for the comparability of credit risk levels, but also for regulatory action to strengthen bank stress resilience. It is a question of additional surpluses (buffers) to capital adequacy standards in order to ensure the lending to the economy in an amount that would not depend on crisis phenomena, as well as to absorb possible costs, thereby contributing to stability in the banking sector [2].

Strengthening banks' credit risk management ability, for example through the introduction of an IRB (Internal Ratings-Based) approach, along with increased supervisory requirements not only improved their stress resilience and market discipline, but also significantly contributed to reduction of their risks. It is obvious that the most important criteria for the effectiveness of

post-crisis regulation is continuity of the bank's financial intermediation function during uncertain times rather than the bank's key performance indicators. It is, therefore, not surprising that additional capital buffers have reduced shortage of capital [3], despite a slight decrease in loan growth rates [4, 5],[3] increased operating profits [6] and banks' ability to absorb risks even during credit expansion [7]. Moreover, higher capital requirements contributed to higher quality of credit assets [8]. Thus, the reform has helped to resolve several issues, which lifted obstacles to the risk mitigation efforts, thus increasing the integrity of banking performance, which is the key to financial stability.

STRESS RESILIENCE OF BANKS

The lessons of the global financial crisis demonstrate the high vulnerability of banks to external challenges, regardless of their size, market specialization, and activity in financial markets. The forefront reforms, which emphasized heightened supervisory standards, have contributed not only to the reduction of credit risks but also to the strengthening of banks' resilience and the minimization of systemic risks. Further studies have shown the indispensability of such an approach, both within individual banks [9] and in the banking sector as a whole [10, 11].

The effectiveness of the post-crisis model of banking regulation is demonstrated by the growth of the Common Equity Tier 1 (CET 1) capital of the EU banks — from 12.72% in the second quarter of 2015 to 15.6% in the second quarter of 2021, and Tier 1 capital — from 13.44% to 16.87% in the same period. Banks' additional efforts in increasing their equity were supplemented by improved control over credit quality, leading in a decrease of non-performing loans

---

[3] This conclusion is ambiguous: a number of studies indicate that international banking regulation reform had no impact on the amount of loans (see, for example, [5]).

(NPL) from 7.48% to 2.32% to total loans. Furthermore, banks' ability to absorb external shocks has improved, reducing the perspectives of risk transformation into a system-wide economic crisis during the COVID-19 pandemic.

Systemically Significant Banks and Systemic Risks

In the framework for stress reduction in the banking sector, international regulators have identified the largest internationally active banks as a potential source of macro-financial instability, while being vulnerable to external shocks, as a separate supervisory category. Such banks are classified as global systemically important banks (further — G-SIBs), and increased supervision has been implemented. In contrast to the deregulation period, a bank's systemic significance is defined not as the risk of G-SIBs bankruptcy, but as the impact of its dysfunction on the state of the financial sphere and macroeconomic conditions.

Compared to other banks, G-SIBs have a significant impact on financial stability, including through risk transmission channels [12, 13], resulting in an increased level of associated risks in the event of instability. The specificity of G-SIBs is reflected in the BCBS methodology,[4] according to which they are subject to additional capital buffers depending on the level of their systemic importance: the higher the level, the greater the buffer.

Despite the efforts of regulators, the additional capital buffer for G-SIBs did not completely reduce systemic stress, including due to the lack of market discipline [14]. The matter is that notwithstanding regulatory restrictions, the fall in the amount of G-SIB transactions, that is associated with higher risks, have not reached a level at which international regulators' responsibilities for financial stability can be performed efficiently. In this regard, in 2015, the post-crisis regulatory concept was complemented by TLAC, a consolidated potential loss absorption indicator that increases G-SIBs' responsibility in relation to market discipline. Such an approach has contributed to strengthening G-SIBs' stress resilience, as evidenced by the transfer of some G-SIBs into buckets with lower systemic importance at the turn of the 2020s.[5]

As a result, the reform has reduced systemic risks [15] and, consequently, the risks of financial distress. It has also contributed to reducing the level of interconnectedness of G-SIBs [16], promoted diversification of the sources of bank profits [17]. Moreover, their simplified operating models have also contributed to alleviation of systemic stress [18]. However, while bank's performance integrity remains one of determinants of financial stability during crises, it is not clear to what extent compliance with Basel III supervisory standards will remain a stress-resilience factor in the event of new external shocks. In reality, during instability the banking sector, compared to other sectors of the financial system, becomes a source of systemic risks [19], especially due to the increased level of systemic significance of banks stipulated by crisis developments [20]. This issue is in line with the dilemma between the amount of capital required to maintain stress resilience and the cost of additional capital necessary to ensure continuity of banks' financial intermediation function. Since the balanced approach to the dilemma will determine credit capacity of banks, the level of stress resilience in the banking sector will determine the pace of economic growth based on which it will be possible to assess costs associated with the post-crisis recovery.

---

[4] Basel Committee on Banking Supervision (2021) The Basel framework. SCO40 — Global systemically important banks. URL: https://www.bis.org/basel_framework/chapter/SCO/40. htm?inforce=20211109&published=20211109 (accessed on 21.03.2022).

[5] Financial Stability Board. List of Global Systemically Important Banks (for the relevant years). URL: https://www. fsb.org/ (accessed on 22.03.2022).
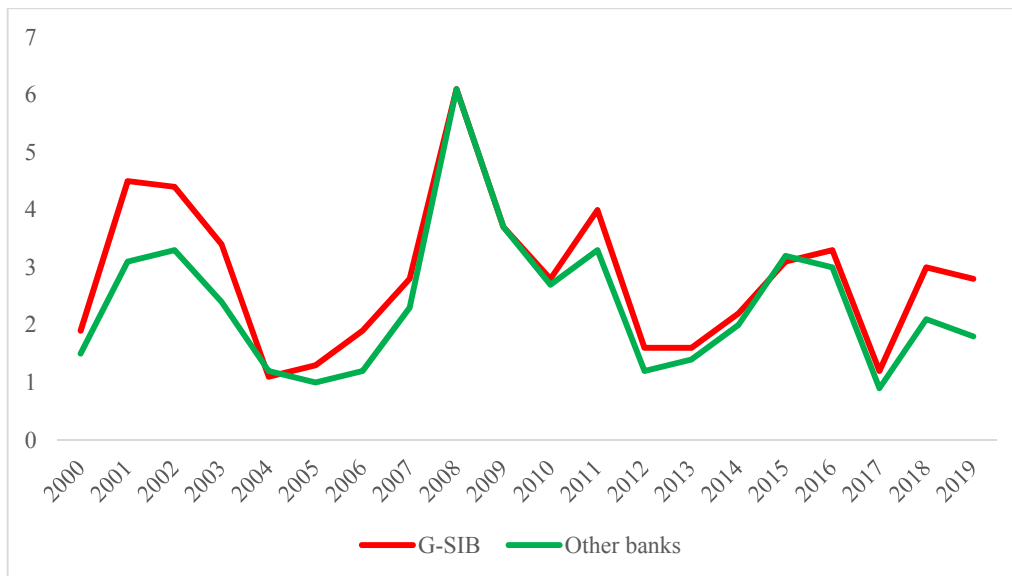
Fig. 1. **Dynamics of ΔCoVaR for G-SIBs and the Remaining Banks in 2000–2019**
Source: Furukawa K. et al. [22].

**Systemic Risks in the Context
of Microprudential Supervision**

The modern world economy is affected by many factors, making it difficult to assess systemic risks. Despite the fact that the reform has contributed to their decrease, the absence of consistent approaches to analyzing the risks of systemic stress dilutes the understanding of stress resilience and financial stability.

The financial area experts are making efforts to develop the concept of systemic risk assessment. One of the approaches is ΔCoVaR [21], which defines systemic risks as financial system risks caused by a particular event (e.g., crisis developments) that, in turn, may cause dysfunction of a bank. Another approach relates to the aggregate ΔCoVaR [22], which is applied for a group of financial institutions, including G-SIBs, and demonstrates its rapid increase for all banks in the sample. Its fluctuations during the Global Financial Crisis and subsequent decline, while remaining volatile, reflect periods of economic instability (*Fig. 1*). The decrease of ΔCoVaR indicates a reduction in systemic risks in the global scope, remaining generally higher for G-SIBs compared with other banks, i.e. G-SIBs' level of systemic risk exceeds the risk of the other categories of banks.

Systemic risks are also evaluated using the SRISK coefficient [23, 24]. Compared to ΔCoVaR, with SRISK one can analyze capital shortages based on the specifics of banking performance, including the size of assets, leverage ratio, and risk level. However, SRISK may overestimate the level of systemic risk, as its original version does not include TLAC (see above). Alternatively, if the assets used in the calculation of TLAC are taken into consideration, it becomes apparent that in 2019, the share of G-SIBs with capital shortages because of a systemic stress event was less than in 2007, i.e. before the Global Financial Crisis (*Fig. 2*).

Assessing bank stress resilience from a systemic risk perspective requires focused attention from financial regulators. There are numerous works in the economic literature that are based on models with application of ΔCoVaR and SRISK, which contributes to a clearer understanding of the systemic risk sources, the extent of systemic stress, and the limits of their impact on both individual banks and the banking sector at large (see, for example, [25, 26]). Besides, by applying SRISK, it was revealed the response of the potential systemic risks on the monetary policy decisions [27], that expands the
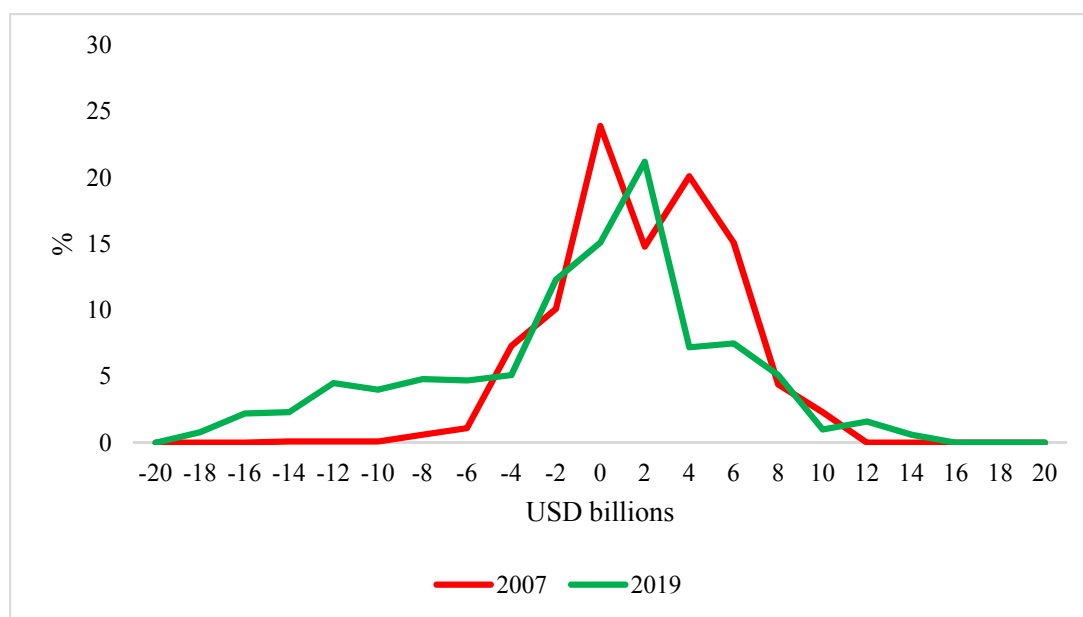
Fig. 2. **Distribution of SRISK for G-SIBs in 2007 and 2019**
Source: Furukawa K. et al. [22].

understanding of the banks' risk-oriented behavior. Calculations based on such models typically show higher level of systemic risk than those identified by the application of microprudential standards. It is likely that, if introduced to regulatory practice, such an approach will meet the expectations of international regulators in their search for effective regulatory instruments that would absorb losses stemming from external shocks. This would allow to accurately calculating the amount required by banks to ensure their performance efficiency despite economic instability and crisis developments, and ultimately — to increase the efficiency of approaches towards financial stability.

ADAPTATION OF BANKS TO THE POST-CRISIS REGULATORY MODEL

Banks' Performance Efficiency in the Context of Tightened Microprudential Supervision

Although the reform has contributed to strengthening the stress resilience of banks, their adaptation to the new supervisory standards and their role in ensuring economic growth still require further research. The post-crisis mechanism of microprudential

policy has considerably improved bank capital structure. According to the Bank of International Settlements, the level of CET 1 capital adequacy ratio of 105 internationally active banks increased from 7.2% in 2011 to 14.0% in 2019, the adequacy of Tier 1 capital increased from 3.5% to 6.0%, and the amount of highly liquid assets on their balance sheets increased by 50% in the same period — up to 10.7 trillion euros.[6]

The growth of banks' capital created new opportunities for them: the focus of their activities changed from the securities markets to traditional banking area. Despite increased minimum leverage requirements and decreased return on equity (ROE), banks have been able to strengthen their stress resilience, as noted above. By the end of 2016, the process of the banking sector adaptation in the countries that implemented the Basel III standards had been completed.[7]

The objectives of higher stress resilience required banks to direct their internal

---

[6] Bank for International Settlements (2021) Crossing the Basel III implementation line. 15 April. URL: https://www.bis.org/speeches/sp210415.pdf (accessed on 24.03.2022).

[7] Structural changes in banking after the crisis. Bank for International Settlements. January 2018. P. 50. URL: https://www.bis.org/publ/cgfs60.pdf (accessed on 24.03.2022).

resources to increase equity and attraction of additional liquidity as a cushion in periods of instability. Therefore, the adaptation process have to decide between stress resilience of banks and financial stability on the one hand, and economic growth, on the other.

Banks' Adaptation to Post-Crisis Regulation as a Key to Economic Growth

In the early stages of the reform, financial experts opined that higher minimum capital adequacy requirements would inevitably slowdown in GDP growth rates, resulting in the reduced access to credit facilities.[8] However, as the reform developed, so did the assessment of its effect on economic growth. The introduction of the Basel III standards, along with the macroprudential regulation measures, has contributed to certain reduction in the level of pro-cyclicality of banking activities [28] mainly due to the shift to a more prudent credit policy. In such circumstances, the credit activity of banks should decrease and, accordingly, be a factor restraining economic growth [29]. However, a number of studies show the opposite effect — the counter cyclicality of regulatory policy does contribute to economic growth [30, 31], which is stipulated not only by the higher level of credit capacity of the banks, but also by their prioritization of traditional banking services.[9]

The increase in the bank lending capability amid the rigorous regulatory framework looks paradoxical, but there are reasonable reasons behind this phenomenon, including the timely and immediate adjustment of their operating models [32], the diversification of the revenue sources [33], the optimization of the asset structure [34], and the increase in operating profits [6]. At the same time, banking activities are often associated with increased risk [35], including in order to squeeze additional profits needed to maintain regulatory compliance. On the other hand, the reduced dependence of banking performance on the rigor of the supervisory standards demonstrates the successful adaptation of banks to the reform, which substantially increased their resilience to external shocks[10] and reduced their vulnerability to crisis developments during the COVID-19 pandemic, despite its unexpectedness and non-economic causes.

In this regard, the only way in solving the dilemma between economic growth and financial stability is to ensure the banking sector's ability to provide the market with additional liquidity regardless of the specifics of supervisory requirements and external shocks. In other words, the level of conservatism in banking activities and supervisory requirements should be limited to the extent that they do not hinder economic growth and contribute to mitigation of systemic stress.

CONCLUSION

International banking regulation reform has achieved the objective of ensuring the stress resilience of banks, which is one of the main contributors to financial stability. In particular, the introduction of the post-crisis supervisory standards has been accompanied by the improved approaches to credit risk management, reduced bank capital shortage and lower level of systemic risks. At the same time, the reform's impact on economic growth remains ambiguous. The more rigorous supervision may reduce economic activity. On the one hand, the reform resulted in a short-term credit contraction, which limited lending in the early stages of the reform and led to a relatively slow post-crisis recovery. On the other hand, the reform prevented new financial shocks, the economic cost of which

---

[8] Assessing the macroeconomic impact of the transition to stronger capital and liquidity requirements. Bank for International Settlements. December 2010. P. 1. URL: https://www.bis.org/publ/othp12.pdf (accessed on 26.03.2022).

[9] So, it draws attention to the increase of the balance sheet of the above 105 banks over the period considered by 25%, which occurred mainly due to increased loans volumes.

[10] Structural changes in banking after the crisis. Bank for International Settlements. January 2018. P. 50. URL: https://www.bis.org/publ/cgfs60.pdf (accessed on 26.03.2022).

could have devalued all previous efforts by international regulators in ensuring the integrity of the banking sector. This is to note that consistency of the reform yielded in banks' adaptation at minimal apparent cost, which has allowed them to restore their role as drivers of economic growth.

The results of this study show the interplay and complementarity of the objectives of the reform, contributing to the formation of economic immunity in the banking sector. At the same time, the effectiveness of their interplay is constrained by the lack of a one-size-fits-all approach in assessing credit and systemic risks, as well as the absence of consensus on the adaptability of banks to the reform.

Despite the timeliness of regulatory actions on systemic risks, future periods of instability might require principally different regulatory approaches in the absence of the economic recipes required for mitigation of such threats. However, with the stress resilience of the world's banking systems during the COVID-19 pandemic, it is unlikely that banks will be vulnerable to external shocks leading to their dysfunction. Given the uncertainty and potential severity of future crises, as well as the need to reinforce the regulatory framework's crisis mitigation base, the adoption of singular approaches to systemic risk assessment in supervisory practice seems unavoidable. In this regard, further improvement of the regulatory mechanism could be based on common, internationally agreed stress resilience criteria for banks subject to the specifics of the national banking systems. At the same time, regulatory policy convergence could be based on EU experience in the development of supranational system of financial regulatory authorities. This will require incentives for convergence and, for non-BCBS countries, incentives for accession to the Basel Accords.

REFERENCES

1. Khan H.H. Bank competition, financial development and macroeconomic stability: Empirical evidence from emerging economies. *Economic Systems*. 2022;46(4):101022. DOI: 10.1016/j.ecosys.2022.101022

2. Borsuk M., Budnik K., Volk M. Buffer use and lending impact. ECB Macroprudential Bulletin. 2020;(11). URL: https://www.ecb.europa.eu/pub/financial-stability/macroprudential-bulletin/html/ecb. mpbu202010_2~400e8324f1.en.html

3. Gehrig T., Iannino M.C. Did the Basel Process of capital regulation enhance the resiliency of European banks? *Journal of Financial Stability*. 2021;55:100904. DOI: 10.1016/j.jfs.2021.100904

4. Pochea M.M., Niţoi M. The impact of prudential toolkits on loan growth in Central and Eastern European banking systems. *Economic Systems*. 2021;45(1):100767. DOI: 10.1016/j.ecosys.2020.100767

5. Behn M., Schramm A. The impact of G-SIB identification on bank lending: Evidence from syndicated loans. *Journal of Financial Stability*. 2021;57:100930. DOI: 10.1016/j.jfs.2021.100930

6. Le T.N.L., Nasir M.A., Huynh T.L.D. Capital requirements and banks performance under Basel-III: A comparative analysis of Australian and British banks. *The Quarterly Review of Economics and Finance*. 2023;87:146–157. DOI: 10.1016/j.qref.2020.06.001

7. Naceur S.B., Marton K., Roulet C. Basel III and bank-lending: Evidence from the United States and Europe. *Journal of Financial Stability*. 2018;39:1–27. DOI: 10.1016/j.jfs.2018.08.002

8. Cappelletti G., Marques A.P., Vassaro P., Budrys Ž., Peeters J. Impact of higher capital buffers on banks' lending and risk-taking: Evidence from the Euro Area experiments. ECB Working Paper. 2019;(2292). URL: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2292~77deb8b18f.en.pdf

9. Cantú C., Lobato R., López C., López-Gallo F. A loan-level analysis of financial resilience in Mexico. *Journal of Banking & Finance*. 2022;135:105951. DOI: 10.1016/j.jbankfin.2020.105951

10. Bui C., Scheule H., Wu E. The value of bank capital buffers in maintaining financial system resilience. *Journal of Financial Stability*. 2017;33:23–40. DOI: 10.1016/j.jfs.2017.10.006

11. Dua P., Kapur H. Macro stress testing and resilience assessment of Indian banking. *Journal of Policy Modeling*. 2018;40(2):452–475. DOI: 10.1016/j.jpolmod.2018.01.005

12. Andrieş A.M., Ongena S., Sprincean N., Tunaru R. Risk spillovers and interconnectedness between systemically important institutions. *Journal of Financial Stability*. 2022;58:100963. DOI: 10.1016/j.jfs.2021.100963

13. Cabrera M., Dwyer G.P., Nieto M.J. The G-20's regulatory agenda and banks' risk. *Journal of Financial Stability*. 2018;39:66–78. DOI:_10.1016/j.jfs.2018.09.001

14. Dzhagityan E., Orekhov M. Global systemically important banks: Do they still pose risks for financial stability? *Vestnik mezhdunarodnykh organizatsii: obrazovanie, nauka, novaya ekonomika = International Organisations Research Journal*. 2022;17(3):48–74. (In Russ.). DOI: 10.17323/1996–7845–2022–03–03

15. Poledna S., Bochmann O., Thurner S. Basel III capital surcharges for G-SIBs are far less effective in managing systemic risk in comparison to network-based, systemic risk-dependent financial transaction taxes. *Journal of Economic Dynamics and Control*. 2017;77:231–246. DOI: 10.1016/j.jedc.2017.02.004

16. Bongini P., Clemente G.P., Grassi R. Interconnectedness, G-SIBs and network dynamics of global banking. *Finance Research Letters*. 2018;27:185–192. DOI: 10.1016/j.frl.2018.03.002

17. Martynova N., Vogel U. Banks' complexity-risk nexus and the role of regulation. *Journal of Banking & Finance*. 2022;134:106120. DOI: 10.1016/j.jbankfin.2021.106120

18. Bakkar Y., Nyola A.P. Internationalization, foreign complexity and systemic risk: Evidence from European banks. *Journal of Financial Stability*. 2021;55:100892. DOI: 10.1016/j.jfs.2021.100892

19. Morelli D., Vioto D. Assessing the contribution of China's financial sectors to systemic risk. *Journal of Financial Stability*. 2020;50:100777. DOI: 10.1016/j.jfs.2020.100777

20. Wang G.-J., Jiang Z.-Q., Lin M., Xie C., Stanley H.E. Interconnectedness and systemic risk of China's financial institutions. *Emerging Markets Review*. 2018;35:1–18. DOI: 10.1016/j.ememar.2017.12.001

21. Adrian T., Brunnermeier M.K. CoVaR. *American Economic Review*. 2016;106(7):1705–1741. DOI: 10.1257/aer.20120555

22. Furukawa K., Ichiue H., Kimura Y., Shiraki N. Too-big-to-fail reforms and systemic risk. Bank of Japan Working Paper Series. 2021;(21-E-1). URL: https://www.boj.or.jp/en/research/wps_rev/wps_2021/data/wp21e01.pdf

23. Acharya V., Engle R., Richardson M. Capital shortfall: A new approach to ranking and regulating systemic risks. *American Economic Review*. 2012;102(3):59–64. DOI: 10.1257/aer.102.3.59

24. Brownlees C.T., Engle R.F. SRISK: A conditional capital shortfall measure of systemic risk. *The Review of Financial Studies*. 2017;30(1):48–79. DOI: 10.1093/rfs/hhw060

25. Nivorozhkin E., Chondrogiannis I. Shifting balances of systemic risk in the Chinese banking sector: Determinants and trends. *Journal of International Financial Markets, Institutions and Money*. 2022;76:101465. DOI: 10.1016/j.intfin.2021.101465

26. Brownlees C., Chabot B., Ghysels E., Kurz C. Back to the future: Backtesting systemic risk measures during historical bank runs and the great depression. *Journal of Banking & Finance*. 2020;113:105736. DOI: 10.1016/j.jbankfin.2020.105736

27. Dzhagityan E.P., Mukhametov O.R. The effect of the ECB's unconventional monetary policy on systemic risks in the eurozone. *Voprosy ekonomiki*. 2023;(12):86–102. (In Russ.). DOI: 10.32609/0042–8736–2023–12–86–102

28. Yu J., Ryu D. Effectiveness of the Basel III framework: Procyclicality in the banking sector and macroeconomic fluctuations. *The Singapore Economic Review*. 2021;66(3):855–879. DOI: 10.1142/S 0217590820460066

29. Asteriou D., Spanos K. The relationship between financial development and economic growth during the recent crisis: Evidence from the EU. *Finance Research Letters*. 2019;28:238–245. DOI: 10.1016/j.frl.2018.05.011

30. Stewart R., Chowdhury M., Arjoon V. Bank stability and economic growth: Trade-offs or opportunities? *Empirical Economics*. 2021;61(2):827–853. DOI: 10.1007/s00181–020–01886–4

31. Neanidis K.C. Volatile capital flows and economic growth: The role of banking supervision. *Journal of Financial Stability*. 2019;40:77–93. DOI: 10.1016/j.jfs.2018.05.002

32. Behn M., Mangiante G., Parisi L., Wedow M. Behind the scenes of the beauty contest: Window dressing and the G-SIB framework. ECB Working Paper Series. 2019;(2298). URL: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2298~c461fb89c7.en.pdf

33. Oino I. Impact of regulatory capital on European banks financial performance: A review of post global financial crisis. *Research in International Business and Finance*. 2018;44:309–318. DOI: 10.1016/j.ribaf.2017.07.099

34. Mayordomo S., Rodríguez-Moreno M. How do European banks cope with macroprudential capital requirements. *Finance Research Letters*. 2021;38:101459. DOI: 10.1016/j.frl.2020.101459

35. Sivec V., Volk M. Bank response to policy-related changes in capital requirements. *The Quarterly Review of Economics and Finance*. 2021;80:868–877. DOI: 10.1016/j.qref.2019.04.013

ABOUT THE AUTHORS

Eduard P. Dzhagityan — Cand. Sci. (Econ.), Assoc. Prof., HSE University, Moscow, Russia
https://orcid.org/0000-0003-3164-4696
Corresponding author:
edzhagityan@hse.ru

Oscar R. Mukhametov — PhD student, Visiting Lecturer, HSE University, Moscow, Russia; Analyst, Financial Research Institute of the Ministry of Finance of the Russian Federation, Moscow, Russia
https://orcid.org/0000-0003-2768-1216
or.mukhametov@hse.ru

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

Business Ecosystem Finance: Modern Agenda and Challenges

I.M. Stepnov[a], J.A. Kovalchuk[b]
[a, b] Financial University, Moscow, Russia;
[b] Moscow Aviation Institute, Moscow, Russia

ABSTRACT

The relevance of the research is confirmed by the fact that, with the widespread distribution of ecosystems as high-tech heirs of clusters and platforms, the issues of financing business ecosystems are rarely studied in the scientific literature and do not receive the necessary theoretical generalization. **The purpose of the research** is to systematize the available forms of financing in industrial business ecosystems within a united digital space. **The objectives of this research** are defined as clarifying the need to include financing functions in the toolkit of emerging industrial business ecosystems and revealing the possibilities of using selected financing methods. **The methods of research**, on the one hand, are based on the emerging theory of ecosystems, which develops both as a firm's theory and as ecosystem management, and on the other hand, on a new concept that can be formulated as a fusion of finance, industrialization and digitalization. **The results of the research** show that there are several approaches to the organization of ecosystem finance. Ecosystems are reported to be equally susceptible to decentralized and centralized (traditional) financing, providing opportunities to create their own decentralized financial environment as well as collaborating with current cryptocurrency-based services. Several forms of financial organization in ecosystems have been identified: a) compensating costs by forming budgets for the creation and ongoing activities; b) attracting ecosystem participants' own funds to various forms of lending (including on the basis of financial technologies). **It is concluded** that the development of financing instruments depends on three factors: 1) government policies to regulate the financial aspects of business ecosystems; 2) the efficiency of using the resources of ecosystem participants; 3) ecosystem interactions with supply chains. It is determined that a completely new theory of business ecosystem finance will be completed only after the exit from the experimental mode of financing business ecosystems.

Keywords: finance; digital finance; financing; industrialization; digitalization; ecosystem; business ecosystem; business model; supply chains; digital economy

INTRODUCTION

The increase in the share of digital solutions in business communications significantly stimulates the creation of fundamentally new forms of interaction of economic agents. This innovative renewal of interaction is aided by the fact that practical solutions, particularly in the field of financing, exceed theoretical generalizations. The new forms of business interaction should include ecosystems, or, according to the work of the author of the ecosystem concept J. Moore [1, 2], business ecosystems. According to experts,[1] from 2018 to 2020, the Russian ecosystem market in terms of subscriptions to services grew more than 12 times. By 2024 (compared to 2020) it is expected to increase by almost 4 times, and by 2030 about 55 mln Russians will be subscribers of ecosystems with a monthly fee of at least 200 rubles.[2]

The success of such industrial business ecosystems as *Huawei, Haier, Samsung Electronics* and others, which grow by bln USD annually, should be mentioned first of all. *Samsung Electronics* recorded revenue of 234 bln USD in 2022,[3] growing by 10% over the year, and *Haier* continues to strengthen its position in the markets, reaching revenues of 243.5 bln yuan and increasing net profit by 12.5% — to 14.7 bln yuan.[4] US sanctions led to a record 69% fall in *Huawei's* net profit to 5.2 bln USD in 2022, but revenue remained virtually unchanged to 92.38 bln USD (or 642.34 bln yuan).[5]

Service ecosystems (Sber, Yandex, VK, MTS) are currently predominant in Russia, which together have ensured an average annual revenue growth of 165% over the last 5 years[6] — from 0.4 to 19.7 bln USD (*Fig. 1*), which requires appropriate funding, while only the Sber ecosystem is provided with its own funding.

Applications for the creation of production business ecosystems are also declared by most of the largest Russian companies with state participation, for example, such as Rostec and Rosatom (with turnovers of more than 1.5 trn rubles each), although elements of such forms create almost all Russian companies, not only implementing such financial solutions as *"Buy now, pay later", "Integration of financial services with ecosystem", "Full cycle: "purchase-payment", "Digital dual asset management"* and others, but also considering the possibility of using digital financial assets.

The successes of the practice implementation lead to a substantial increase in publications devoted to the classification of business ecosystems and their economic, entrepreneurial, and social essence (to which a lot of foreign reviews are devoted, for example, D. Teece [3], E. Altman [4], R. Kapoor [5], M. Jacobides [6], X. Parisot [7], M. Spaniol and N. Rowland [8] and others, and Russian publications, first of all, A.V. Babkin [9], E. A. Tretiakova [10], E.V. Popov [11], T. O. Tolstykh [12] and others).

In many publications on business ecosystems, most researchers (except for publications devoted to crypto assets) do not analyze the question of financing new structural solutions, both planned and current. In one of J. Moore's most recent publications, dedicated to the man in the ecosystem [13], the word "finance" does not appear, as if ecosystems have the ability to attract finance without any problems. J. Moore restricts his paper to the cost of the business ecosystem to support the creativity

---

[1] ICT Moscow. J'son & Partners Consulting. Russian ecosystems. Players, services, subscriptions, user experience fom2018–2024. URL: https://ict.moscow/research/ekosistemy-rossii-igroki-servisy-podpiski-polzovatelskii-opyt-2018–2024/?amp&amp&amp (accessed on 17.04.2023).

[2] Petrova J. By 2030, ecosystems in Russia will have 55 million subscribers. Frank Media, 01.02.2022. URL: https://frankrg.com/58581 (accessed on 17.04.2023).

[3] Consolidated Financial Statements of Samsung Electronics Co., Ltd. and its Subsidiaries Index to Financial Statements. URL: https://images.samsung.com/is/content/samsung/assets/global/ir/docs/2022_con_quarter04_all_1.pdf (accessed on 17.04.2023).

[4] Haier Smart Home Co., Ltd. 2022 Annual Report. URL: https://smart-home.haier.com/en/gpxx/?id=yjbg&spm=inverstor.31547_pc.irheader_20200506_2.2 (accessed on 17.04.2023).

[5] Huawei Investment & Holding Co., Ltd. 2022 Annual Report. URL: https://www-file.huawei.com/minisite/media/annual_report/annual_report_2022_en.pdf (accessed on 17.04.2023).

[6] The role of ecosystems and marketplaces in the development of small and medium-sized enterprises in Russia. June 2022. URL: https://delret.ru/research/rol-ekosistem-marketplejsov (accessed on 17.04.2023).
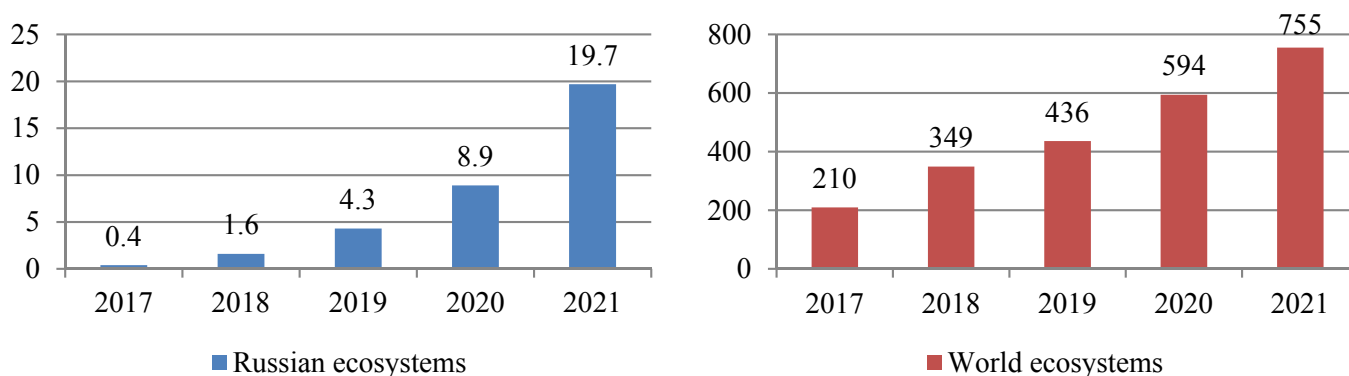
Fig. 1. Comparison of Ecosystem Revenue Growth, Billion Dollars

Source: The role of ecosystems and marketplaces in the development of small and medium-sized businesses in Russia. June 2022. URL: https://delret.ru/research/rol-ekosistem-marketplejsov (accessed on 17.04.2023).

of the individual, providing "zero distance with the consumer" [13, p. 65].

At the same time, the supporters of the crypto approach, i.e. the use of cryptocurrency-based financing, are actively creating their own ecosystems, frequently allocating to them with the precision of the underlying cryptocurrency — the ecosystem of bitcoin, the ecosystem of Ethereum[7] etc., including the emergence of a new category — decentralized finance (DeFi) [14].

The second group of authors is determined that the implementation of ecosystems in industry does not require special solutions to attract financial resources and that the existing financial system of the state or corporations, for example, in an open innovation ecosystem [15, 16], allows such projects to be implemented successfully. This approach raises some doubts, as if it were fair, there would be no new challenges associated with the digitalization of finance.

Furthermore, financial technologies, which initially relied on the facts of accelerated settlements and ease of use [17], are beginning to prevail in a number of business ecosystems, not only as a settlement instrument, but also as a financing tool.

---

[7] Top 5 cryptocurrency ecosystems by capitalization in May 2022. Crypto.ru, 13.05.2022. URL: https://crypto.ru/top5-kriptovalyutnyh-ekosistem-po-kapitalizatsii/ (accessed on 17.04.2023).

At the same time, in practice, key beneficiaries of the results of digitalization have also not completed their choice regarding the role of finance in the ecosystem. Many banks, for example, try to get involved in the digital economy by focusing on the real sector rather than the financial sector, which is supported by the perspective of central banks actively examining the capabilities of digital financial instruments. At the same time, the consulting company *BSC* insists in its reviews that financial institutions pay attention to digital ecosystems [18], which will either enable banks to recover from the crisis phenomena of the last two decades, or have the possibility of being consumed by them if they refuse to cooperate with business ecosystems.

All of this allows us to emphasize the importance of the chosen subject, to formulate the purpose of our research — the systematization of available forms of funding for ecosystems — and to initiate a discussion that will allow us to define the contours of the changes that are affecting the financing of projects, specifically industrial business ecosystem functions in the format of the digital economy (*Fig. 2*).

Not all directions of digitalization (not the complete model of the digital economy) are considered the object of the study, but only the part that is aimed at creating a single digital space in industry as a business ecosystem,
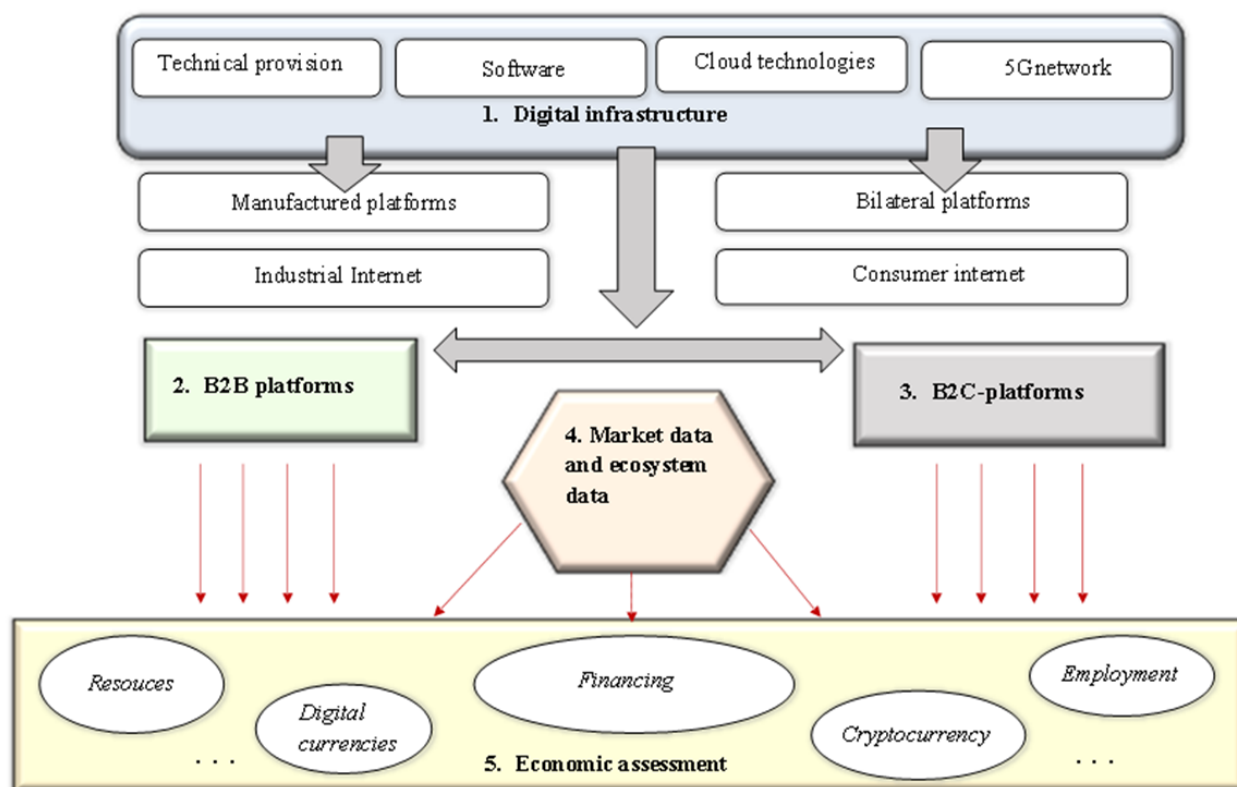
Fig. 2. **The Structure of the Digital Economy**
Source: Adapted by the authors based on [19].

which allows to clarify the research question and to specify the objectives of this study: 1) indicate the need for financial services to be included in the toolset of growing industrial business ecosystems; 2) discover possible financing methods in digital ecosystems. The theoretical basis of the first problem is contained in the paper of R. Levine and S. Zervos [20], in which it is justified that it is finance that is an important driving force that contributes to the modernization of the industrial structure.

When considering the problem presented in this study, we use two classic approaches to understanding finance: a) the distribution of resources over time, according to the classical vision (E. Fama and M. Miller [21]), and b) how to manage cash flows through various organizations (first of all, business ecosystems in the modern vision, not yet having organizational and legal status), according to the classic approach (J. Hampton [22]).

METHODOLOGY

We are based on the assumption that funding is an indispensable resource without which any form of business, including ecosystems, is impossible. Not to mention the nature of finance (their role and origin), the two approaches to finance functions (reproductive and distributive), note that finance as a resource does not lose its significance in the digital economy, and finance remains an important component of the success of any project.

The methods of research are the systemic approach and its modification — the ecosystem approach. The basis of the ecosystem approach to the study is the creation of the theory of ecosystems, for example [3–6], including publications that extend the boundaries of modern firm theory to ecosystems [23].

Over a 15-year period, the research was based on scientific publications that both
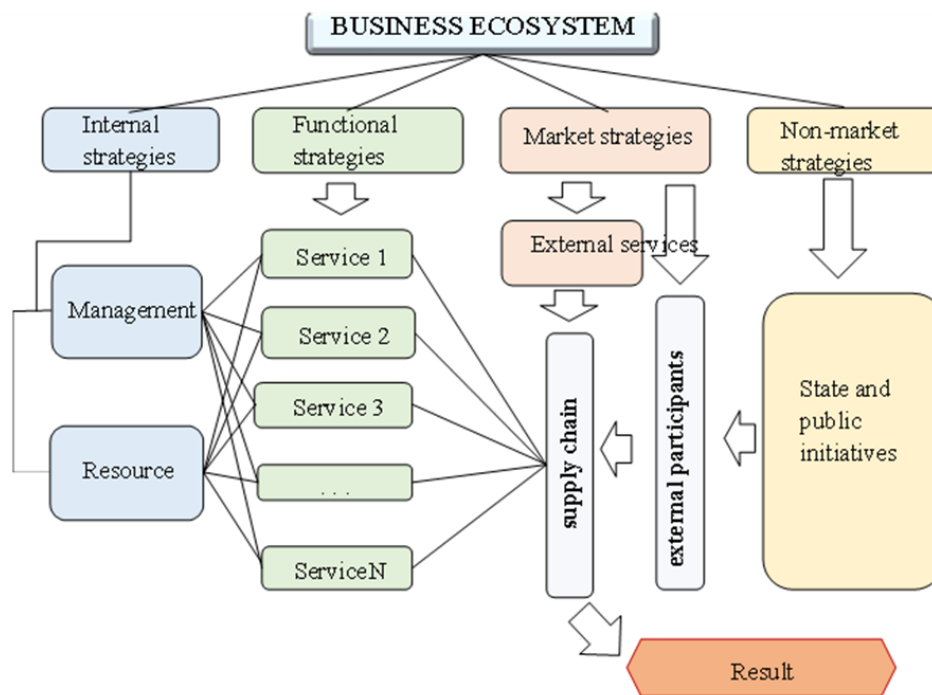
Fig. 3. **Generalized Management Model of the Business Ecosystem**
Source: Clarified by the authors based on [24].

generalized ideas about ecosystems and digital platforms and revealed specific features of different ecosystem types. We use the following model to ensure the consistency of business ecosystems (*Fig. 3*). It should be noted that this presentation does not contain any financing solutions.

The most promising approach to considering the financing of selected types of ecosystems (manufactured or industrial), in our view, is the concept of "*FID* — fusion of industrialization and digitalization" [25], which authors point to the required resources, assuming that financial support is one of them. This approach is consistent with our decisions, when we say that modern technology has a complex structure (with transformative and managing components) [26], while the authors of the quoted article talk about the two cores of the business ecosystem — production and management. It should be noted that, in terms of financing, such a concept should be supplemented, and it would be right to call it *FFID* (Fusion of Finance, Industrialization and Digitalization).

RESULTS AND DISCUSSION

Basic of the study is the conclusion that at present the appearance of a single financial mechanism of business ecosystems has not developed. Various sources of finance resources for ecosystems are combined designs, using the potential of both traditional finance and virtual (or digital). In fact, we can assume that ecosystem finance is currently in a pilot mode, completion of which will identify key development directions, but we can already note that banks working with ecosystems [18] are achieving better financial performance than the traditional banking sector.

As a result of this study, we managed to systematize several approaches to solving the issue of providing financial resources for the activities of ecosystems (*Fig. 4*).

Ecosystem cost compensation, including budget allocation for its functioning ("Internal strategies", *Fig. 4***)**
A number of studies [27, 28] show that the original appearance of a projected ecosystem
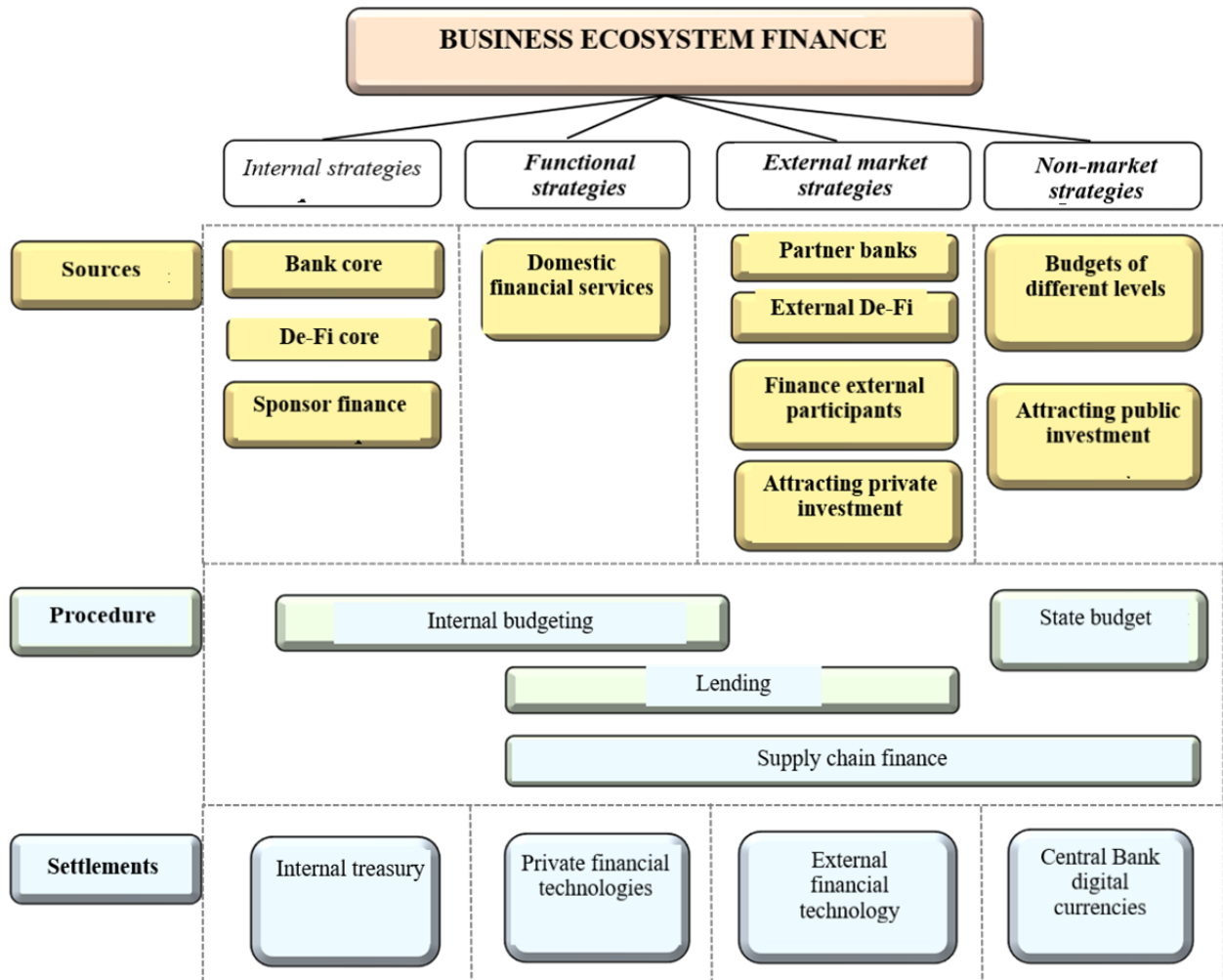
Fig. 4. **Organizational Structure of Business Ecosystem's Financial Sector Based on a Generalized Model**
Source: Developed by the authors.

is usually fixed at the time of creation and dynamically revised as it develops. This uncertainty leads to the conclusion that, in the initial design of ecosystem relationships, it is impossible to set the purpose of returns. In most of M. Jacobides's publications and ecosystem synthesis [6], it is assumed that ecosystem financing is costly, on the assumption that it creates a more efficient form of governance rather than a more effective form of profit. Accordingly, like any other management, ecosystem management must have a budget for its creation and maintenance. The effectiveness of such a budget is based on the fact that the ecosystem: a) either reduces exchange costs, thereby improving the outcome of financial transactions; b) increases sales, thus realizing the scale effect. Most platform

and subsequent ecosystem solutions are based on these preconditions, as are J. Moore, who argues that ecosystems create a new space for human development, or M. Jacobides, who more confidently speaks of creating a new resource management system.

The cost approach is implemented by allocating a budget without demanding efficiency, but with predetermined results. Note that business ecosystems do not have organizational and legal forms, and, for example, in article M. Jovanovic et al. [29] the concept of "ecosystem sponsor" is introduced for an ecosystem investor who is entrusted with relations related to the organizational-legal form. On the basis of its own financial resources, the sponsor also manages the involvement of potential participants [30, 31].

The budget allocated by the sponsor (as initial capital investments) ensures a broader market presence [32, 33] in line with the interests of the stakeholders in the sector [34].

In any case, the cost model is applicable, and in the initial stages of constructing business ecosystems, it is even required, but it should be emphasized that the cost model itself can contribute to the collapse of the ecosystem formed (especially if the business model is incorrect).

In general, the cost ecosystem financing model is intuitive because the emergence of new digital opportunities is closer to its approach to infrastructure solutions. It should be noted that the participation of the state in the creation of, for example, industrial ecosystems is also likely to be cost-effective. Unfortunately, the existing theoretical basis does not for the estimation of the size of such budgets, and empirical data are still insufficient. At the same time, the creation of many ecosystems is linked to the implementation of the concept of technological leadership, where the amount of resources allocated is determined by opportunity rather than economically reasonable costs.

Use of credit money in the functioning of the ecosystem ("Functional strategies", *Fig. 4*) and partner banks ("Market strategies", *Fig. 4*)

Cost financing is not feasible when implementing directly operational activities, so in this case, a different approach is required: the use of borrowed funds, the source of which can be the ecosystem itself, based on the banking (or cryptocurrency) core.

Currently, the unavailability for business ecosystems of the classic instrument of attracting financing through an *IPO* (as equity) significantly increases the significance of credit money for ecosystems. There is no doubt that an *IPO* can be carried out by a parent company, but in this case, the financing model will be reduced to the first approach — cost financing.

With such financing, integration of virtual and traditional finance is acceptable — for

example, the use of procedures for lending in cryptocurrencies and subsequent conversion into fiat currencies with the appropriate reverse process. Note that this approach also requires the use of swaps, which must be included in the financial services of ecosystems due to the high current volatility of cryptocurrencies. The possibility of such a solution arises from the comparability of the money supply, for example, the ruble and the capitalization of cryptocurrencies (*Fig. 5*).

The ecosystem mechanism (*Fig. 3*) may provide for a procedure (as a functioning service) to attract credit similar to a banking or DeFi organization (compliant with national legislation). At the same time, by its economic nature, the financial service of the ecosystem is more of an intermediary than a full-fledged business.

One of the possible ways of creating a financial service in the business ecosystem is the acquisition of banks and the formation of an internal service from them (*Fig. 4*). An alternative to this approach is the creation by the bank of a new unit that performs settlements within the framework of the ecosystem management of the partner company, such as, for example, *Goldman Sachs*[8] for *Apple*. At the same time, credit money arises as a result of settlements, but additional cash resource generation is not completed.

The most common mechanism of using credit resources to finance ecosystems is reversible factoring, which allows us to talk about replacing the "pushing" approach to the flow of finance with "pulling".

The "buy now — pay later" mechanism, based on artificial intelligence and business analytics, is also beginning to gain personal place and importance, allowing for reverse factoring intermediaries within supply chains. In this case, the reverse factoring is not completed by the end consumer, but by an internal intermediary, who, for example, buys

---

[8] Podkletnov A. Goldman Sachs has billions of dollars in losses due to the Apple card. Is that true? Habr, 15.02.2023. URL: https://habr.com/ru/articles/716950/ (accessed on 17.04.2023).
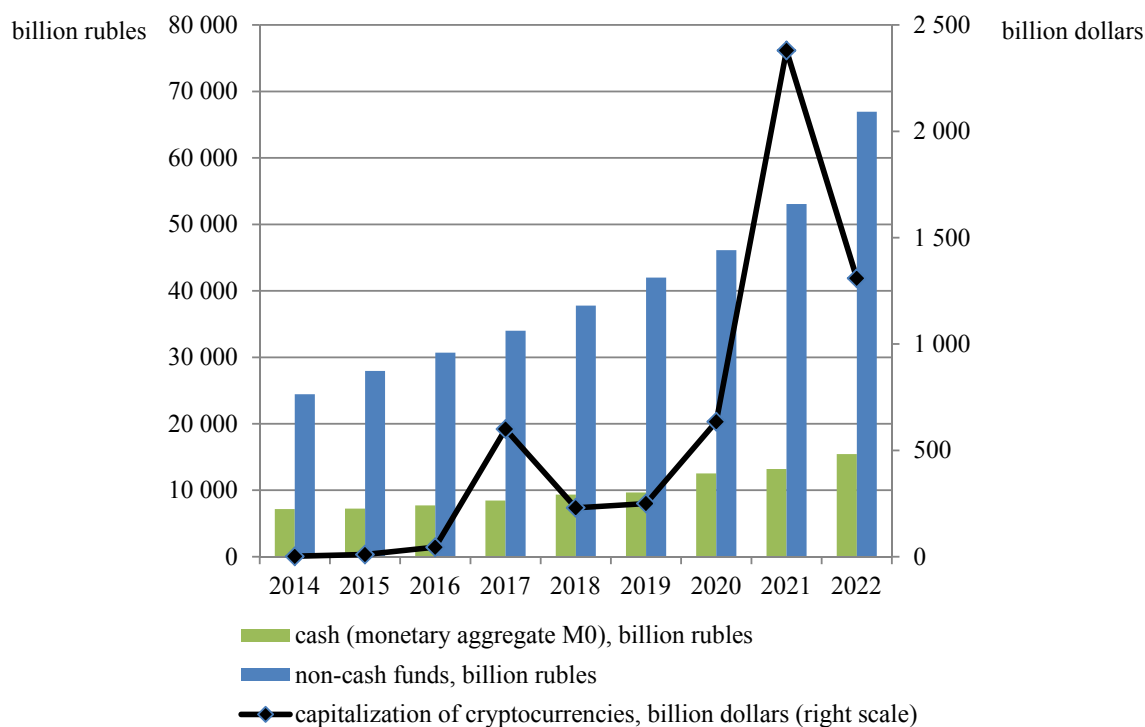
Fig. 5. **Dynamics of Money Supply Indicators in the Russian Federation and the World Market Capitalization of Cryptocurrencies**

Source: Compiled by the authors based on data from: Bank of Russia. Money supply (national definition). URL: https://cbr.ru/statistics/ms/; Digital Economy Compass 2022. URL: https://www.statista.com/study/128160/digital-economy-compass-2022/#professional (accessed on 17.04.2023).

a batch of goods whose sales are guaranteed by business analytics forecasts, providing the final consumer with payment terms.

Furthermore, the attractiveness of full-cycle financing (so-called "purchase-payment") is increasing, which can be completed either with advance payment or entirely on the basis of credit money. This model is often used for collaborative economic solutions in which the return on credit investments in a collaborative business model is delivered through more efficient exploitation of an asset than a conventional purchase, providing a priority for protecting ownership of an ecosystem asset.

Use of the money of ecosystem participants ("Market strategies", *Fig. 4*)

A characteristic feature of almost all existing financial ecosystems is the attraction of participant funds to ensure their own cash flow. In the case of a bilateral contract, such

a participant continues to control the entire supply chain; however, ecosystems can be identified by the fact that complete control over the entire supply chain is not possible, and several participants are present in the same chain with their own funds. The success of such solutions requires the establishment of a clearing service within the ecosystem (*Fig. 3*).

Creation of financial technologies as own settlement instruments (including on the basis of digital financial assets) ("Functional Strategies", *Fig. 4*)

This approach requires a participant with their own financial resources to convert them into digital financial assets or financial technology units and use a supply chain tool that is inherent in the ecosystem. In addition to providing an additional commission (income) to the ecosystem, it enables consistency of settlements across the financial model and

necessary swapping independent of central banking and other regulatory. Note that the external consumer of the products and services of the ecosystem may not feel this approach to financing by making the usual purchase or sale of goods and services.

The disadvantage of this approach is the loss of part of the funds in the inputs and withdrawals of financial resources into the ecosystem, the need for continuous valuation of money in generally accepted currencies, and significant difficulties for public companies to conduct audits of their activities.

This strategy can be practically implemented by developing one's own calculating services as well as using well-known settlement services. The ecosystem can itself issue digital financial assets in one form or another, complying with the relevant legislation, generate its own cash, and use it directly as the currency of the ecosystems (e.g., Ethereum).

In the last case, the ecosystem will need an additional number of exchanges and other settlement centers to increase the liquidity of the digital financial asset used. If an ecosystem functions only as part of its interaction, i.e. the supply chain is completely absorbed by the ecosystems, then fintech solutions can be quite self-sufficient, and in this case, the main problem will be either limiting the volume of the issue of the calculation instruments (and the increase in the value of such an instrument) or the demand issue (and its devaluation).

Investment in the ecosystem: private ("Market strategy", *Fig. 4*) and public ("Non-market strategies", *Fig. 4*)

Such a process can be initiated by an inflow of external investment into the ecosystem (often sectoral in nature), in which external structures invest in the ecosystem in anticipation of higher returns than the current market return, or in anticipation of more effective achievement of required public policy objectives. For example, banks can open deposits in an ecosystem, the state can invest a certain budget or a return on funding into the

ecosystems, and how individual participants can invest (for example, to participate in the ecosystem you need to own a certain amount of coins issued by that ecosystem, as in the case of Dominica's digital citizenship[9]).

Supply chain financing

The question of competition and interaction of ecosystems and supply chains is relevant. Understanding the need to attract cash resources has the answer to the question of how different supply chain financing is in general and ecosystem financing in particular.

A comparison reveals that three different situations can be formed:

a) ecosystems and supply chains coexist (as shown in *Fig. 3* and *Fig. 4*);

b) supply chains complement the ecosystem (e.g. as a technology carrier, management, environment, etc.);

c) ecosystem complements the supply chains.

These situations do reflect the actual situation, but do not reveal the funding mechanism, as different funding needs arise depending on the method of interaction.

If, in case (a), it is possible to talk about resource sharing, then (b) the source of funding is generally the resources of the ecosystem, and (c) the ecosystem becomes a source of additional (transaction) costs.

The practice uses models of financing of early repayment of debt, pledge of movable property and reverse factoring financing, financing for receivable debt (direct factoring), funding for stocks (holding obligations), advance payment, and collateral of pre-paid goods for financing.

Thus, summarizing the results of the study, we note that the modern portfolio of financial instruments in ecosystems is combined, heterogeneous and developing, while there

---

[9] Announcement on Issuing First National Token DMC by Tron, Huobi, DMC Labs with Dominica Government Endorsement. Huobi, November 29, 2022. URL: https://www.huobi.com/support/en-us/detail/54924020805230 (accessed on 16.05.2023).

is no unity of sources of financing (at least, traditional and virtual).

CONCLUSION

The study, based on the fact that ecosystems are increasingly widespread, has shown that ecosystems can use both centralized, state-regulated and decentralized finance (in a way that is not contrary to government regulation). This combined opportunity enables a substantial increase in the volume of attracted financial resources and a reduction in their cost.

It is important to note that the need for initial funding based on cost compensation rather than project returns is a historical feature of ecosystems (contracted from platforms). As mentioned before, the word "sponsor" of the ecosystem is used for this purpose. This condition can act as an important barrier to the formation of ecosystems.

The financing characteristics of existing business ecosystems are largely dependent on their interaction with supply chains, including the three opportunities identified in the study (equal and mutually reinforcing impact, supply chain priority, ecosystem priority). Such interaction develops as a result of the distinctive features of the industry segment and the ecosystem managers' strategy.

Investment processes in ecosystems that are extremely attractive to large financial institutions and that respond promptly to changing financial relationships should also be analyzed. Central bank digital currencies will create more opportunities for direct investment, requiring financial institutions to decide between more active penetration into developing ecosystems or less active penetration.

The financial characteristics of ecosystems identified in this paper indicate that the funding tool is in the process of developing and requires long-term monitoring of financial experiments.

ACKNOWLEDGMENTS

REFERENCES

1. Moore J.F. The death of competition: Leadership and strategy in the age of business ecosystems. New York, NY: HarperCollins; 2016. 320 p.

2. Moore J.F. Business ecosystems and the view from the firm. *The Antitrust Bulletin*. 2006;51(1):31–75. DOI: 10.1177/0003603X0605100103

3. Teece D.J. Business ecosystem. In: Augier M., Teece D.J., eds. The Palgrave encyclopedia of strategic management. London: Palgrave Macmillan UK; 2018:151–154.

4. Altman E.J., Kiron D., Schwartz J., Jones R. The future of work is through workforce ecosystems. *MIT Sloan Management Review*. 2021;62:1–4.

5. Kapoor R., Lee J.M. Coordinating and competing in ecosystems: How organizational forms shape new technology investments. *Strategic Management Journal*. 2013;34(3):274–296. DOI: 10.1002/smj.2010

6. Jacobides M.G., Cennamo C., Gawer A. Towards a theory of ecosystems. *Strategic Management Journal*. 2018;39(8):2255–2276. DOI: 10.1002/smj.2904

7. Parisot X., Isckia T. Business ecosystem theorization: Towards a complex adaptive system framework applying a co-evolutionary metaphor. In: Proc. EURAM 2020 Online conf. "The business of now: The future starts here" (Dublin, December 4–6, 2020). Dublin: Trinity College, The University of Dublin; 2020:1660.

8. Spaniol M.J., Rowland N.J. Business ecosystems and the view from the future: The use of corporate foresight by stakeholders of the Ro-Ro shipping ecosystem in the Baltic Sea Region. *Technological Forecasting and Social Change*. 2022;184:121966. DOI: 10.1016/j.techfore.2022.121966

9. Babkin A.V., Alekseeva N.S. Trends in the development of the digital economy based on a study of scientometric databases. *Ekonomika i upravlenie = Economics and Management*. 2019;(6):16–25. (In Russ.). DOI: 10.35854/1998–1627–2019–6–16–25

10. Tretiakova E.A., Freyman E.N. Ecosystem approach in modern economic research. *Voprosy upravleniya = Management Issues*. 2022;(1):6–20. (In Russ.). DOI: 10.22394/2304–3369–2022–1–6–20

11. Popov E.V., Simonova V.L. Potential of a company's ecosystem digitalization. *Voprosy upravleniya = Management Issues*. 2022;(1):34–46. (In Russ.). DOI: 10.22394/2304–3369–2022–1–34–46

12. Tolstykh T.O. Shmeleva N.V., Klyuka F.O. Strategy of formation of industrial ecosystems for enterprises of the mineral resource complex. In: Theory and practice of strategizing: Coll. select. sci. pap. and conf. mater. Vol. II. Moscow: MISIS; 2022:53–59. (In Russ.).

13. Moore J.F., Rong K., Zhang R. The human ecosystem. *Journal of Digital Economy*. 2022;1(1):53–72. DOI: 10.1016/j.jdec.2022.08.002

14. Kovalchuk J.A., Stepnov I.M., Niyazova Yu.M. Decentralized financial services: Practical approaches and perspectives. *Informatsionno-ekonomicheskie aspekty standartizatsii i tekhnicheskogo regulirovaniya = Information and Economic Aspects of Standardization and Technical Regulation*. 2020;(5):104–113. (In Russ.).

15. Etzkowitz H., Zhou C. The triple helix: University-industry-government innovation and entrepreneurship. New York, NY: Routledge; 2017. 176 p.

16. Costa J., Moreira A.C. Public policies, open innovation ecosystems and innovation performance. Analysis of the impact of funding and regulations. *Journal of Open Innovation: Technology, Market, and Complexity*. 2022;8(4):210. DOI: 10.3390/joitmc8040210

17. Glebova A.G., Ivanovskaya Zh.B., Lukashenko I.V. Financial technologies of non-financial ecosystems: World practice. *Ekonomika. Nalogi. Pravo = Economics, Taxes & Law*. 2022;15(1):72–80. (In Russ.). DOI: 10.26794/1999–849X-2022–15–1–72–80

18. Ampenberger M., Hanspal R., Hochstein C., Pidun U., Ramachandran S. Financial institutions must get serious about digital ecosystems. Boston Consulting Group. Mar. 01, 2023. URL: https://www.bcg.com/publications/2023/exploring-digital-financial-ecosystem-opportunities (accessed on 17.04.2023).

19. Sharma A., Das N., Singh S.P. Causal association of entrepreneurship ecosystem and financial inclusion. *Heliyon*. 2023;9(3): e14596. DOI: 10.1016/j.heliyon.2023.e14596

20. Levine R., Zervos S. Stock market development and long-run growth. *The World Bank Economic Review*. 1996;10(2):323–339. DOI: 10.1093/wber/10.2.323

21. Fama E.F., Miller M.H. The theory of finance. New York, NY: Holt, Rinehart & Winston; 1972. 346 p.

22. Hampton J.J. Financial decision making: Concepts, problems, & cases. Englewood Cliffs, NJ: Prentice-Hall; 1989. 641 p.

23. Kohtamäki M. et al. Digital servitization business models in ecosystems: A theory of the firm. *Journal of Business Research*. 2019;104:380–392. DOI: 10.1016/j.jbusres.2019.06.027

24. Kovalchuk J.A., Stepnov I.M., Bikalenko M.S. Ecosystem approach to the management of economic agents' interaction in the industry. *Upravlencheskie nauki = Management Sciences*. 2022;12(3):6–23. (In Russ.). DOI: 10.26794/2304–022X-2022–12–3–6–23

25. Shi Y. et al. Fusions of industrialisation and digitalisation (FID) in the digital economy: Industrial system digitalisation, digital technology industrialisation, and beyond. *Journal of Digital Economy*. 2022;1(1):73–88. DOI: 10.1016/j.jdec.2022.08.005

26. Stepnov I. The uncertainty of the technological future. In: Stepnov I., ed. Technology and business strategy. Cham: Palgrave Macmillan; 2021. 314 p. DOI: 10.1007/978–3–030–63974–7_2

27. Tavalaei M.M., Cennamo C. In search of complementarities within and across platform ecosystems: complementors' relative standing and performance in mobile apps ecosystems. *Long Range Planning*. 2021;54(5):101994. DOI: 10.1016/j.lrp.2020.101994

28. Thomas L.D.W., Autio E., Gann D.M. Processes of ecosystem emergence. *Technovation*. 2022;115:102441. DOI: 10.1016/j.technovation.2021.102441

29. Jovanovic M. et al. Managing a blockchain-based platform ecosystem for industry-wide adoption: The case of TradeLens. *Technological Forecasting and Social Change*. 2022;184:121981. DOI: 10.1016/j.techfore.2022.121981

30. Beck R., Müller-Bloch C., King J.L. Governance in the Blockchain economy: A framework and research agenda. *Journal of the Association for Information Systems*. 2018;19(10):1020–1034. DOI: 10.17705/1jais.00518

31. Bonina C., Koskinen K., Eaton B., Gawer A. Digital platforms for development: Foundations and research agenda. *Information Systems Journal*. 2021;31(6):869–902. DOI: 10.1111/isj.12326

32. Kim W.C., Mauborgne R. Nondisruptive creation: Rethinking innovation and growth. *MIT Sloan Management Review*. 2019;60(3):1–11

33. Ozalp H., Cennamo C., Gawer A. Disruption in platform-based ecosystems. *Journal of Management Studies*. 2018;55(7):1203–1241. DOI: 10.1111/joms.12351

34. Jensen T., Hedman J., Henningsson S. How TradeLens delivers business value with blockchain technology. *MIS Quarterly Executive*. 2019;18(4):221–243. DOI: 10.17705/2msqe.00018

ABOUT THE AUTHORS

Igor M. Stepnov — Dr. Sci. (Econ.), Prof., Department of Corporate Finance and Corporate Governance, Financial University, Moscow, Russia
http://orcid.org/0000-0003-4107-6397
Corresponding author:
stepnoff@inbox.ru

Julia A. Kovalchuk — Dr. Sci. (Econ.), Prof., Department of Management and Marketing of High-Tech Industries, Moscow Aviation Institute, Moscow, Russia; Leading Researcher, Financial University, Moscow, Russia
http://orcid.org/0000-0002-9959-3090
fm-science@inbox.ru

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 18.04.2023; revised on 29.05.2023 and accepted for publication on 01.06.2023.
The authors read and approved the final version of the manuscript.

Methodological Aspects of Determining the Estimated (Marginal) Cost of Objects in the Implementation of Projects Based on the IPA

I.V. Kosorukova, S.G. Sternik, E.E. Heifets
Financial University, Moscow, Russia

ABSTRACT

The paper is devoted to the study of the issues of determining the estimated (marginal) cost of investment projects that are implemented within the framework of the IPA. The **purpose** of the study is to develop scientific and practical recommendations for determining the estimated (marginal) value of real estate objects created in the framework of investment projects implemented on the basis of the IPA. The paper is **relevant** because current regulatory documentation does not clearly define the concepts of estimated (marginal) cost of infrastructure objects, and there are no recommendations for their assessment, which leads to distortions of the cost base for obtaining subsidies and impacts the evaluation of the effectiveness of such projects. The **scientific novelty** of the research consists in the development of scientific and practical recommendations for determining the estimated (marginal) value of real estate objects created as part of an investment project implemented on the basis of the IPA. The authors used the following **methods** of scientific research: deduction, induction and logical method. The concept of the estimated (marginal) value of real estate objects is clarified, which is based on the estimated cost of construction, taking into account a certain number of assumptions. A review of the current methods of calculating the estimated value in Russia and abroad is conducted. It is **concluded** that in Russia there is no single base for determining the cost of the CIW. The basic index method in the prices of 2000–2001 significantly reduces the accuracy of calculations. The idea of forming a new dynamic system of the resource-index method, which takes into account the life cycle of a building and is based on big data of price information in construction, on the basis of which it is possible to develop a system of forecasting the estimated value of an object using machine learning methods, is prospective.

Keywords: estimated (marginal) value of real estate objects; investment promotion and protection agreements; estimated cost of construction

INTRODUCTION

In accordance with the Federal Law of 01.04.2020 No. 69 "On the Protection and Promotion of Capital Investments in the Russian Federation" (hereinafter — 69 Federal Law) investment promotion and protection agreements (further — IPA) are intended to support large private investors in their implementation of new investment projects. It is proposed to resume the investment cycle in the Russian economy with the help of IPA for eight years (IPA concluded on 01.01.2030). The IPA parties are represented in *Fig. 1*.

The objective of the IPA is the implementation of a new investment project as a set of interrelated activities and processes, which can have two directions:

1) creation, construction, reconstruction, or modernization of real estate objects or a complex of related property objects and their subsequent operation;

2) creation and use of results of intellectual activity or means of individualization.

The purpose of the investment project is to produce a profit and/or other beneficial effect, including preventing or minimizing the negative impact on the environment.

The dynamics of investments in fixed assets in the range of regions of the Russian Federation (*Table 1*) have uneven changes in growth rates: for the Central Federal District, there is a decline in investment in 2022, although the average growth rate is the highest among all the districts; for the Southern and Volga Federal Districts, the trend is positive, but the average rate of growth for the South Federal District has not exceeded 100% in the last 5 years, as for the North Caucasus Federal District. The analysis's presented results indicate the need to match the rate of change of capital investment by Russian regions in order to increase the attractiveness of federal district territories for the local population and to reduce internal migration to the Central Federal

District, which, among other things, solves many social problems. IPA-based projects are expected to solve this problem.

The dynamics of investment in fixed assets aimed at environmental protection (*Fig. 2*), show that there has been a sharp increase in such investments in 2021 compared to 2020, with a growth rate of 152.8%, and continued in 2022. During the 10 years from 2012 to 2022, this indicator grew 2.63 times.

The spheres of the economy in which investment projects can be realized under the terms of the IPA are of strategic importance for the economic development of the country and make a significant contribution to the amount of capital investment (*Table 2*).

Structure of investments (*Fig. 3*) indicates that from 2012 to 2022, their main share shifts from protection of water resources to protection of atmospheric air: the ratio of shares in 2012, 45% and 29.7%, respectively, and in 2022–36% and 45.4%. Investment projects on the basis of IPA are intended to increase the effectiveness of such investments in order to ensure the ecological sovereignty of Russia.

In the context of IPA application practice in general, it is important to note the complex problems connected to the receipt of a subsidy related to an estimated (marginal) value, the legal status of which is particularly problematic. To get financing, the organization must provide a report on the conduct of a technological and pricing audit from an expert organization within three years of the project's commissioning. The expert organizations are responsible for the accuracy and completeness of the material included in the audit report.

In international and federal valuation standards, there is no notion of the estimated (marginal) value of an object. However, the estimated (marginal) value is found in the context of the following regulatory instruments relating to tender procurement:

• Federal Law from 05.04.2013 No. 44 "On the contract system in the sphere of
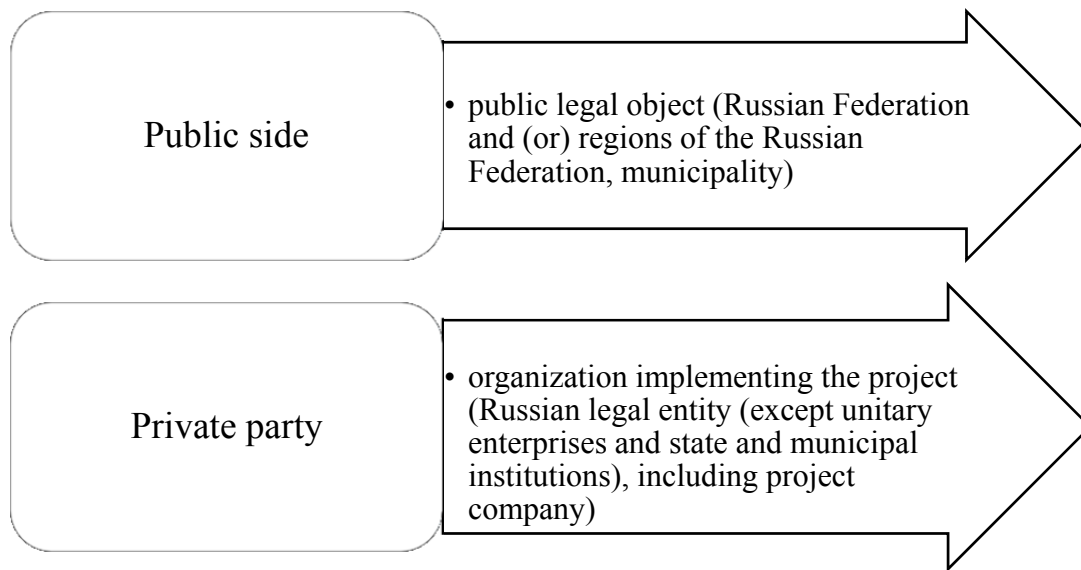
Fig. 1. **The Parties to the Investment Promotion and Protection Agreements**

Source: Compiled by the authors.

Table 1

Dynamics of Investments in Fixed Assets by District of the Russian Federation in 2018–2022 (in Comparable Prices; as a Percentage of the Previous Year)

Federal district of Russia	2018	2019	2020	2021	2022	Average growth rate
Russian Federation	105.4	102.1	99.9	108.6	104.6	104.1
Central FD	111.7	115.0	101.2	114.5	99.8	108.2
Northwestern FD	115.5	84.1	98.4	103.6	95.0	98.8
Southern FD	94.4	89.1	98.3	100.1	103.7	96.9
North Caucasus FD	101.2	107.7	106.5	98.9	107.9	104.4
Volga FD	99.3	102.9	98.2	104.8	103.5	101.7
Ural FD	105.8	94.1	101.2	100.0	110.0	102.1
Siberian FD	105.4	106.8	100.4	110.8	105.6	105.7
Far Eastern FD	106.2	108.8	94.0	114.2	110.8	106.6

Source: Developed by the authors according to Rosstat.
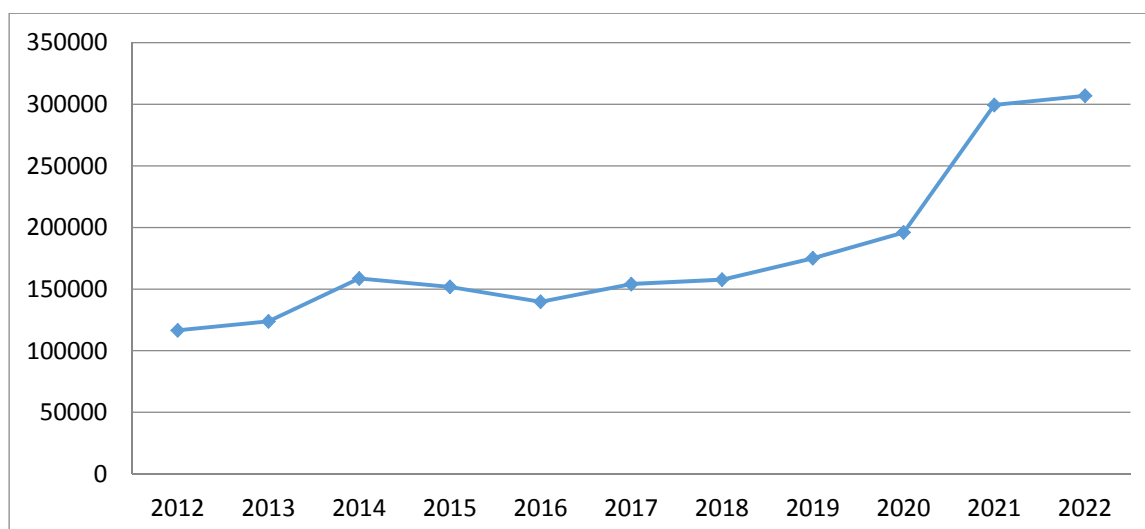
Fig. 2. **Investments in Fixed Assets for the Environmental Protection and Sustainable Use of Natural Resources in the Russian Federation in 2012–2022, mln rub.**

Source: Developed by the authors according to Rosstat.

Table 2

Investments in Fixed Assets by Type of Economic Activity, Billion Rubles

Industry	Year			
	2018	**2019**	**2020**	**2021**
Agriculture, forestry, hunting, fishing and fish farming	781.5	844.2	861.4	964.2
Manufacturing	2 513.2	2 707.6	2 971.0	3 423.7
Transportation and storage	3 083.0	3 315.9	3 124.7	3 759.4
Education	268.8	383.2	454.9	479.7
Health and social services activities	232.3	330.8	571.6	585.4
Cultural, sports, leisure and recreational activities	218.2	212.9	228.9	281.6
Total	17 782.0	19 329.0	20 302.9	22 945.4

Source: Developed by the authors according to Rosstat.

procurement of goods, works, services for the provision of state and municipal needs".[1] The law states that the estimated (marginal) value of the contract is determined by the customer,

based on the value of goods, works, services, determined on the basis of their average market prices;

• Order of the Government of the Russian Federation from 12.08.2008 No. 590 "On the procedure for determining the limit indices of price change when concluding state contracts for

---

[1] Legal-reference system. URL: https://www.consultant.ru/law/podborki/predpolagaemaya%2528predelnaya% 2529_stoimost/ (accessed on 20.10.2023).
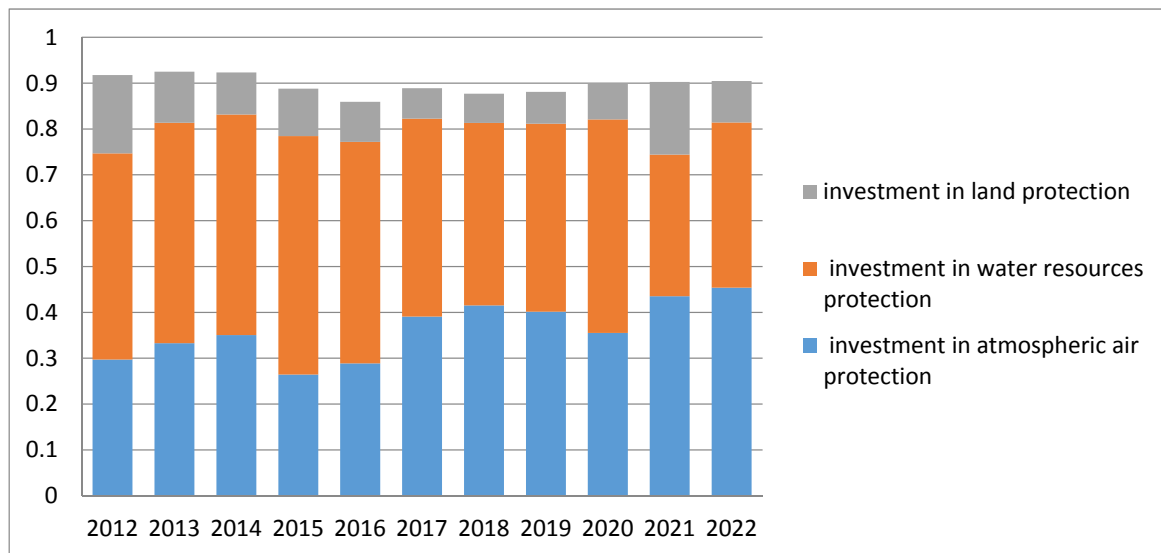
Fig. 3. **Structure of Investments in Fixed Assets for the Environmental Protection and Sustainable Use of Natural Resources in the Russian Federation in 2012–2022**

Source: Developed by the authors according to Rosstat.

the performance of works (provision of services) for state needs".[2] The order states that the estimated (marginal) value takes account of the client's planned expenses and expected inflation.

"In Order No. 1599,[3] it was noted that the determination of the presumed (limit) value is based on "the assessment of the justification of the choice of the main architectural, design, technological, and engineering solutions in terms of their optimality", as well as "the justification for the classification of an infrastructure object to the providing or associated infrastructure" and its conformity to "the needs of the project" [1]. It was also established that "the amount of the

subsidy cannot exceed the estimated cost of establishing an infrastructure object" and "the costs actually incurred during the design and construction (reconstruction) of project infrastructure objects included in the estimate documentation are accepted as reimbursable".

Thus, in the context of real estate objects, according to the logic of the legislator, the estimated (marginal) value is understood as the estimated value of the object.

If, in the framework of procurement, the estimated (marginal) value is determined by the customer on the basis of market analysis, then within infrastructure properties, the algorithm of action is somewhat complicated, because there is no unified interdepartmental method of calculating the estimated value.

There are numerous intricacies and "bottom stones" in the computation of estimated value in the current world, because the structure of this notion remains unknown to many. This article discloses key information about the characteristics of calculating the estimated value of construction and installation work (further — CIW) for real estate in the modern world, the current structure of this process, as well as the problems associated with it.

---

[2] Legal-reference system. URL: https://rulaws.ru/goverment/Postanovlenie-Pravitelstva-RF-ot-12.08.2008-N-590/ (accessed on 20.10.2023).

[3] Decree of the Government of the Russian Federation from 3 October 2020 No. 1599 "On the procedure for granting from the federal budget of subsidies to legal entities (excluding state (municipal) institutions, state (Municipal) enterprises) for the reimbursement of costs for the establishment (building), modernization and (or) reconstruction of the provision and / or associated infrastructure necessary for the implementation of the investment project, in respect of which an agreement has been concluded on the protection and promotion of capital investments, as well as the cost of payment of interest on loans and loans, coupon payments on bond loans attracted for the specified purposes, and determining the amount of refund of these costs". Access the legal-reference system "Consultant Plus".

METHOD

E.B. Tyutyukina, T.N. Sedash [2], V.N. Lisitsa [3] and others have studied the financial aspects of the implementation of investment projects under the IPA. Pricing issues in the construction industry are discussed in papers by I.N. Polovtsev [4], D.B. Lavrent'ev [5], Somov M. Yu. [6], A.V. Rassokhin [7], N.B. Kudryashov [8], A.V. Smirnova, E.G. Degtyareva [9], K.A. Gureev, V.S. Gladkikh [10], A.V. Savchenko [11], V.D. Ardzinov, N.V. Chepachenko [12].

The publications examined include issues of history and difficulties with improving pricing, an analysis of the situation and possibilities for its development, as well as current pricing problems in modern construction.

However, not all issues relating to this topic were adequately covered. For example, these publications do not address issues related to the estimated (marginal) value of the IPA or the use of digital technology and artificial intelligence in building pricing.

The methodical basis for calculating the estimated value of real estate objects is based on the Methodology (hereinafter — Methodology) of calculation of estimated cost of construction of capital construction objects in the Russian Federation, which includes reconstruction and capital repairs. This Methodology is regulated in its current form by the Order of the Ministry of Construction of 04.08.2020.[4]

In terms of the conditions under which the Methodology's provisions are applied, these include projects involving the associated attraction of resources from the Russian Federation's budgets, structural legal entities of Russia, or legal persons in which Russia is more than 50% of the authorized capital.

The methodology is used in the case of reconstruction, preservation or demolition of cultural heritage monuments.[5]

A consolidated estimate is a consolidated document describing all the calculations carried out within the framework of the project.

"The project estimates summarize all costs for the construction of buildings and structures: for each of the types of construction (e.g., general, sanitary, etc.); the purchase of equipment and its installation; the acquisition of production equipment, tools, appliances; for public buildings — economic equipment and objects of interior arrangement".[6]

Estimates of related expenses include costs that are not governed by standard estimates.

It is necessary to consider the key methods used in the formulation of the estimate, which include *resource*, *resource-index*, as well as *base-index.[7] It is important to understand that the realization of the formation of an estimate according to any of the listed methods involves the calculation of certain estimates, information on which is presented below.*

We will focus on the above-mentioned methods in detail. The **resource method** *is* based on estimations and pricing for the resources used, information about which is provided by the State in the specialized system (Federal State Information System — further FSIS). Accordingly, FSIS exists precisely for the regulation of the price level in the construction sector, and it was created in accordance with the Order of the Government of the Russian Federation of 23.09.2016.

Using a resource-based approach, the formulation of estimates implies a uniform

---

[4] Methodology for determining the estimated cost of construction, reconstruction of capital repair, demolition of capital construction objects, works on preservation of objects of cultural heritage (historical and cultural monuments) of the peoples of the Russian Federation on the territory of the Russia Federation: established by Order of the Ministry of Construction and Housing and Communications of Russia of 4 August 2021 No. 421.

[5] See ibid.

[6] See ibid.

[7] Methodology for determining the estimated cost of construction, reconstruction of capital repair, demolition of capital construction objects, works on preservation of objects of cultural heritage (historical and cultural monuments) of the peoples of the Russian Federation on the territory of the Russia Federation: established by Order of the Ministry of Construction and Housing and Communications of Russia of 4 August 2021 No. 421.

calculation of the direct for all three methods, including three components:

Cost = (Work intensity (people/hours) × Cost (people/hours)) + (Quantity (machine/hours) × Cost (machine/hours)) + (Material cost (pcs) × Cost of materials (pcs)).

Resource methods are divided into two groups: *classical* and *sequential*.

In the classical method, direct costs are generally estimated by calculating the total resource indicators of the estimate. At the same time, there is no work link. In the sequential method, direct costs are calculated for each work in the estimate line by calculating input resources, which are summed up in the same way as in the calculation of the unit rates.

The resource-index method involves consideration of three parameters in relation to the resources required for construction:
- estimated norms;
- estimated prices in base ratio (the value varies depending on the dynamic indices of the estimated value of unit prices);
- estimated prices according to the FSIS of pricing in construction (methods of estimate formation, information on prices for materials and labor, normative, lists of legal entities, etc.).[8]

The whole FSIS of pricing in construction contains a register of current regulatory and legal information, regulating the formation of estimates in the field of construction. According to FSIS terminology, this value is an estimated price.

Finally, the **basic-index method** is based on the use of single pricing as well as its deeper components in the formation of the estimate of the construction price. The unit rates are governed by the base prices, which in turn depend on the estimated price dynamics indicators described in the Federal Register of Estimates (further — FRE).[9]

Table 3 presents the advantages and disadvantages of two methods: the basic index and resource methods.

Thus, although the resource method is more accurate, it is difficult to use because of the large amount of work, while the basic-index method is simpler in calculations, but gives a fairly large error.

RESULTS AND DISCUSSION

To illustrate the work of the methods, we will calculate the estimate of the infrastructure object (external gas pipeline in the Moscow area) (*Table 4*).

Based on the calculations presented, it can be concluded that the deviation of the calculation results by the basic-index method, compared with the resource method, was 30%. This could lead to errors in planning and implementation, increasing the risk of project underfunding.

Based on the results of the comparative analysis of pricing systems in the construction industry in the UK, Germany, the USA and Russia (*Table 5*), it can be concluded that in Russia the most commonly used baseline-index method, in which the main work on valuation is carried out in the prices of the base, not the current period.

The basic-index method involves using the estimates of prices for the base year (2000–2001), which increase in accordance with the approved CIW value variation indices. For this reason, the cost of the CIW calculated in this way does not correspond to the actual cost and the value of the materials is taken from the contractor's prices, which leads to an increase in the price of the work. The use of the resource method for individual types of pricing improves the accuracy of the calculation, but the number of open pricings is not sufficient to convert all the estimates into a single type. Furthermore, the Russian cost

---

[8] Federal State Information System for Pricing in Construction. URL: https://fgiscs.minstroyrf.ru/ (accessed on 20.10.2023).

[9] Methodology for determining the estimated cost of construction, reconstruction of capital repair, demolition of capital construction objects, works on preservation of objects

of cultural heritage (historical and cultural monuments) of the peoples of the Russian Federation on the territory of the Russia Federation: established by Order of the Ministry of Construction and Housing and Communications of Russia of 4 August 2021 No. 421.

Table 3

Comparative Analysis of Methods

Basis and index method	Resource method
Accuracy of the cost of construction	
"–" Prices are presented in the year 2000, the indices are averaged. Errors in estimates up to 25%	"+" The most accurate method of existing. It reflects the actual cost of construction
Labour-intensive calculation	
"+" Since all rates are already in the database, the counter spends less time and effort. If there are no prices in the estimations for the essential materials, only prices from price lists should be justified	"–" The most labor-intensive method, because it is necessary to find and confirm in monetary equivalent prices for materials, wages of labour of workers and mechanists, as well as regulatory indicators and the cost of operation of machines and mechanisms
Frequency and scope	
"+" The method received the greatest spread in the implementation of projects with budgetary investments	"+" Method has acquired recognition in companies that develop their own pricing
Transferring indices to a different price level is an option	
"+" Recalculation of estimates using indices is done for a few minutes of machine time, which allows you to get a quick result	"–" It is not possible to recalculate the cost of construction to another price level using indices, all prices need to be searched again

Source: Developed by the authors.

Table 4

Comparative Analysis of Cost Estimation Methods, Million Rubles

Type of work	Basis and index method	Resource method
Construction work	67.55	92.45
Installation work	18.69	17.77
Other work and costs	11.06	1.58
Labor funds	9.38	27.63
Total	106.68	139.43

Source: Developed by the authors.

assessment methodology does not take into account costs associated with the lifecycle of buildings or on the basis of work packages of significant cost [13].[10]

The moral obsolescence of the estimate base is that the reform of the system of calculating the cost of construction affects only the arithmetic calculation of norms and pricing and does not extend to the formation of a new normative base updated construction technologies and the updating.

Fig. 4 reflects the main problems in the system of estimates and ways to solve them.

It is advisable to establish a single, up-to-date source of information that can be used to calculate the limit value of the property.

---

[10] Tas Elcin, Yaman Hakan. Engineering, construction, and architectural management, 01 Jun 2005, Vol. 12, Issue 3, pages 251 – 263. URL: https://www.emerald.com/insight/content/doi/10.1108/09699980 (accessed on 20.10.2023).

Methods Used in Foreign Countries

Country	Russia	USA	UK	Germany
Methods used	Basic-index, resource-index	Resource, resource-index		

Source: Developed by the authors.

Absence of a single value base for CIW	• A single regulatory framework for CIW is required
Basic-index method reduces calculation accuracy	• Database of estimates needs to be updated
Outdated CIW pricing database	• Continuous monitoring and updating of the CIW pricing database
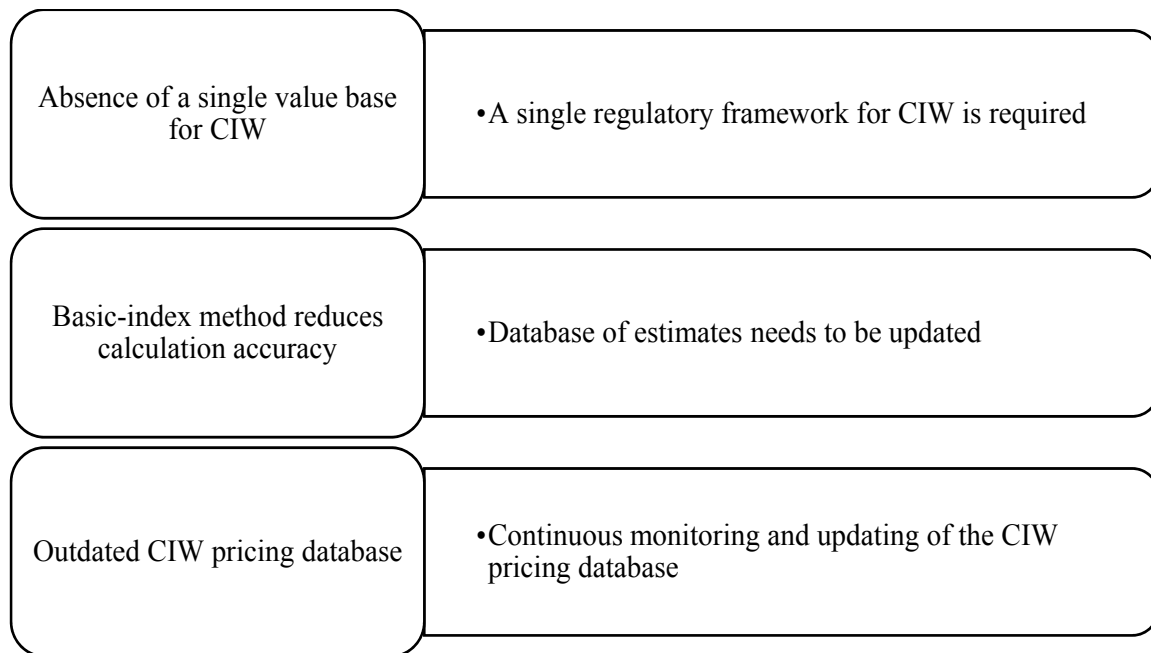
Fig. 4. **Problems and Possible Ways of Solving Problems in the System of Estimated Pricing in the Russian Federation**
Source: Compiled by the authors.

The creation of a single resource-based pricing base for different types of calculations can solve the problem of the inconsistency of estimates with the real cost of construction and will improve the accuracy of cost forecasts using machine learning methods.

When developing a methodology for calculating the estimated cost of a building while considering the life cycle of a project, it is critical to include all stages and aspects that may affect the project's cost. In the context of the task, the method of assessing the effectiveness of the management of secure construction (further — MSC) engineering projects using the model of analytical network processes — fuzzy comprehensive evaluation (ANP-FCE) [14].

Machine learning can provide accuracy in calculating and forecasting estimates. For example, the machine learning algorithm "stacking-assembly" for predicting the cost of road construction projects was described in the article Meseret Getnet Meharie [15]. In part, the article proposes an assembly model of stacking, which was developed by automatically and optimally combining three different basic prognostic models: linear regression, base vector method and neural network using the gradient boosting algorithm as a meta-regressor.

To learn a model, machine learning requires a significant amount of data. Machine learning approaches allow the application of various algorithms for forecasting that can account for complicated data connections and trends. Machine learning can also automate the process of estimating costs. This will allow for time and resource savings, as well as a reduction in the possibility of errors connected to manual calculation.

The cost of resources and other factors may change over time. It is therefore important to constantly update the machine learning model with new data so that it reflects the current situation and gives more accurate forecasts.

CONCLUSION

In order to resolve conflicts and use outdated information in the cost formation of the CIW, a single, updated source of information is required that can be used to calculate the limit cost of the infrastructure under analysis. The formation of the current database will enable the use of machine learning methods to determine the estimated value and its forecasting depending on the implementation phases of the investment project (subject to an annual update of pricing).

It is also necessary to develop a cost classifier and methodology for calculating value on European models, taking into account the cost of the building's life cycle, project phasing, cost planning alternatives, and phased approximation of value at the early stages of the project, including with the use of BIM (Building Information Modeling) — methodology used to create and manage digital building models. BIM is able to automate the costing process to generate comparisons with machine learning models to estimate building costs.

In the future, the system will prevent many errors in construction cost calculation, save money early in the development process, and solve the problem of an independent audit of the project's technological and pricing base implemented within the framework of IPA.

REFERENCES

1. Kosorukova I.V., Shestakova E.D. Practical aspects of the implementation of investment protection and promotion agreements in Russia. *Imushchestvennye otnosheniya v Rossiiskoi Federatsii = Property Relations in the Russian Federation*. 2022;(12):49–59. (In Russ.). DOI: 10.24412/2072–4098–2022–12255–49–59

2. Tyutyukina E.B., Sedash T.N. Implementation of investment projects under investment protection and promotion agreements: Financial issues. *Finansy i kredit = Finance and Credit*. 2022;28(10):2225–2248. (In Russ.). DOI: 10.24891/fc.28.10.2225

3. Lisitsa V.N. Agreement on the protection and promotion of capital investments as a type of public-private investment contract. *Yuridicheskaya nauka i praktika = Legal Science and Practice.* 2021;17(1):65–72. (In Russ.). DOI: 10.25205/2542–0410–2021–17–1–65–72

4. Polovtsev I.N. Issues in building product pricing in the Russian Federation. *Universum: ekonomika i yurisprudentsiya = Universum: Economics and Law*. 2016;(6):3. URL: http://7universum.com/ru/economy/archive/item/3242 (accessed on 20.10.2023). (In Russ.).

5. Lavrent'ev D.B. Reforming the system of estimated rationing and pricing in construction in modern Russian conditions. *Molodoi uchenyi = Young Scientist*. 2017;(11):229–231. URL: https://moluch.ru/archive/145/40548/ (accessed on 20.10.2023). (In Russ.).

6. Somov M. Yu. Problematic issues of estimate rationing in construction. *Aktual'nye voprosy ekonomicheskikh nauk.* 2016;(48):101–107. URL: https://cyberleninka.ru/article/n/problemnye-voprosy-smetnogo-normirovaniya-v-stroitelstve (accessed on 20.10.2023). (In Russ.).

7. Rassokhin A. V. The practice of implementing an estimate standardization system in the construction industry and possible ways of development. *Smetno-dogovornaya rabota v stroitel'stve = Estimate and Contractual Work in Construction.* 2017;(3):20–24. (In Russ.).

8. Kudryashov N. B. Basic methods for calculating estimated costs in construction. *Smetno-dogovornaya rabota v stroitel'stve = Estimate and Contractual Work in Construction.* 2018;(6):59–61. (In Russ.).

9. Smirnova A. V., Degtyareva E. G. Estimate business in construction: Analysis of problems at the present stage. In: Current problems of engineering sciences. Proc. 6th Annu. sci.-pract. conf. of professors, students and young scientists of the North Caucasus Federal University "University science for the region" (Stavropol, April 02–27, 2018). Stavropol: TESERA; 2018:199–200. (In Russ.).

10. Gureev K.A., Gladkikh V.S. Problem of discrepancy of cost sheet price of a building-assembling works to the market one. *Izvestiya vuzov. Investitsii. Stroitel'stvo. Nedvizhimost' = Proceedings of Universities. Investment. Construction. Real Estate.* 2017;7(4):40–51. (In Russ.).

11. Savchenko A. V. Existing problems of justifying construction prices in the Russian Federation. *Innovatsii i investitsii = Innovation & Investment.* 2019;(12):229–231. (In Russ.).

12. Ardzinov V.D., Chepachenko N.V. Problems of pricing and budget normalization in construction. *Ekonomika i upravlenie = Economics and Management.* 2016;(5):30–33. (In Russ.).

13. Tas E., Yaman H. A building cost estimation model based on cost significant work packages. *Engineering, Construction and Architectural Management.* 2005;12(3):251–263. DOI: 10.1108/09699980510600116

14. Li X.K., Wang X.M., Lei L. The application of an ANP-Fuzzy comprehensive evaluation model to assess lean construction management performance. *Engineering, Construction and Architectural Management.* 2020;27(2):356–384. DOI: 10.1108/ECAM-01–2019–0020

15. Meharie M.G., Mengesha W.J., Gariy Z.A., Mutuki R.N.N. Application of stacking ensemble machine learning algorithm in predicting the cost of highway construction projects. *Engineering, Construction and Architectural Management.* 2022;29(7):2836–2853. DOI: 10.1108/ECAM-02–2020–0128

ABOUT THE AUTHORS

Irina V. Kosorukova — Dr. Sci. (Econ.), Prof., Prof. of the Department of Corporate Finance and Corporate Governance, Financial University, Moscow, Russia
http://orcid.org/0000-0002-8330-2834
Corresponding author:
ivkosorukova@fa.ru

Sergey G. Sternik — Dr. Sci. (Econ.), Prof., Prof. of the Department of Corporate Finance and Corporate Governance, Financial University, Moscow, Russia
http://orcid.org/0000-0003-1411-1011
sergey-sternik@yandex.ru

Elizaveta E. Heifets — Cand. Sci. (Econ.), senior lecturer of the Department of Corporate Finance and Corporate Governance, Financial University, Moscow, Russia
https://orcid.org/0009-0002-6615-3432
eekhejfets@fa.ru

Authors' declared contributions:
I. V. Kosorukova — literature analysis, problem statement, article concept development, statistical data collection, tabular and graphical representation of results.
S.G. Sternik — literature analysis, comparative analysis of methods for calculating estimates, analysis of estimated pricing abroad, analysis of factors for the formation of the estimated cost of the building.
E.E. Heifets — calculation of the estimated cost of real estate, problems and possible solutions to problems in the system of estimated pricing.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 23.09.2023; revised on 23.10.2023 and accepted for publication on 26.10.2023.
The authors read and approved the final version of the manuscript.

Analysis of Financing Mechanisms and Sources of Budget Formation of the Testing Centers of the Complex "Ready for Labor and Defense"

O.I. Samarchenko[a], D.G. Stepyko[b], D.V. Gracheva[c], D.A.O. Farzaliev[d]

[a] Financial University, Moscow, Russia;
[a, b] Military University of the Ministry of Defense of the Russian Federation, Moscow, Russia;
[c, d] Plekhanov Russian University of Economics, Moscow, Russia

ABSTRACT

The Russian physical culture and sports complex "Ready for labor and defense" is established in Russia since 2014. The main element of the project is testing centers, of which more than 2 600 in the country. At the same time, the activities of such centers are often not systematized and have different, sometimes diametrically opposite approaches to its organization. The **subject** of this study is the activities of testing centers, including personnel, financial, logistical and informational parameters. For several years, the federal operator is developing various methodological materials for the development of testing centers. The **purpose** of this study is to develop financing mechanisms for the identified forms of organization of testing centers. The main research **methods** are the statistical method and the method of comparative analysis. As part of our research, we analyzed statistical information for the period 2020–2022, as well as a survey of 170 testing centers located in 59 regions of Russia and having different organizational and legal forms and a number of other different features. Based on the results of the study, the main sources of financing for the activities of testing centers were identified, as well as mechanisms and recommendations for increasing budgetary and extra-budgetary funding of various activities of testing centers were developed. The results of the study are practical, tested, successfully applied by some organizations and can be used in testing centers of various types.

Keywords: physical and sports organization; RLD complex; testing center; organizational and legal form; structure; sources of financing; provision of activities; subsidy; grant funds

INTRODUCTION

The authors of the Russian Physical and Sports Complex "Ready for Labour and Defense" (further — RPSC RLD) conducted a complete study to investigate the testing center's (further — TC) existing and implemented funding mechanisms. Statistical and other data for 2020–2022 are analysed. The collection and analysis of actual data characterizing the organization and regulation of the activities of 170 physical and sports organizations evaluating the level of physical training of the population according to the results of the performance of RPSC RLD tests in the regions of the Russian Federation was completed.

According to Federal Statistical Observation No. 2-RLD "Information on the implementation of the Russian Physical and Sports Complex "Ready for Labour and Defense" (further — RLD), the country at 31 December 2021 operated 2 650 TC, which is 1.2% higher than the same values at the end of 2020[1].

From the TC:

• 188 un. — in the structure of public educational organizations (minus 7 units per year);

• 14 un. — in the structure of secondary professional education organizations (minus 1 unit per year);

• 20 un. — in the structure of higher professional education organizations (plus 1 unit per year);

• 1 047 un. — in the structure of additional education organizations (minus 7 units per year);

• 353 un. — in the structure of sports training organizations (plus 56 units per year);

• 877 un. — in the structure of physical and sports organizations (minus 9 units per year);

• 67 un. — in the structure of non-profit organizations (plus 29 units per year);

• 84 un. — in the structure of other organizations.

Of 2 650 TC created:

92.9% (2 462 un.) — by decision of local government;

6.0% (159 un.) — by decision of region authorities of the Russian Federation;

1.1% (29 un.) — by decision of the federal authorities.

988 TC, or 37% of the total, have been created and are operational in rural areas.

There is a significant increase in testing centers in sports training organizations [1]. The share of TC in non-profit organizations is also gradually increasing, indicating their increasing role in the implementation of the strategy for the development of physical culture and sports in the Russian Federation until 2030 [2, 3].

At the same time, according to the Federal Operator RLD, the number of TC in 2022 remained the same, which indirectly indicates the establishment of close to the optimally needed number of such centers over the years of implementation of the RLD complex in the regions of the Russian Federation[2].

In 2021, TC specialists conducted 115 538 activities (in 2020 there were 90 thous.), which included the implementation of the test standards of the RLD complex by different categories of the population [4]. 16.5 thous. of these were noticed in rural regions[3]:

• 47 941 — on the basis of physical and sports organizations (8% more than in 2020);

• 26 001 — on the basis of additional

---

[1] Statistical information RPSC RLD. Ministry of Sports of the Russian Federation. URL: https://www.minsport.gov.ru/sport/physical-culture/41/27653 (accessed on 13.01.2023).

[2] Russian Physical and Sports Complex "Ready for Labour and Defense" (RPSC RLD). URL: https://www.gto.ru/history (accessed on 10.01.2023).

[3] Statistical information RPSC RLD. Ministry of Sports of the Russian Federation. Statistical information. URL: https://www.minsport.gov.ru/sport/physical-culture/41/27653/ (accessed on 13.01.2023).

Table 1

Sources of Financing for RLD Testing Centers

No.	Sources of financing	Share (%)
1	From the municipal budget (in the framework of the municipal task)	90.2
2	Subsidy for a public assignment	8.8
3	Grants (regional and municipal)	11.7
4	Sponsorship contributions	2.9
5	No financing available	7

Source: Compiled by the authors.

education organizations (18.0% less than in 2020);

• 16 469 — on the basis of general educational organizations (53.3% compared to 2020);

• 1 451 — in organizations of secondary professional education (by 12% less than in 2020);

• 599 events — in higher education organizations (52% more than in 2020);

• 9 525 — in institutions providing citizen sports training (by 25.3% higher than in 2020);

• 1 972 — on the basis of non-profit organizations (21.5% more than in 2020).

ANALYSIS OF THE EXPERIENCE OF THE WORK OF PHYSICAL CULTURE AND SPORTS ORGANIZATIONS

The work of physical and sports organizations — TC was evaluated according to the following criteria:

• availability of normative legal acts and mandatory legal documents;

• availability of movable and immovable property of TC;

• financing indicators;

• level of staffing, i.e., the availability of personnel to perform the functions of each of the individual parts of the testing process;

• information provision.

Based on the list of aspects and parameters of the activities of TC, to collect information and conduct an analysis of the actual experience of the organization of activities of physical and sports organizations, and to conduct the assessment of the level of physical fitness of the population on the results of their performance of the norms of tests of the RLD complex, in the framework of the study, a questionnaire was formed and sent to fill in 170 TC, operating in the territory of 59 regions of the Russian Federation.

A summary of the material obtained on the experience of organizing the activities of physical and sports organizations showed that the sample presented constituted 6.4% of the total number (2 650) of RLD testing centers, is randomized and is sufficient for qualitative analysis.

The results of the analysis of the materials received and the questionnaire

Organizational and Legal Forms of RLD Testing Centers

No.	Organizational and legal forms	Share (%)
1	Municipal budgetary institution	44
2	Municipal autonomous municipal institution	28
3	MBI structural office (RPSC RLD testing center)	26
4	Autonomous non-profit organization (ANO)	less than 1

Source: Compiled by the authors.

data revealed the following: The vast majority (78.2%) of the organization's founders are municipal administrations, with 14.7% of cases — as the municipal body of management for physical culture and sports, 5.3% — as the municipal body of administration for education, and others — for less than 2% [5].

Analysis of sources and forms of financing of activities of the organization to implement activities of RPSC RLD [4] demonstrates diversification of sources of financing (*Table 1*). TC is financed by:
• municipal budget (in the framework of the municipal task);
• subsidies for a public assignment;
• grants (regional and municipal);
• sponsorship contributions.

It is significant that some TCs have several sources of financing [6, 7].

21.7% of organizations have RPSC RLD test preparation teams based on TC, with the exception of two centers, training and consultations are provided free of charge. Only 2 centers indicate the provision of paid services for organizing and conducting events as an additional source of income.

Comprehensive analysis has revealed that for TC to function well, it must be constructed on a sports facility (the organization approved by TC must own or lease sports facilities) with a permanent

team of trainers, instructors, administrators, and workers.

TC operates in the following organizational and legal forms (*Table 2*).

The relationship between financing and the TC forms identified in the study should be described separately. Financing of TC is largely determined by its organizational and legal form and the level of competence of the manager, as well as the demanding results of the founder of the center and level of satisfaction of the population with the quality of the services provided aimed at assessing the physical fitness level of different genders and social groups of the population.

The financing mechanisms themselves are equally different, with a number of features that must be considered when selecting and using each of them.

By systematizing the information on the financing mechanisms used by TC, several approaches can be proposed to the structuring of financial routes.

This approach is based on the conditions of TC functioning, depending on the selected organizational and legal form.

Given that the vast majority of testing centers are established by authorities and charged with a public purpose, financial costs are mainly financed by budgets at the appropriate levels (municipal or regional). TC currently has a diverse range of budgetary and extrabudgetary funding sources (for a given TC) [8].

---

[4] Non-profit organization "Directorate of Sports and Social Projects". Moscow; 2023. URL: https://gto.ru/document. (accessed on 05.15.2023).

Matrix of Financing Mechanisms for Testing Centers Depending on the Form

Financing Options	Types of institutions for testing centers				
	GBI/RBI	MBI	GAI/MAI	BPEI	MGI
Federal financing	+	+	+	+	–
Regional government assignment	+	–	–	–	–
Regional special subsidy	+	+	+	+	–
Municipal state assignment	–	+	–	+	+
Municipal special subsidy	–	+	+	+	–
Reimbursable services to population	+	+	+	+	–
Reimbursable services to organizations	+	+	+	+	–
Consolidated budget	+	+	+	+	–
Competitive financing (grants, awards, etc.)	+	+	+	+	–

Source: Compiled by the authors.

Note: GBI — state budgetary institution; RBI — regional budgetary institution; MBI — municipal budgetary institution; GAI — state autonomous institution; MAI — municipal autonomous institution; BPEI — budgetary professional educational institution; MGI — municipal government institution.

It should be noted that the financing structure of TC, despite its organizational and legal form, consists of two components: state budgetary expenditure obligations (federal, regional, or local budgets brought to TC either as a government assignment or subsidy) and extrabudgetary funds attracted by TC[5]. In the latter case, the organizational and legal form of the establishment and existence of TC are important [9].

Extrabudgetary funding mechanisms may be classified by source of funding or by target of request. In any case, we consider it appropriate to specify all the practical mechanisms and capabilities of TC.

Furthermore, when deciding on the form of the testing center that is developed, we must consider its purpose and objectives, as well as the available resources and financing for the completion of its tasks. This planning will allow for correct structuring of the conditions for operation and selection of the organizational and legal form of the

---

[5] Methodical recommendations for the organization of tests (tests) included in the Russian Sports and Culture Complex "Ready for labour and defense" (RLD) approved at the meeting of the Coordinating Commission of the Ministry of Sports of the Russian Federation on the introduction and implementation of the Russian Physical Culture and Sports Complex "Ready for labour and defense" (RLD) by Protocol from 23.07.2014 No. P/1 [Electronic Resource]. Access from the legal reference system Garant (accessed on 10.01.2023).

TC, allowing it to receive finance in the expected amounts [10].

Based on the results of the information received, a matrix of possible financing mechanisms for TC in various forms has been compiled (*Table 3*).

CONCLUSION

On the basis of experience and survey materials, we have developed financing mechanisms for identified forms of TC organization: from budgetary and extrabudgetary sources.

The mechanisms' purpose is to maximize the diversification of accessible financing sources. Each TC in management should be informed about the sources and how to use them, i.e., have the instruments to implement each of the mechanisms. At the same time, the first step is the determination of the required amount of funds, their calculation, and subsequent justification, first of all, budgetary. We propose the following calculation mechanism.

In the territory served by TC, a certain number of people live; 70% of the population of the territory in 2030, according to the current demographic forecast of the age of 6+, is number X. At this time, a certain number of residents of the territory have also been registered in the AIS RLD system, from which they have started to comply with the standards; that is, they have fulfilled at least one standard in the reporting year; this is the indicator Y. Given that the goal of the state is to attract people to regular physical culture and sports by 2030, 70% of the population, and AIS RLD is one of the few digital tools to solve it. Each participant who fulfills the RPSC RLD standards has an individual digital footprint, which allows objectively to establish and confirm the fact of his involvement. Returning to the calculation mechanism, the difference between X and Y is divided by the number of reporting periods up to 2030. The mechanism's simplified formula is now structured as the following:

$$N = (X - Y) / 7.$$

As a result, we determine the number of personnel who have to provide the service and establish the conditions for them to fulfill the complex's standards. TC will be able to develop a primary need and an indicative amount of funds by multiplying the amount by the cost of the service. This calculation is simply an initial basis for justification and should be informed and clarified based on the individual characteristics of the TC and the territory.

Mechanism 1 (budgetary financing).

The TC at the budget planning stage determines the amount of funds required for operational activities (the above method may be used).

Furthermore, depending on the organizational and legal structure of the testing center, the scope and ability of the founder to finance the activities of TC (the scope of the government assignment/target subsidy) is determined. A list of possible additional sources of public funding at all levels of regulation was then formed. At this stage, the available financial resources and the prospects for funding are assessed. Initially, focus should be on events that are directly related to the activities of TC — for example, physical and sports activities. Secondly, it is necessary to provide for financing of TC project activities, which can be submitted in the form of a grant (e.g. for training of specialists, sports instructors or sports judges). Thirdly, the activities indirectly related to the activities of the center should be taken into account: installation of flat ground for mass sports, provision of sports equipment, marketing services.

The next step is operational action to submit various applications for funding. In

cases of rejection, the reasons should be carefully analyzed and action adjusted for the future. In the case of a positive decision, the expenditure part of the funding received should be planned, taking into account the rules for the spending of budgetary funds and the provisions of the current procurement legislation.

Mechanism 2 (extrabudgetary financing).

After evaluating the availability of extrabudgetary financing, approval from the governing bodies, including the founder, should be obtained for conducting revenue-generating operations. Following a positive decision, the next step should be to monitor the sources and formats of such funding. TC's extrabudgetary activities will be related to the provision of services to the public and various organizations. Accordingly, funding sources can be the funds of both physical and legal persons, including cash. It is important to consider the elements of interaction and the accounting system for such money, as well as to plan the expenditure portion in a manner similar to the mechanism outlined above. It should be emphasized that the expenditure of extrabudgetary funds is subject to different regulatory systems than the use of budgetary funds.

The next step is expected: developing involvement and contract relationships with TC consumers. It is also important to remember that TC can provide both regular services (such as sectional training sessions for the implementation of RPSC RLD or GPT) and one-time services (such as sports holidays, festivals, corporate events, and other events).

Despite the specifics of TC's work, it is possible to provide information and analytical services, as well as sociological research, on behalf of public and private organizations and people if competent staff are available.

Thus, the results of the study identified the features of the organization of the activities of TC and developed funding mechanisms. It emphasizes that when using these approaches, TC has the ability to depend on financial stability and the expansion of its activities. To achieve this goal during the reporting period, the mechanisms used should be reviewed, and appropriate adjustments should be made to improve the testing center's funding.

REFERENCES

1. Andriyanova L. A., Krasnov S. A. The RLD complex as a direction for the implementation of an intersectoral program for the development of student sports at the university. In: Actual problems of physical culture and sports, development trends in modern conditions. Proc. 14th Int. sci.-pract. conf. (Moscow, June 10–11, 2021). Moscow: Moscow State University of Civil Engineering; 2021:23–31. URL: https://mgsu.ru/resources/izdatelskaya-deyatelnost/izdaniya/izdaniya-otkr-dostupa/2021/Sbornik_Aktualniye-problemy-fizkultury-i-sporta_2021.pdf (In Russ.).

2. Zakirov F. H. Modern trends in the development of the domestic branch of physical culture and sports. In: Issues of professional development. Proc. 3rd Int. sci.-pract. conf. Chelyabinsk, UralGUFK; 2021:50–55. (In Russ.).

3. Bratkov K. I., Stepyko D. G. Current trends in the development of commercial activity of state sport organizations. *Nauka i sport: sovremennye tendentsii = Science and Sport: Modern Tendencies.* 2019;7(2):21–29. (In Russ.).

4. Tomilova M. V., Malits V. N., Eroshov V. V., Pavlov V. N. Main results of the implementation of the Strategy for the Development of physical culture and sports in the Russian Federation for the period up to 2020 and strategic priorities of state policy in the implementation of physical culture and sports in the Russian Federation for the period up to 2030. *Nauchnyi Vestnik MGIFKSiT = Research Bulletin of MSIPCST.* 2020;(3):92–101. (In Russ.).

5. Per'kova E. Yu. Analysis of the dynamics and structure of sources of financing of physical culture and sports in Russia. *Nauka i praktika regionov.* 2019;(2):31–35. (In Russ.).

6. Pokhabov A. D. Organizational and financial order of the test centers of All-Russian gymnastic sports complex "Ready for labour and defend" (VFSK GTO). General problems in start of complex GTO. *Znanie.* 2016;(3–4):133–136. (In Russ.).

7. Yakushev D. S. Specifics of regional financing of the VFSK GTO complex (on the example of Smolensk region). *Izvestiya Tul'skogo gosudarstvennogo universiteta. Fizicheskaya kul'tura. Sport = News of the Tula State University. Physical Culture. Sport.* 2019;(12):56–61. (In Russ.).

8. Panov E. V. About the importance of the RWD (ready for work and defense) standards in the law enforcement system at the present stage. In: Physical education, sports, physical rehabilitation and recreation: Problems and development prospects. Proc. 12th Int. sci.-pract. conf. (Krasnoyarsk, June 15, 2022). Krasnoyarsk: Reshetnev Siberian State University of Science and Technology; 2022:366–369.

9. Yuzvovich L. I., Lvova M. I. Problems of financing socially oriented programs at the regional level. *Ekonomika, predprinimatel'stvo i pravo = Journal of Economics, Entrepreneurship and Law.* 2022;12(11):2985–3006. (In Russ.). DOI: 10.18334/epp.12.11.116498

10. Voronina V. T. The financing of the All-Russian sports complex "Ready for labour and defence" (ASC RLD). *Azimut nauchnykh issledovanii: ekonomika i upravlenie = ASR: Economics and Management (Azimuth of Scientific Research).* 2019;8(1):111–114. (In Russ.). DOI: 10.26140/anie-2019–0801–0023

ABOUT THE AUTHORS
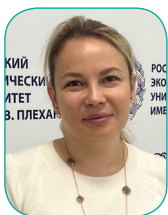
Olga I. Samarchenko — Cand. Sci. (Econ.), Senior Lecturer, Financial University, Moscow, Russia; Researcher, Military University of the Ministry of Defense of the Russian Federation, Moscow, Russia
https://orcid.org/0000-0001-7166-3213
Corresponding author:
olozitskaya@gmail.com

Dmitriy G. Stepyko — Cand. Sci. (Ped.), Senior Researcher, Military University of the Ministry of Defense of the Russian Federation, Moscow, Russia
https://orcid.org/0000-0003-2969-5355
dstepyko62@gmail.com

Daria V. Gracheva — Lecturer, Department of Physical Culture and Sports, Plekhanov Russian University of Economics, Moscow, Russia
https://orcid.org/0000-0003-1390-495X
Gracheva.DV@rea.ru

Dzhavid A. O. Farzaliev — Lecturer, Department of Physical Culture and Sports, Plekhanov Russian University of Economics, Moscow, Russia
https://orcid.org/0000-0003-3753-9504
farzaliev.dao@rea.ru

Author's declared contribution:

O. I. Samarchenko — calculation of financial indicators, description of RLD financing mechanisms, development of mechanism and proposals to solve the problem.

D. G. Stepyko — Identification of problems, analysis of normative and legal sources, identification and description of effective practices, development of mechanisms and proposals to solve problems.

D. V. Gracheva — analysis of survey data, table presentation of the results of the study.

D.A.O. Farzaliev — collection of analytical and statistical data, collection of survey data.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 28.04.2023; revised on 29.05.2023 and accepted for publication on 26.06.2023.

The authors read and approved the final version of the manuscript.

Formation of the Relationship Between the Exchange Rate and the Investment Yield of Pension Assets in Kazakhstan: Causes and Consequences

V. Yu. Dodonov

Kazakhstan Institute for Strategic Studies under the President of the Republic of Kazakhstan, Almaty, Kazakhstan

ABSTRACT

The efficiency of pension asset management, reflected in their performance, determines the stability of the funded pension system of Kazakhstan, and also has the potential to significantly affect the budget process, since the state guarantees recipients a positive real return on their pension savings and compensates from the budget for losses incurred during periods when inflation exceeds the nominal rate of return. The need to ensure a positive real return on pension assets managed by the National Bank of Kazakhstan determines not only the high **relevance** of the issue of investment management itself, but also other aspects that affect the return, including changes in the exchange rate of the Kazakhstani tenge. The **subject** of the article is the impact of the tenge exchange rate on the profitability of pension assets, which can be very significant, since it forms one of the main components of investment income — income from foreign currency revaluation. This influence can also act as a factor in the formation of the tenge exchange rate during periods when the real return of pension assets decreases due to the negative situation in the financial markets and high inflation, and this thesis reflects the **scientific novelty** of the article. The assessment of the hypothesis about the formation of the relationship between the exchange rate of the Kazakhstani currency and the investment yield of pension assets is the **aim** of this work, and the identification of the main causes and consequences of this phenomenon is its **task**. Comparative and correlation analysis of indicators of investment return of pension assets, changes in the exchange rate of the Kazakhstani currency, parameters of the external sector and others were used as research **methods**. The **results** of the analysis confirm the existence of a relationship between the indicators of profitability of pension assets and the tenge exchange rate, and allow us draw the **conclusion** that this profitability has an indirect impact on the formation of the Kazakhstani currency exchange rate over the past few years, which has been characterized by non-standard dynamics in the context of a significant improvement in the external economic environment.

Keywords: pension assets; return on pension assets; investment portfolio; inflation; currency market; tenge exchange rate; revaluation of foreign currency; payment balance

INTRODUCTION

In recent years, Kazakhstan has experienced a decline in the relationship between external sector indicators such as exports, trade balance, current account balance, and the tenge's national currency exchange rate. The positive relationship between these factors and currency exchange rates has been extensively researched and supported by various theoretical studies [1–3]. In particular, R. Dornbusch and S. Fischer [4] are considering factors influencing the exchange rate, such as commodity prices, market participants' expectations and the price of financial assets, which justified the particular importance of the current balance of payments account in this process, while R. Baldwin and P. Krugman [5] identified the influence of cross-border investment flows on the rate of exchange. Empirical studies have additionally confirmed the importance of external sector indicators in the formation of the exchange rate [6, 7] (in particular, A. G. Schulgin et al. [8] revealed the effect of trade balance on exchange-rate adjustments in countries with intermediate currency regimes), including for different types of economies and currency market conditions, such as ASEAN countries [9], India [10], Germany [11], China [12], and Turkey [13]. In the countries with the transit economy, this relationship is also identified by a number of authors [14–16], as well as in the post-Soviet states [17, 18] — in particular, A. Yu. Kuzmin [19, p. 19] as "one of the most important factors of the behavior of the exchange rate of the ruble", which identifies capital movements that form the balance of the current account.

In Kazakhstan, there has been a relationship between external sector indicators and, to a significant part, oil prices, the country's main export commodity for a long time. However, this relationship has been gradually deforming since 2018, as shown by the stable fall in the exchange rate of the Kazakh currency despite changes in

external sector variables, particularly during periods of significant improvement.

This new reality on the Kazakhstan foreign exchange market contributed to the conclusion that new and stronger variables influencing the development of the tenge exchange rate are growing. One of these issues, in our opinion, is need to maintain a positive real return on pension assets concentrated in Kazakhstan's Unified Accumulative Pension Fund (UAPF).

Assessment of the hypothesis of the formation of interdependence between Kazakhstan's exchange rate of currency and the return on investment of pension assets is the purpose of this paper, as is the identification of the causes and consequences of this phenomenon and its tasks.

ACCUMULATIVE PENSION SYSTEM OF KAZAKHSTAN: RETURN OF PENSION ASSETS AND MAIN FACTORS OF ITS FORMATION

Kazakhstan implemented pension reform in 1998, after which the country operates a three-level pension system, which includes pension payments from the state budget (solidarity and basic pensions), a compulsory accumulative system and a voluntary accumulative system. The main element of the accumulative system is the Unified Accumulative Pension Fund (further — UAPF), which operates in the form of a joint-stock company. The UAPF is a state-owned organization, and the National Bank of Kazakhstan manages almost all pension savings accumulated in it.[1] "UAPF" JSC was established on 22 August 2013 on the basis of the State Accumulative Pension Fund as part of the reform of the accumulative pension system, during which the compulsory pension savings of all previously existing accumulated pension funds were transferred

---

[1] In 2021, four non-governmental portfolio managers were admitted to the management of a portion of the UAPF pension assets, but they currently account for only about 0.1% of the portfolio.

to the UAPF. As a result, at present, "the only administrator of the cumulative pension system is the "UAPF" JSC,[2] and all pension savings resulting from the compulsory pension contributions paid by citizens are concentrated in this financial institution.

Thus, UAPF is a critical element of the social security system of Kazakhstan, in connection with which the efficiency of management of concentrated pension assets, which is reflected in the indicators of their returns, is of particular importance. The return on pension assets during the full eight years of operation of the UAPF ranged from 6.31% to 15.65%; the average for that period was 9.72%. This indicator reflects nominal yields, but in Kazakhstan, the real yield indicator, defined as the difference between nominal yield and inflation, is also important. This is due to the fact that in the country, at the legislative level,[3] UAPF depositors, whose assets are managed by the National Bank, are guaranteed the preservation of compulsory pension contributions with the level of inflation. In practice, this means that if the return on pension assets under the management of the National Bank[4] is less than the level of inflation, the State will compensate for this difference for the relevant years in the process of implementing pension payments.

During the UAPF's eight years of operation, the nominal return on pension assets generally exceeded inflation, resulting in a positive real return (*Fig. 1*). Except for 2014, in which fund formation processes continued (asset consolidation after transfer from other funds was completed at the end of the first quarter) and the National Bank managed its assets for a partial year, negative real return occurred only in 2016.

Negative real returns in 2014 and 2016 were low, but the State had an obligation to compensate for the difference between pension asset returns and inflation. Currently, the costs are moderate. Thus, in 2021, the budget cost of payment of obligations under the state guarantee of security of pension contributions to the UAPF amounted to 1 420 mln tenge, which is equivalent to 0.05% of the amount of pensions paid by the state. However, if you compare these costs not with state pension payments, but with payments from the UAPF within the framework of the accumulation system, the result will be more significant. In 2021, pension payments from the UAPF by age (payment of pensions as such) amounted to 101.4 bln tenge[5] and in comparison, with this indicator, the amount of compensation for maintenance of pension contributions is noticeable, amounting to 1.4%.

The scale of state compensation for negative real returns on pension assets depends on two main parameters: the amount of pension assets in the UAPF and the level of pension payments. In 2014 and 2016, when negative real returns were recorded, the amount of pension savings amounted to 4.5 and 6.7 trn tenge respectively. According to the results of 2021, this indicator reached 13.1 bln tenge. The potential state cost of compensation in the framework of guaranteeing their preservation grows in combination with the increase in savings. Another parameter on which these costs depend is the amount of pension payments, which also increases steadily as the number of pension recipients increases within the accumulative system. If in 2014 the amount of pension payments from UAPF amounted

---

[2] Corporate strategy of development of the joint stock company "Unified Accumulative Pension Fund" for 2022–2026. Website of "UAPF" JSC. URL: https://www.enpf.kz/upload/medialibrary/ d00/d00545312c8329e5dca249cd8498b31e.pdf (accessed on 19.07.2022).

[3] In accordance with paragraph 1 of article 5 of the Law of the Republic of Kazakhstan "On Pension Provision in the Republic of Kazakhstan".

[4] The State is not responsible for the security of pension savings transferred by depositors to the management of non-State management companies.

[5] UAPF summarized preliminary results for 2021. Key indicators of UAPF as at 1 January 2022. URL: https://www.gov.kz/memleket/entities/zhetysu-zhambyl/press/article/details/72656?lang=ru (accessed on 19.07.2022).
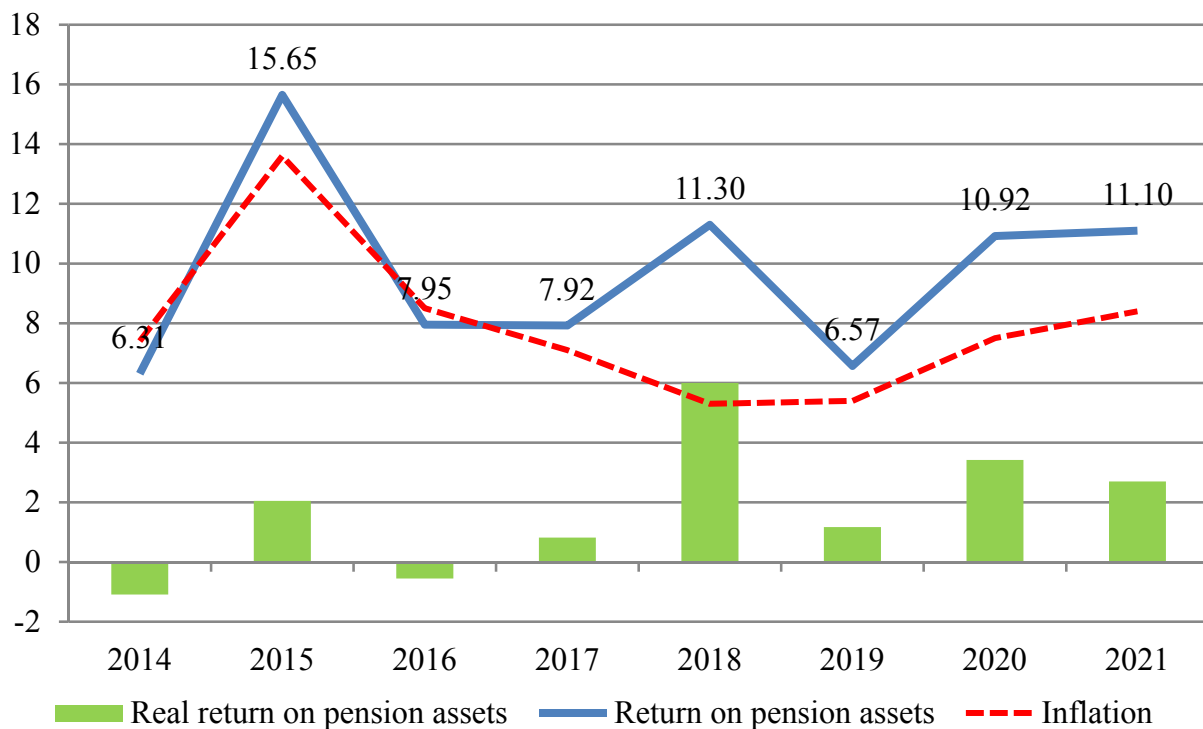
Fig. 1. **Return on UAPF Pension Assets Compared to Inflation, %**

Source: Compiled by the author from "UAPF" JSC data.

to 93 bln tenge, then in 2021 — already 2 883 bln.[6] The budget cost of compensation also grows proportionately. Given the increasing amount of pension savings and payments, the cost of errors in the management of pension assets is rising significantly, and achieving positive real returns on them is a critical task in the context of ensuring the long-term stability of the budget process.

Meanwhile, rising turbulence in global financial markets has made it increasingly difficult to get significant yields on pension assets, especially considering that pension funds have generally followed conservative investment strategies that do not include high yields. Both developed-country [20–24] and emerging-market [25–28] funds use the strategy of positioning pension assets in order to minimize investment risks. UAPF is also focused on investments in low-risk financial instruments (government securities,

bonds, deposits), whose total share in the fund's portfolio is about 90%.

This practice makes it difficult to exceed inflation through returns on pension assets. In most developed economies and in a large part of developing economies, the real return on pension assets is low. A study by the World Bank for 2000–2005 showed that the average real return on pension assets during this period for the US was 1.5% per annum, for Canada— 3.5%, for the UK — 1.9%, for Western Europe — 2%, for Brazil — 2.7%, for Japan— 4.8%, that is, was fairly moderate. Although in some countries (Bolivia, Peru, Uruguay, Poland) the real yield was around 10% [27]. OECD data for 2020 demonstrate moderate real returns for pension funds from the Organization countries, most of which were below 5%, and some (Australia, the Czech Republic, Poland) were negative (OECD, 2021[7]).

---

[6] Indicators on pension assets in dynamics. Website of "UAPF" JSC. URL: https://www.enpf.kz/ru/indicators/pa/current.php (accessed on 21.07.2022).

[7] PENSION FUNDS IN FIGURES. OECD, JUNE 2021. URL: https://www.oecd.org/daf/fin/private-pensions/Pension-Funds-in-Figures-2021.pdf (accessed on 22.07.2022).

GROWTH IN THE SHARE OF FOREIGN FINANCIAL INSTRUMENTS IN THE UAPF PORTFOLIO AND FORMING THE RELATION BETWEEN ITS REVENUE AND TENGE EXCHANGE RATE

The limited opportunities for increasing returns, as well as the inadequate development of the domestic market of equity and debt securities in Kazakhstan, together with the rapid growth of the amount of pension assets, exceeding the capabilities of the local market, caused the rapid increase of UAPF investments in foreign financial instruments (*Fig. 2*). If at the beginning of 2015 (the first full year of operation of UAPF), the share of foreign exchange instruments in the portfolio of the fund was 11.86%, and their volume was 536 bln tenge,[8] then at 1 January 2022, these figures were measured, respectively, 32.7% and 4 277 bln tenge.[9]

The growth of the share of foreign exchange financial instruments in the investment portfolio of UAPF, which since 2018 has remained above 30% (the average for the last four years was 31.1%), has been accompanied by an increase in the real return on pension assets. From 2018 to 2021, this indicator was only positive, ranging from 1.2% to 6%, and the average for these four years was 3.3%. In the UAPF's first four years of operation, when the share of foreign exchange financial instruments in its portfolio was significantly lower, two years of positive real return on pension assets were followed by two years of negative return, with a four-year average of only 0.3% (*Fig. 3*).

The increase in the return on pension assets over the past four years could be explained in part by the fact that the expansion of the range of financial instruments through more active investments in foreign markets has enabled additional revenue to be generated. However, in our view, this factor of yield formation did not play a significant role in its increase. The UAPF portfolio contains a very small proportion of high-volatility securities (shares, depositary receipts) that provide a high rate of return. This is largely due to the low contribution of market revaluation earnings to the UAPF's total investment earnings. The share of this component in investment income during 2015–2021 ranged from 5.1% to 10.5%, and the seven-year average was 2.6%.[10]

The revenue from foreign currency revaluation has had a significantly higher influence on the increase in the volume of investment revenue. The total income for the eight-and-a-half-year period (from 2014 to the first half of 2022) was approximately 1.5 trn tenge, and the average share of total investment income for that period was 22.5%.[11] Thus, the revaluation of currencies yields a higher return on investment due to the exchange rate difference than the revaluation of securities.

A significant percentage of revenue from foreign currency revaluation, which for the period of operation of the UAPF represents almost a quarter of its total investment income, means that the final financial result depends on this component. Accordingly, the positive real return on pension assets is largely due to the availability and size of currency revaluation income. Thus, in 2016, when the National Bank allowed a single decline in the real return on pension assets below zero, the revaluation of the currency also brought the largest loss in seven

---

[8] Information on investment management of pension assets of "UAPF" JSC for December 2014. Website of "UAPF" JSC. URL: https://www.enpf.kz/ru/indicators/invest/review.php#2022 (accessed on 22.07.2022).

[9] Information on investment management of pension assets of "UAPF" JSC for 1 January 2022. Website of "UAPF" JSC. URL: https://www.enpf.kz/ru/indicators/invest/review.php#2022 (accessed on 22.07.2022).

[10] Calculated from data from the following sources: Information on investment management of pension assets of "UAPF" JSC for 2014–2022. Website of "UAPF" JSC. URL: https://www.enpf.kz/ru/indicators/invest/review.php#2022 (accessed on 22.07.2022).

[11] Calculated from data from the following sources: Information on investment management of pension assets of "UAPF" JSC for 2014–2022. Website of "UAPF" JSC. URL: https://www.enpf.kz/ru/indicators/invest/review.php#2022 (accessed on 22.07.2022).
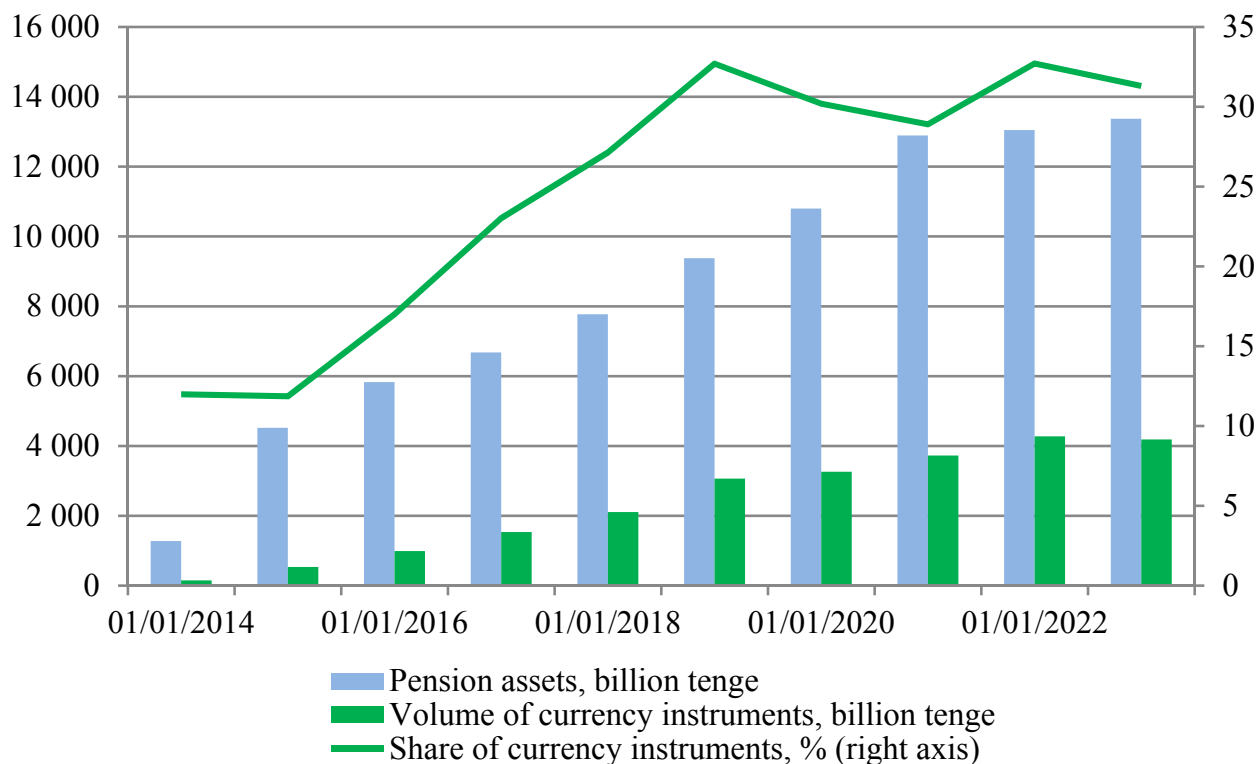
Fig. 2. Dynamics of the Volume and Net Weight of Pension Assets Invested in Foreign Currency Financial Instruments Compared to the Total Volume of UAPF Pension Assets

Source: Compiled by the author from "UAPF" JSC data.
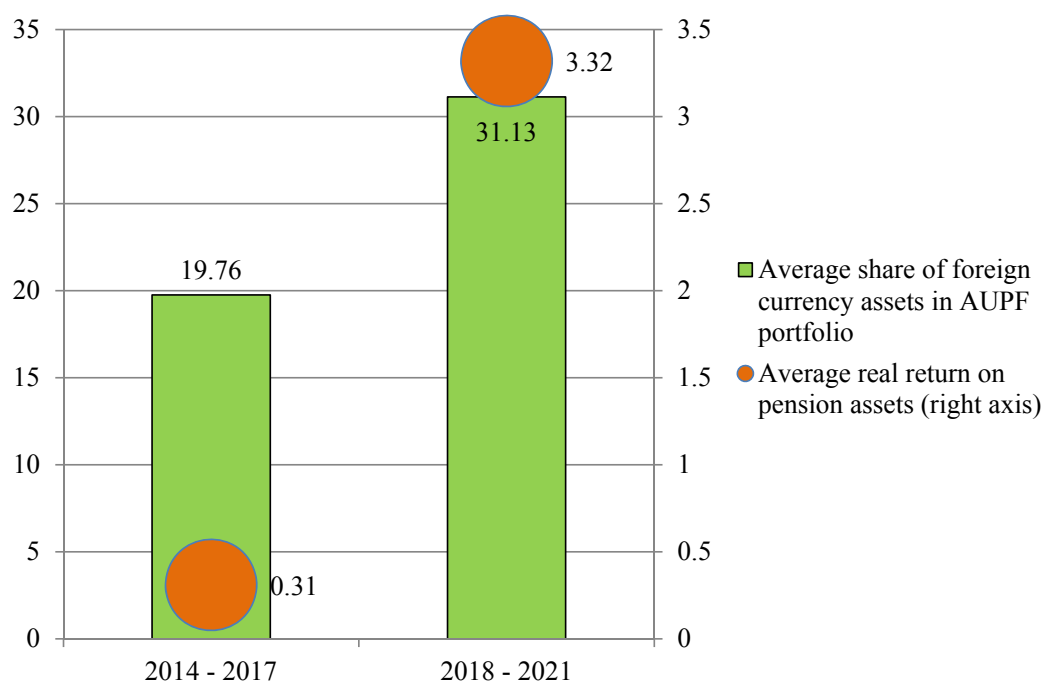
Fig. 3. Real Return on UAPF Pension Assets and the Share of Foreign Currency Financial Instruments in the Portfolio, %

Source: Compiled by the author from "UAPF" JSC data.
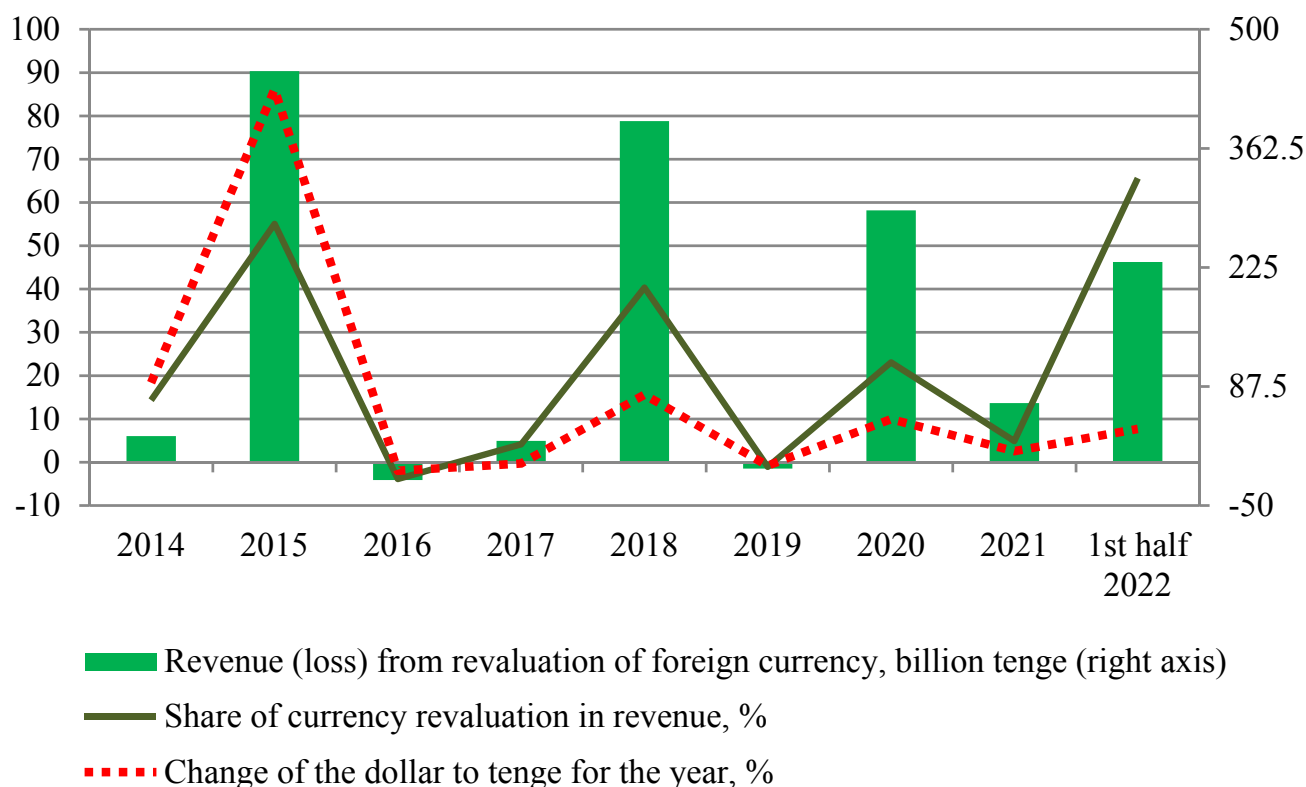
Fig. 4. **Comparative Dynamics of Indicators of Income from Currency Revaluation and Changes in the Exchange Rate of the US Dollar Against Tenge**

Sources: Compiled by the author from "UAPF" JSC and National bank of Kazakhstan data.

full years of its management of the UAPF portfolio. The relationship between revenue from foreign currency revaluation and return on pension assets is also confirmed by the high correlation factor between these indicators at the level of 0.86 for the period from 2014 to 2021.

In its turn, the revenue from the revaluation of the currency, UAPF is formed primarily by the change in the tenge exchange rate. Thus, in 2020, net profit from foreign currency transactions of 290.9 bln tenge was formed by exchange rate difference of 291 bln tenge and loss from trade operations of 81 mln tenge.[12] The exchange

rate difference results from a change in the tenge to other currencies in which the currency part of pension assets is invested. The predominant foreign currency in this case is the US dollar, which accounts for almost the entire amount of investment of pension savings in foreign currencies. So, at 1 July 2022, the share of the dollar in foreign exchange assets was 99.7%.[13] Accordingly, a change in the tenge against the US dollar leads to a difference in the exchange rate and, as a consequence, an investment return or loss from the revaluation of foreign currency. The relationship between the change in the US dollar to the tenge, the amount of revenue from currency revaluation, and the percentage weight of this revenue in the total

---

[12] Joint Stock Company "Unified Accumulative Pension Fund". Assets of the pension system. Financial statements and audit report of the independent auditor for the year ended 31 December 2020. p. 22. Website of "UAPF" JSC. URL: https://www.enpf.kz/upload/medialibrary/a32/a326c3b53c580bd54d45e19b2b3daffb.PDF (accessed on 25.07.2022).

[13] Information on investment management of pension assets of "UAPF" JSC for 1 July 2022. p. 4. Website of "UAPF" JSC. URL: file:///C:/Users/Первый/Downloads/guid=b7379b3f-e4e4–4ed7–88a0-efdfc57c5161%20(4).pdf (accessed on 25.07.2022).
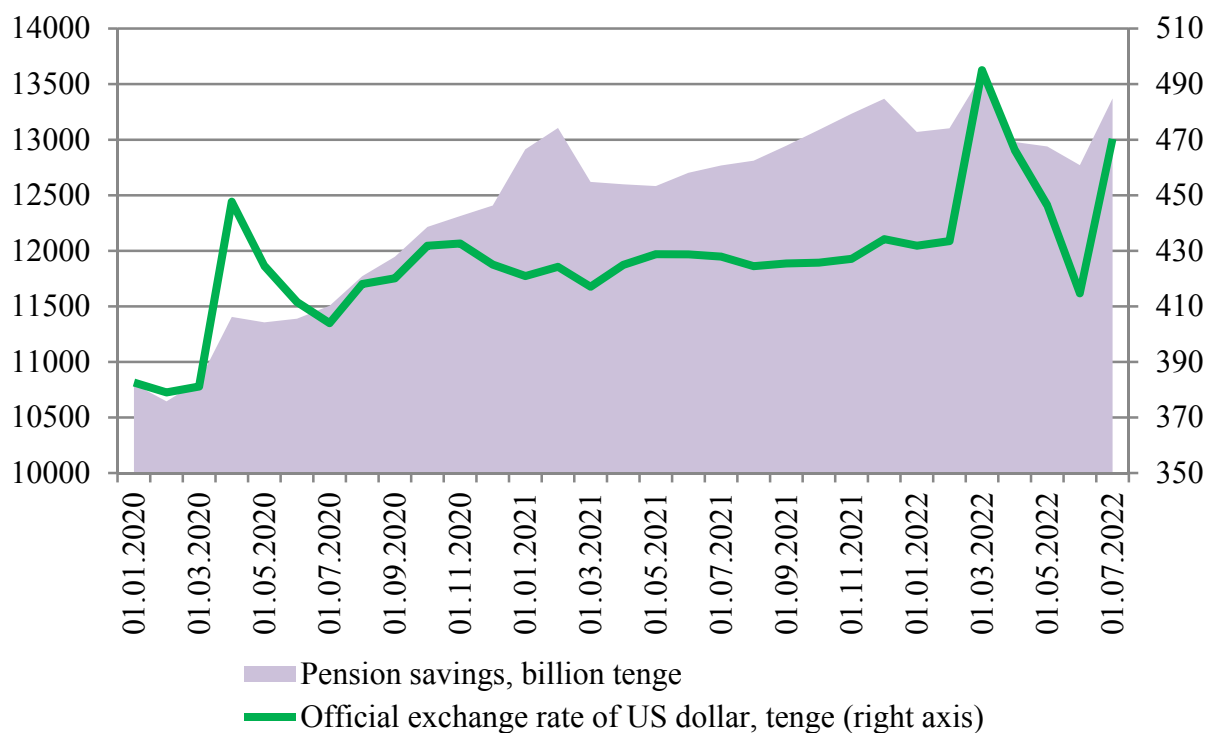
Fig. 5. **Comparative Dynamics of the Volume of Pension Assets of the UAPF and the Exchange Rate of the US Dollar Against Tenge**

Sources: Compiled by the author from "UAPF" JSC and National Bank of Kazakhstan data.

investment income on pension assets are reflected in the graphs (*Fig. 4*).

The graphs demonstrate the relationship between the change in the tenge rate and the revenue (or losses) from currency revaluation, as well as its importance in the formation of the UAPF's investment return. This correlation indicates the availability of revenues during tenge devaluation periods and the development of losses from currency revaluation during tenge strength years (2016 and 2019). The emergence of this relationship and its strengthening as the share of foreign exchange instruments in the assets of the UAPF increased, also formed a more general dependence of the return on pension assets as a whole on the change in the tenge rate. At the same time, it should be noted that the exchange rate difference, which forms the revenue from the revaluation of the currency, arises as a consequence of the change in the value of pension assets; that is, the change in the tenge rate affects not only their yield,

but also their volume. The devaluation of the tenge increases the volume of pension assets, and the strengthening of tenge reduces it. The influence of the tenge on pension assets has been more visible at short intervals in recent years, when the share of foreign exchange instruments in the UAPF portfolio exceeded 30%. The dynamics of the tenge and the amount of UAPF pension assets at monthly intervals from 1 January 2020 to 1 July 2022 — during the period when the average value of the net weight of foreign assets was 31.2% — reflects the existence of a correlation between these indicators (*Fig. 5*).

More significant changes in the amount of pension assets unfolded during periods of strong tenge rate fluctuations. This relationship is confirmed by a rather strong correlation factor (0.7) between the data variables in the time period under research. It is these changes in the value of assets associated with fluctuations in the tenge exchange rate that have largely determined
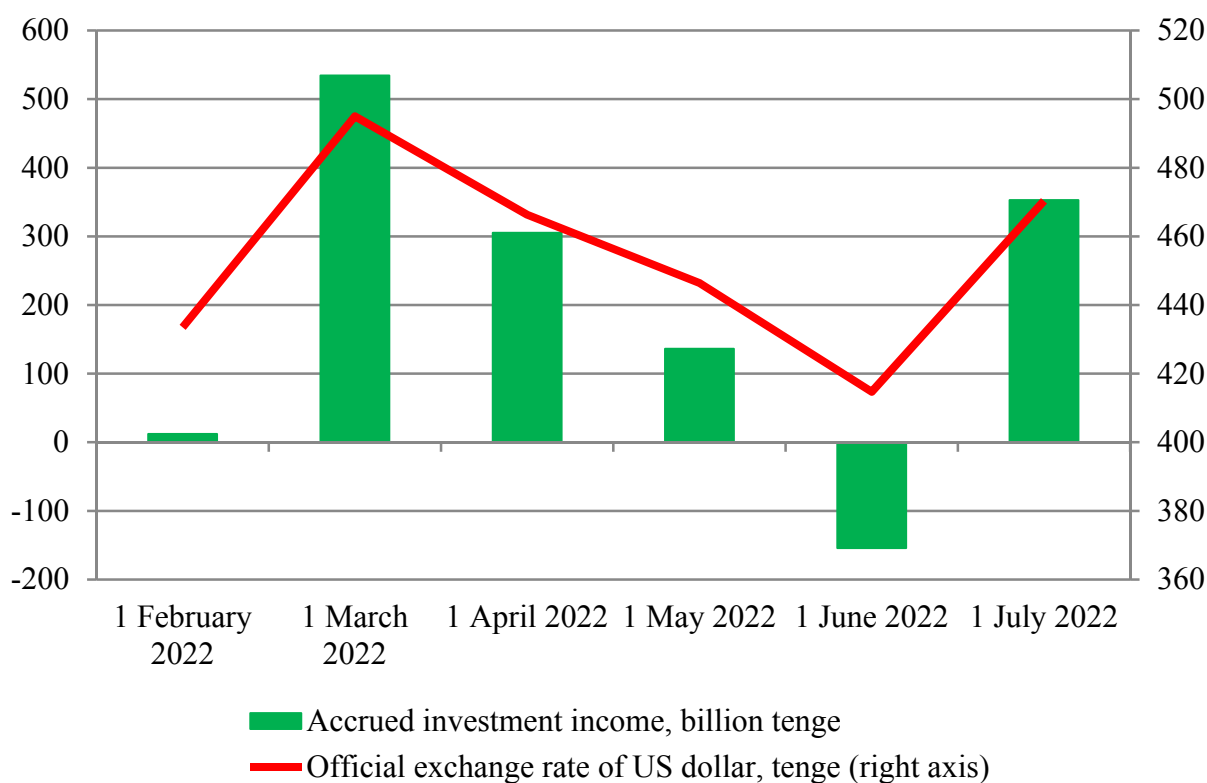
Fig. 6. **Dependence of Investment Income (Loss) of UAPF on the Dollar/Tenge Exchange Rate in the First Half of 2022**

Sources: Compiled by the author from "UAPF" JSC and National Bank of Kazakhstan data.

the dynamics of the volume of investment returns (losses) of the UAPF through the revaluation of the currency. The relationship between this indicator and the dollar to the tenge was pronounced during periods of high volatility in the Kazakhstan foreign exchange market, in particular, in the first half of 2022 (*Fig. 6*).

RELATION BETWEEN RETURN PENSION ASSETS AND TENGE EXCHANGE RATE AND ITS CONSEQUENCES FOR THE CURRENCY MARKET OF KAZAKHSTAN

Thus, it can be noted that there is a significant relationship between the situation in the domestic currency market of Kazakhstan and the parameters of the cumulative pension system, which arose as a result of the increase in the share of foreign assets in the UAPF portfolio. Given

the high role of currency revaluation income in ensuring the return on pension assets and the need to ensure that it exceeds inflation, it can be concluded that this relationship is mutual. In other words, not only does the change in the tenge rate affect the return on pension assets, but there is also a need to ensure that the return can also affect the tenge exchange rate.

The hypothesis of such influence, in our opinion, can be confirmed by quite significant changes in the process of formation of the tenge exchange rate in the last few years, precisely during the period when the share of foreign exchange instruments in UAPF assets reached its highest point. The essence of these changes is that the tenge rate has gradually lost connection with the main external sector parameters that regulate currency demand and supply in the domestic market — exports, trade balance, current
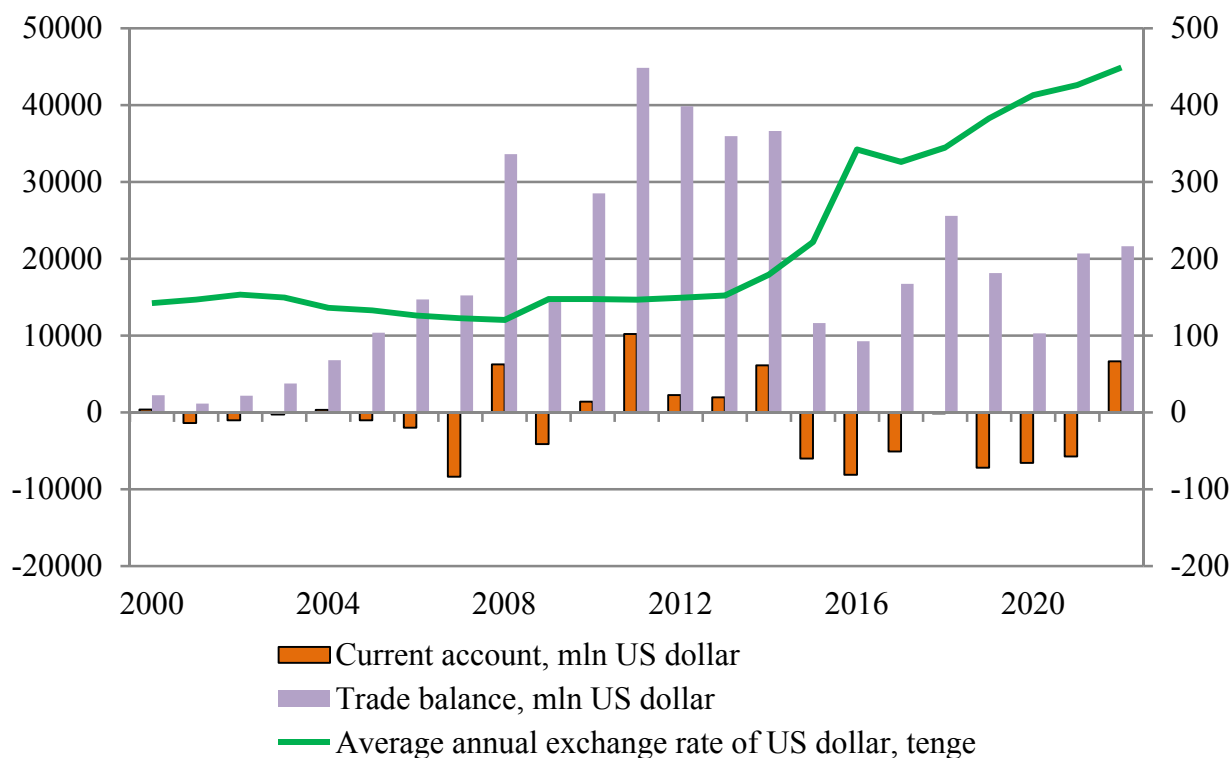
Fig. 7. **Comparative Dynamics of the Exchange Rate of the US Dollar Against the Tenge, the Trade Balance and the Current Account**

Sources: Compiled by the author from National bank of Kazakhstan data.

account balance — as well as the factors that determine these parameters, especially the foreign economic situation, including the price of oil, which is a priority factor for Kazakhstan.

In Kazakhstan, during the long period 2000–2016 (*Fig. 7*) the tenge rate was largely due to fundamental factors. This was reflected, among other things, in its increasing in 2002–2008 against the context of rising oil prices and the resulting increase in foreign trade surpluses; stability in 2010–2013 against the backdrop of a trade surplus formed by a high and stable oil price; and finally, the decline in 2014–2016, caused by a fall in key external sector parameters as oil prices fell from 110 to 35 dollars.

However, since 2018, the relationship between the tenge rate and indicators of the external sector has been disrupted. Kazakhstan's currency during this period

is gradually declining regardless of oil prices, the size of the trade balance surplus and current account. At the same time, the decline has significant proportions: the dollar strengthened to the tenge in the period from 2017 to the first half of 2022 by 38% — stronger than during the global financial crisis of 2009 (20.3%), or during the triple fall of oil prices in 2015 (24%). This situation supports the conclusion that some new forces were introduced in the construction of Kazakhstan's currency, which is starting to dominate over traditional currencies. At the same time, the effects of these new factors are increasing, which is noticeable in the period 2021–2022, when tenge accelerated its decline against the background of sharp growth of the foreign trade surplus and current account balance.

The distortion that have developed in recent years in the tenge course formation

are, in our opinion, a result of problems with the budget process, the necessity to ensure the support of the National Fund, etc. [29]. In relation to the problem of the impact of pension assets on Kazakhstan's foreign exchange market, it is important to note that the period of loss of the tenge rate's relationship with fundamental factors and parameters of the external sector coincides with the period of maximization of the share weight of foreign instruments in the UAPF portfolio and the emergence of a hard dependence of its return on the exchange rate.

This problem was apparent in the first half of 2022, when the tenge rate fell from 431.8 to 465.1 tenge per US dollar[14] against the background of rising oil prices and subsequent growth of the positive trade balance and current account of Kazakhstan. In our view, the phenomenon of the decline of the Kazakhstan currency in such favorable conditions is explained by the fact that during this period there was also a sharp fall in the return on pension assets of UAPF, with its decrease reaching very large negative values. This decline was caused by two main factors: an acceleration of inflation, which rose to 14.5% in June against 8% in December 2021,[15] and a sharp decline in global financial markets, which led to a fall in the value of assets in the UAPF portfolio. As a result, the real return on pension assets became negative, with unacceptably high values — in May, this figure exceeded 10%. A further factor in the decline in yields was the strengthening of the tenge, which formed an investment loss from the revaluation of foreign currency in the amount of 81

bln tenge.[16] Negative real returns of such a scale at the end of the year could form very large obligations of the State to compensate for them with aggregate pension savings in the UAPF of about 13 trn tenge 10% of the compensable difference between inflation and return is equivalent to 1.3 trn tenge. This situation, in our opinion, may have resulted in the National Bank regulating pension assets and trying to increase the return on assets as quickly as possible.

In the context of falling financial markets and rising inflation, the only way to increase returns was to increase the UAPF's investment income component, such as currency revaluation income. The main source of this revenue is the devaluation of the tenge, which occurred intensively in the first half of 2022, despite extremely favorable external factors. The decline in the exchange rate of tenge contributed significantly to the formation of income on pension assets from the revaluation of foreign currency, which amounted to 231 bln tenge over the six months and formed two-thirds of the total investment income.

Taking into account the above-mentioned aspects of the situation in the field of formation of the tenge exchange rate in Kazakhstan's foreign exchange market, it is possible to conclude that the situation with the UAPF yield has a substantial influence on this rate. The realization of this influence is facilitated by the fact that both the manager of pension assets and the regulator of the foreign exchange market is — the National Bank of Kazakhstan. In the first half of 2022, during the period of aggravated problems with UAPF yields, the regulator sharply reduced the volume of currency sales from the National Fund on the Kazakh foreign exchange market, which could not but affect the formation of the tenge exchange rate.

---

[14] Daily official (market) exchange rates. National Bank of Kazakhstan. URL: https://nationalbank.kz/ru/exchangerates/ezhednevnye-oficialnye-rynochnye-kursy-valyut/report?rates%5B%5D=5&beginDate=2022–01–01&endDate=2022–06–30 (accessed on 07.09.2022).

[15] Price statistics. Office of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. URL: https://stat.gov.kz/official/industry/26/statistic/5 (accessed on 07.09.2022).

[16] Information on investment management of pension assets of "UAPF" JSC for 1 July 2022. Website of "UAPF" JSC. URL: https://www.enpf.kz/ru/indicators/invest/review.php#2022 (accessed on 22.07.2022).

Currency sales from the National Fund constitute a significant part of the trading in the exchange market and amounted to 28% in 2021.[17] Therefore, the decline in these sales could not fail to affect the tenge price, making a significant contribution to its decline. That is, the weakening of the tenge and the resulting revenue from the revaluation of foreign currency have somewhat mitigated the loss of UAPF returns.

CONCLUSION

In our opinion, the hypothesis of the formation of a relationship between the exchange rate and the investment returns of pension assets in Kazakhstan is confirmed by the identified sustained influence on this return of the foreign currency revaluation

factor in the UAPF portfolio, as well as by the non-standard dynamics of the Kazakh currency in conditions of significant improvement in the external economic situation. The main consequence of the relationship considered can be recognized as the growth of its influence on the foreign exchange market of Kazakhstan and the increase in the role of the return on pension assets as a new factor in the formation of the tenge exchange rate.

Taking into account the fact that the real return on pension assets is derived from the level of inflation and the situation in the global financial markets, it is possible to forecast further complications of the task of ensuring its positive values. Negative real returns on pension assets will mean increased public budget expenditure on compensation and contribute increasingly to the imbalance of the budget process.

---

[17] Operations of the National Fund. National Bank of Kazakhstan. URL: https://nationalbank.kz/ru/page/operaciinacionalnogo-fonda (accessed on 10.09.2022).

REFERENCES

1. Blackhurst R., Adam M.C. The relation between the current account and the exchange rate: A survey of the recent literature. In: De Grauwe P., Peeters T., eds. Exchange rates in multicountry econometric models. London: Palgrave Macmillan; 1983:58–102. DOI: 10.1007/978–1–349–17286–3_3

2. Isard P., Faruqee H., Kincaid G.R., Fetherston M. Methodology for current account and exchange rate assessments. IMF Occasional Paper. 2001;(209). DOI: 10.5089/9781589060814.084

3. Fratzscher M., Juvenal L., Sarno L. Asset prices, exchange rates and the current account. *European Economic Review*. 2010;54(5):643–658. DOI: 10.1016/j.euroecorev.2009.12.005

4. Dornbusch R., Fischer S. Exchange rates and the current account. *The American Economic Review*. 1980;70(5):960–971.

5. Baldwin R., Krugman P. Persistent trade effects of large exchange rate shocks. *The Quarterly Journal of Economics*. 1989;104(4):635–654. DOI: 10.2307/2937860

6. Arize A.C., Osang T., Slottje D.J. Exchange-rate volatility and foreign trade: Evidence from thirteen LDC's. *Journal of Business & Economic Statistics*. 2000;18(1):10–17. DOI: 10.1080/07350015.2000.10524843

7. Kharroubi E. The trade balance and the real exchange rate. *BIS Quarterly Review*. 2011;(Sep.):33–42. URL: https://www.bis.org/publ/qtrpdf/r_qt1109e.pdf

8. Shul'gin A.G., Larin A.V., Novak A.E. Empirical analysis of balance of payments effects. *Finansovaya analitika: problemy i resheniya = Financial Analytics: Science and Experience*. 2012;(20):16–26. (In Russ.).

9. Liew K.-S., Lim K.-P., Hussain H. Exchange rate and trade balance relationship: The experience of ASEAN countries. *Journal of Management Sciences*. 2000;3:15–18. URL: https://www.researchgate.net/publication/23746205_Exchange_Rate_and_Trade_Balance_Relationship_The_Experience_of_ASEAN_Countries

10. Bhat S. A., Bhat J. A. Impact of exchange rate changes on the trade balance of India: An asymmetric nonlinear cointegration approach. *Foreign Trade Review*. 2021;56(1):71–88. DOI: 10.1177/0015732520961328

11. Goldberg M. D., Frydman R. Macroeconomic fundamentals and the DM/$ exchange rate: Temporal instability and the monetary model. *International Journal of Finance & Economics.* 2001;6(4):421–435. DOI: 10.1002/ijfe.166

12. Balalaeva I. E. Yuan exchange rate estimation and forecasting according to balance of payment. *Ekonomicheskie otnosheniya = Journal of International Economic Affairs*. 2018;8(3):453–460. (In Russ.). DOI: 10.18334/eo.8.3.39195

13. Nikitina M. G., Druzin R. V. Influence of Turkey's balance of payments on the exchange rate of the national currency in the context of financial instability. *Uchenye zapiski Krymskogo federal'nogo universiteta imebi V. I. Vernadskogo. Ekonomika i upravlenie = Scientific Notes of V. I. Vernadsky Crimean Federal University. Economics and Management*. 2022;8(1):99–108. (In Russ.).

14. Stučka T. The effects of exchange rate change on the trade balance in Croatia. IMF Working Paper. 2004;(65). URL: https://www.imf.org/external/pubs/ft/wp/2004/wp0465.pdf

15. Benazić M., Kersan-Škabić I. The determinants of exchange rate in Croatia. *Eastern Journal of European Studies*. 2016;7(1):125–150. URL: https://www.researchgate.net/publication/312563452_The_determinants_of_exchange_rate_in_Croatia

16. Vieira F. V., MacDonald R. The role of exchange rate for current account: A panel data analysis. *EconomiA*. 2020;21(1):57–72. DOI: 10.1016/j.econ.2020.05.002

17. Levkovich A. P., Voitekhovich A. N. Features of the relationship between the exchange rate and the balance of payments of countries with transitive economies. *Vestnik Belorusskogo gosudarstvennogo ekonomicheskogo universiteta = Belarusian State Economic University Bulletin*. 2013;(1):14–21. (In Russ.).

18. Osipov D. G., Smirnov V. V., Gurdzhiyan V. L. Analysis of changes in Russia's balance of payments. In: Ashmarina S. I., Mantulenko V. V., eds. Global challenges and prospects of the modern economic development (GCPMED 2020). (Samara, December 15–16, 2020). London: European Proceedings; 2020:93–100. (European Proceedings of Social and Behavioural Sciences. Vol. 79). DOI: 10.15405/epsbs.2020.03.13

19. Kuzmin A. Yu. Russian ruble exchange rate: Modeling of comparative medium-term and long-term dynamics. *Finance: Theory and Practice*. 2021;25(6):6–15. DOI: 10.26794/2587–5671–2021–25–6–6–15

20. Blake D. Pension schemes and pension funds in the United Kingdom. 2nd ed. Oxford: Oxford University Press; 2003. 770 p.

21. Baker A. J., Logue D. E., Rader J. S. Managing pension fund risk. In: Managing pension and retirement plans: A guide for employers, administrators, and other fiduciaries. New York, NY: Oxford University Press; 2004:194–212. DOI: 10.1093/019516590X.003.0016

22. Dyson A. C. L., Exley C. J. Pension fund asset valuation and investment. *British Actuarial Journal*. 1995;1(3):471–557. DOI: 10.1017/S 1357321700001203

23. Hue B., Jinks A., Spain J., Bora M., Siew S. Investment risk for long-term investors: Risk measurement approaches. Considerations for pension funds and insurers. *British Actuarial Journal.* 2019;24: e16. DOI: 10.1017/S 1357321719000102

24. Hinz R., Rudolph H. P., Antolín P., Yermo J., eds. Evaluating the financial performance of pension funds. Washington, DC: The World Bank; 2010. 280 p. URL: https://openknowledge.worldbank.org/server/api/core/bitstreams/58cdb8ed-512f-5f76-afd6–68fe1ff34808/content

25. Sokolov A.P. Investment policy of private pension funds. *Vestnik Saratovskogo gosudarstvennogo sotsial'no-ekonomicheskogo universiteta = Vestnik of Saratov State Socio-Economic University*. 2011;(4):135–139. (In Russ.).

26. Mel'nikov R.M. A mechanism of investment risks regulation of participants of accumulative component of the pension system of the Russian Federation and ways of its improvement. *Finansy i kredit = Finance and Credit*. 2014;(42):34–44. (In Russ.).

27. Gorlovskaya I.G., Ogorelkova N.V., Reutova I.M. Internal factors of the efficiency of managing portfolio pension accumulations. *Nauchnyi vestnik: finansy, banki, investitsii = Scientific Bulletin: Finance, Banking, Investment.* 2019;(3):13–22. (In Russ.).

28. Kabiri M.S., Elmsiyah C., Nouisser O. Strategic asset allocation and active management: evidence from Moroccan pension funds. *Finance: Theory and Practice*. 2022;26(4):157–170. DOI: 10.26794/2587–5671–2022–26–4–157–170

29. Dodonov V. Yu. Investment activity of the public institutions in foreign financial markets as a new factor in the tenge exchange rate. *Vostochnaya analitika = Eastern Analytics*. 2020;(1):17–33. (In Russ.). DOI: 10.31696/2227–5568–2020–01–017–033

ABOUT THE AUTHOR

Vyacheslav Yu. Dodonov — Dr. Sci. (Econ.), Chief Researcher, Institute of Philosophy Political Science and Religious Studies by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan, Almaty, Kazakhstan
https://orcid.org/0000-0003-0741-417X
dodonovv@mail.ru

Conflicts of Interest Statement: The author has no conflicts of interest to declare.

Sentiment Analysis Using Machine Learning for Forecasting Indian Stock Trend: A Brief Survey

A. S. Dash, U. Mishra

MIT College of Management, MIT Art, Design & Technology University, Pune, India

ABSTRACT

Due to new technical advances, the machine can think as a person-investor and express its reaction to readily available financial information. Forecasting models for the Indian stock market can be developed based on the analysis of these sentiments. The **purpose** of the study is to identify gaps in existing approaches to the analysis of sentiments and models of forecasting trends in the Indian stock market, which can improve the accuracy of the prediction of the dynamics of Indian stocks. The paper presents an overview of the literature on the analysis of sentiments of financial information using lexical methods, machine learning methods and forecasting for the Indian stock market based on sentiment analysis data. The scientific works, conference reports, dissertations, books and articles published by scientists for the period from 2015 to 2021 are considered. The datasets published in Indian Stock Exchanges suggest increasing participation of retail investors in the Indian Stock market in recent times. To help investors in decision-making, various prediction models are available based on the financial information. The results of the survey showed that investors' attitudes based on the microeconomic and macroeconomic information associated with stocks influence the movement of the stock price. Therefore, forecasting a future trend or price requires a sentiments analysis based on available financial information. It was **concluded** that using machine learning to extract sentiment from financial data allows for more accurate forecasts than sentiment analysis based on vocabulary. The results of this study can be useful for students and new professionals in the field of financial information data analysis and stock market predictions who want to get connected with this area, identify problem concerns, and develop models for predicting decision-making.

Keywords: sentiment analysis; stock market; prediction; machine learning; decision making; trend analysis

INTRODUCTION

Investors in the Indian stock market invest their money into retail investors, foreign institutional investors, mutual funds, insurance funds, pension funds, banks, and so on. The investment decisions on the stock market are to gain good returns with the movement of stock prices and dividends. The movement of the price of a stock depends on several factors, such as company performances, announcements, microeconomic conditions, macroeconomic environment, the sentiment of investors towards the stocks, and any new information associated with the stock.

The investors take the long positions with an upward movement or trend of the stock price, so that they gain from the uptrend and with a downward movement or trend, the investor takes the short positions to cover their loses. The correct investment decisions made by investors on stock markets during an upward trend and the downward trend will increase the potential of earning better and adjust the risks in a better way. Many times, due to inaccurate considerations while investing in the stock market, investment decisions go wrong, bringing enormous losses to the investors. The retail investors bear the brunt due to inadequate information on market trends.

To provide a correct decision and to reduce their risk, the prediction of stock price trends is necessary for the short- or long-term based on the investment horizon.

The investor sentiment towards the stock provides a good input to predict the stock price trend using machine learning algorithms. The sentiment analysis of the financial information available related to companies identifies the behaviour of human sentiment towards the stock information available currently. Sentiment analysis is a popular language processing technique where the polarity of the textual data is determined. The sentiment analysis is performed in 2 ways: the

classical Lexicon-Based Approach and the Machine Learning-Based Approach.

This research aims to find out major studies related to Sentiment Analysis processes for financial market information through a deep literature survey and explore the use of machine learning services for sentiment analysis of financial market information for the Indian market, which helps predict the market trend.

THE OBJECTIVE OF THE STUDY

The objectives of this study of a literature review on sentiment analysis through machine learning for Indian financial market are following:

1) To find out various research works completed in the field of sentiment analysis through machine learning for Indian financial markets for the period 2015 to 2021.

2) To find out the impact of sentiment analysis on the price movement of a stock in the Indian stock market.

3) To find out the prediction models used for predicting the trend of stock price movement in the Indian stock market using sentiment analysis.

METHODOLOGY

This research is descriptive research, where the study of literature is mainly based on the available secondary sources such as previous research papers, conference papers, journal papers, past PhD theses, books, online blogs, and articles by various research scholars and academicians for the period of 2015 to 2021. The research for this work is done in both online and offline modes, where literature was identified using specific criteria and word searches. The keywords used to filter out the right kinds of literature are "Sentiment Analysis through Machine Learning", "Sentiment Analysis on Indian Financial Market Information", "Impact of Sentiment Analysis on Indian Financial Market Information".

The secondary kinds of literature were searched based on the specified keywords. In this research, more than 140 papers were scanned, more than 20 PhD theses were referred, and more than 50 various blogs along with online articles were studied. The studied kinds of literature were categorized based on their relevance to the topic, contribution of knowledge, and contribution of research work related to sentiment analysis on the Indian stock market. The pieces of literature related to sentiment analysis on foreign markets were kept in low- and medium-importance categories to focus only on the Indian market.

INDIAN STOCK MARKET

The Indian stock market is one of the oldest stock markets in Asia. The Bombay Stock Exchange (BSE) was established in 1875 as "The Native Share and Stockbrokers Association".[1] After the liberalization of the Indian market in 1991, the National Stock Exchange (NSE) was incorporated in 1992, and it was recognized as a stock exchange by the "Security Exchange Board of India" in April 1993.[2]

As per Bombay Stock Exchange market capitalization data published in October 2021, the total market capitalization was 259 Lakh Crore.[3]

As per the Market Statistics — October 2021 report by the WFE Statistics team, the market capitalization of NSE is 3.4 trn USD, or 252 Lakh Crore Rupees as of August 2021.[4]

The companies are listed on either one or both stock exchanges. In BSE around 5 213 companies were listed as of August 2021[5] and in NSE around 1 920 companies were listed as of August 2021.[6]

TYPE OF INVESTORS

Various investors invest in these listed companies through the NSE or BSE. Private Indian promoters

---

[1] BSE History & Milestones — Bombay Stock Exchange. 2021. URL: https://www.bseindia.com/static/about/History_Milestones.html (accessed on 26.06.2022).

[2] NSE History & Milestones — National Stock Exchanges. 2021. URL: https://www.nseindia.com/national-stock-exchange/history-milestones (accessed on 26.06.2022).

[3] BSE Market Capitalization Report — Bombay Stock Exchange. 2021. URL: https://www.bseindia.com/markets/equity/EQReports/AllIndiamktcap_Histori.aspx (Accessed on 26.06.2022).

[4] BSE History & Milestones — Bombay Stock Exchange. 2021. URL: https://www.bseindia.com/static/about/History_Milestones.html (accessed on 26.06.2022).

[5] BSE Market Capitalization Report — Bombay Stock Exchange. 2021. URL: https://www.bseindia.com/markets/equity/EQReports/AllIndiamktcap_Histori.aspx (accessed on 26.06.2022).

[6] NSE History & Milestones — National Stock Exchanges. 2021. URL: https://www.nseindia.com/national-stock-exchange/history-milestones (accessed on 26.06.2022).

hold around 34.6% of the total market capitalization of NSE-Listed companies, followed by Foreign Institutional Investors, holding 21.7%, foreign promoters holding 9.7%, and retail investors holding 9% as of December 2020 (*Fig. 1*).[7]

The shares are being traded on these exchanges daily. NSE's turnover for March 2021 was 13.9 trn rupees.[8] The motive of the transactions is to gain monetary benefit. In these transactions, Foreign Institutional Investors (FIIs), Domestics Institutional Investors (DIIs) Mutual Funds, Corporates, Proprietary Traders, Individual Investors, and others such as Trusts, Partnership firms, VC Funds, etc. are involved. Traditionally, qualified investors, such as FII, and DII participated much more than individual investors. However, in the last 6 years, this trend has changed.

In the financial year 2021, individual investors, such as individual domestic investors, NRIs, sole proprietorship firms, and HUFs, will account for 45% of the total turnover in the cash segment of the NSE. As per the report, NSE has added 90 Lakh new investors in the current fiscal year. More individual investors are now entering the Indian stock market to participate in stock market trading (*Fig. 2*).

STOCK PRICE MOVEMENT

Stock prices change based on the demand and supply of shares on the exchanges. If the demand for the stock exceeds the supply, the price of the stock rises; similarly, if the supply of the stock exceeds the demand, the price of the stock falls. The movement of the price of a particular stock can behave the same way for a few days, a few weeks, or even months based on demand and supply.

The direction of price movement is termed a trend [1]. The trend can be upward or downward. An upward trend is formed when the price movement makes higher swing highs and higher swing lows. A downward trend is formed when the price movement makes lower swing lows and lower swing highs [2]. The trends are measured

---

[7] Market Pulse-A Monthly review of Indian economy and markets.2021:3–4. URL: https://static.nseindia.com//s3fs-public/inline-files/Market_Pulse_April_2021.pdf (accessed on 28.06.2022).

[8] Market Pulse-A Monthly review of Indian economy and markets. 2021. URL: https://static.nseindia.com//s3fs-public/inline-files/Market_Pulse_April_2021.pdf (accessed on 28.06.2022).

for the short-term, medium-term or intermediate-term, and long term. The short-term trend can be the price movement in the same direction for a few days to a few weeks; the medium-term trend can be the price movement in the same direction for a few weeks to a few months; and the long-term trend can be the price movement in the same direction from a few months to a few years [3].

TYPE OF STOCK PRICE ANALYSIS

According to the Efficient Market Hypothesis, the price of a stock reflects all the information available to the market, and it is impossible to beat the market [4]. However, the EMH is highly controversial, as modern financial theory suggests no market is perfectly efficient, and thus stock prices do not always accurately reflect their true value. The Indian stock market returns are not completely random. It exhibits a weak form of market efficiency, so the prediction of the true value of stock price exists [5]. Investors try to perform various price analyses of a particular stock before deciding to buy or sell that stock. Predominately, two types of stock price analysis — fundamental analysis and technical analysis — are performed by investors. Fundamental analysis is to identify the stock's correct value by examining various economic factors from the micro to macro level.

On the other hand, technical analysis is the study of historical price movements of securities and the patterns through charts and various indicators to identify the correct price of the security and forecast the future movement.

SENTIMENT ANALYSIS

As per the theory of behavioural finance, Noise in the form of information makes the market inefficient. Also, testing theories in the financial market is very difficult due to the presence of Noise. Under the influence of Noise, traders or investors behave irrationally and take the stock price away from the true price level. However, the true price of stock returns in the long run [6].

The stock price tends to be diverse from its true value under the influence of noisy signals present in the financial market. The traders act on these signals and move the true price of a stock in a different direction. So, the investors are subject to sentiments; this sentiment
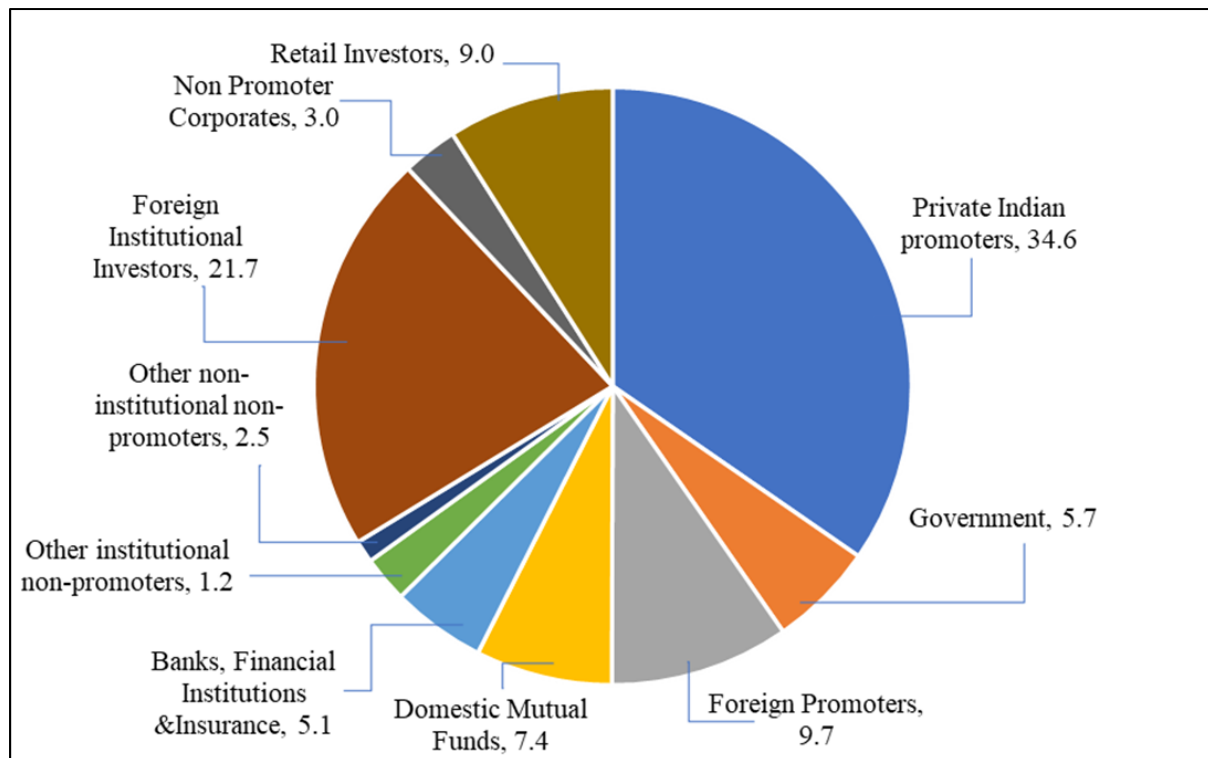
Fig. 1. **Types of Investors Holding in Percentage the Ownership of NSE-Listed Companies as of December 2020**
Source: Market Pulse-A Monthly review of Indian economy and markets. 2021. URL: https://static.nseindia.com//s3fs-public/inline-files/Market_Pulse_April_2021.pdf (accessed on 28.06.2022).
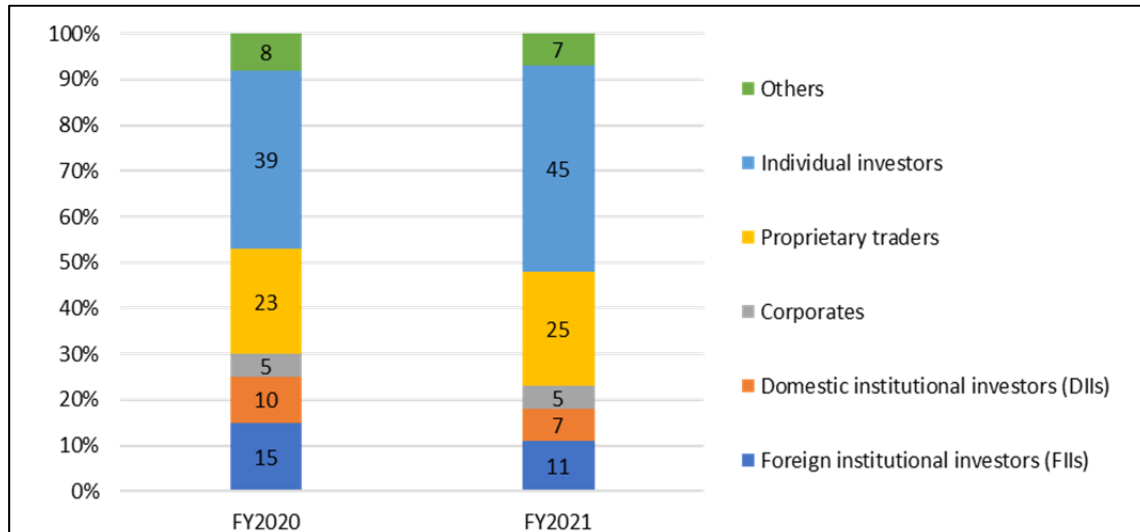
Fig. 2. **Types of Investors Participate in the Capital Market at NSE (in %)**
Source: Market Pulse-A Monthly review of Indian economy and markets. 2021. URL: https://static.nseindia.com//s3fs-public/inline-files/Market_Pulse_April_2021.pdf (accessed on 28.06.2022).

is their belief about the future cash flow of the security, which is not justified by the available information [7].

Based on the research by Baker & Wurgler, it has been clear that investor sentiments affect the stock price movement. In their work, they have proposed a top-down approach to measure investor sentiment [8, 9]. Measuring investor sentiment is not straightforward; however, using imperfect proxies, they created a model

to measure the sentiment. In their model, they have listed out various proxies such as investor psychology to respond the corporate news, trade volumes, mutual fund investments, announcement of dividends, implied volatility of stock options, listing day returns on initial public offerings (IPOs), the volume of initial public offerings, new equity issues, and insider trading information. Based on these proxies, they provided the sentiment index as

$$SENT = -0.23CEFD + 0.23TURN + 0.24NIPO + \\ + 0.29RIPO + 0.32PDND + 0.23S.$$

In this equation, they have used 6 proxies or factors to define the sentiment. These 6 factors are the closed-end fund discount (*CEFD*), detrended log turnover (*TURN*), number of IPOs (*NIPO*), first-day return on IPOs (*RIPO*), dividend premium (*PDND*), and equity share in new issues (*S*). The major challenge of this model was characterizing and measuring uninformed investor sentiment and the variation in investor sentiment over time.

On a similar principle, various studies were conducted on the Indian stock market to identify the relationship between investor sentiment and stock market volatility. Investor sentiment plays a vital role in the Indian stock market's volatility. As per the study, investors are more responsive to negative news than positive. The negative sentiment plays a greater role in the volatility of the Indian market [10].

To measure the linkage between investor sentiment and stock market volatility, similar studies have been performed on the Indian stock market along with the world stock market. Jyoti & Jitendra, in their research, went ahead to assess the predictability the asset volatility in the Indian stock market using investor sentiment. To measure investor sentiment through their model, they provided six macro-economic factors such as the Index of industrial production (IIP), short-term interest rates as Treasury bill rates (TBR), term spread (difference between long-term bond yield and Treasury bill rate), the exchange rate (EX), wholesale price index (WPI) and foreign institutional investments (FII) and four market-symmetric factors such as four market-wide systematic factors, market risk premium (Mkt), the premium on the portfolio of small stocks relative to large stocks (SMB), the premium on the portfolio of

high book/market stocks relative to low book/market stocks (HML) and momentum factor (WML). Their study concluded that investor's sentiment does predict the volatility of assets in the Indian stock market. In this research, investor sentiment is predominately derived from the available quantitative data [11].

The sentiment is human behaviour, and any information, whether qualitative or quantitative, has some influence on the sentiment value. In the past few decades, as information availability has tremendously increased, many researchers have worked towards an understanding of investors' sentiment using both qualitative and quantitative data. When any new information is available, it has some degree of impact on the sentiment of the investor [12].

In recent times, much research has been conducted to identify any causal relationship between financial information and the impact on Indian stock markets. P. Misra in his research, identified the relationship between BSE Sensex and macroeconomic variables such as the Index of Industrial Production (IIP), inflation, the rate of interest, the price of gold, the rate of exchange, FII, and supply of money. He also confirms that there exists a long-term causality between these macroeconomic variables and BSE Sensex [13].

Some of the researchers conducted the study on individual variables. As Foreign Institutional Investors are one of the largest players in the Indian stock market, their net investment is positively influenced by the NIFTY returns [14].

Financial information related to microeconomic and macroeconomic variables are announced and published through national newspapers, company websites, or NSE and BSE websites. These announcements impact the sentiment of investors towards the stock. There is a significant impact of the announcement of a new product launch or approvals or decisions on the company's share prices [15]. So abnormal returns are generated on the event day. The sentiment from the news event has some time limit on the investor. The effect of positive or negative sentiments lasts for certain days on the stock price movement from the event date [16].

The investor sentiment factor based on financial news adds significantly to the traditional asset pricing model [17]. The news articles were collected from the published data of the Guardian Newspaper and

sentiment analysis was conducted to understand the impact on the London stock market. Based on the analysis, it was found that the sentiment metric influences the volatility of the London Stock Exchange Index [18].

Financial information published on the listed stock exchange, newspaper, or microblogging sites is unstructured. Chan & Chong, in their research, published a model on how to extract insights from unstructured data for sentiment analysis [19]. They also identified that this information contains noise, which needs filtering. A detail filtering technique to reduce the noise present in financial news sentiments was discussed in the research carried out by M. W. Uhl [20]. To understand the sentiment of the investor when new financial information is available, sentiment analysis is needed on the available financial news.

As per the Oxford dictionary definition, sentiment analysis is the process of computationally identifying and categorizing opinions expressed in a piece of text, especially to determine whether the writer's attitude towards a particular topic, product, etc. is positive, negative, or neutral.[9] Sentiment analysis is a popular language processing technique where the polarity of the textual data is determined.

Sentiment analysis is a branch of Natural Language Processing (NLP) for analysing public opinion [21]. The sentiment analysis is performed in 2 ways, as shown by F.Z. Xing et al. [22]. One is the classical Lexicon-Based Approach, and the other is the Machine Learning-Based Approach.

In the Lexicon-Based Approach, dictionaries of words are mapped with emotional polarities, such as positive, negative, and neutral. Then these words are matched to the input data to calculate the overall polarity of the data [23]. *Figure 3* represents the flow chart for a Lexicon-Based Sentiment Analysis Model.

MACHINE LEARNING APPROACH

In the Machine-Learning Approach, various machine learning algorithms are used to identify the polarity of the textual data. Machine-Learning is a subset of Artificial Intelligence, where complex algorithms are programmed to replicate the function of the Human Brain in such a way that they can solve complex problems in the same way the human brain solves.

Machine learning is an application of artificial intelligence that provides the system with the ability to automatically learn from the training set of data and improve on the experience it has gained from the training data without being explicitly programmed for it. Machine learning focuses on the learning capabilities of computer programs that can access data and use it to learn for themselves what the human brain does.

In the machine learning approach, two datasets are used, where the first one is used to train the model and the second dataset is used to Test the model (*Fig. 4*).

In the past, several studies have been conducted to test sentiment analysis from various social media and news sources using machine learning algorithms. It has been concluded that the accuracy and efficiency of sentiment analysis using the machine learning approach are better than the Lexicon-based approach [21].

There are various challenges involved in creating a system to analyse the sentiment, using the machine learning approach. Infrastructure is one of the major challenges, as a huge amount of data is required to train the machine learning model and then test to get the desired accuracy. The system should be able to store and process this data. Another challenge is the use of machine learning algorithms and desired expertise in that field to create these models. As a result, small, medium-sized organizations or individuals do not have the necessary resources to build some of these sentiment analysis systems [26].

To overcome these challenges, we need to identify major cloud-based AI platform services that offer sentiment analysis through Application Programming Interfaces using their powerful supercomputers in a very cost-effective way. Following are a few major technology solutions currently available:

• IBM Watson Natural Language Understanding Services;

• Microsoft Azure Cognitive Services;

• Google Cloud Natural Language AI;

• Amazon Comprehend.

These major technology companies are providing Application Programming Interfaces (APIs), which enable developers or individuals to use these interfaces in their programs and receive the Sentiments analysis

---

[9] Online Oxford Dictionaries. 2019. URL: https://www.oxfordlearnersdictionaries.com/ (accessed on 28.06.2022).
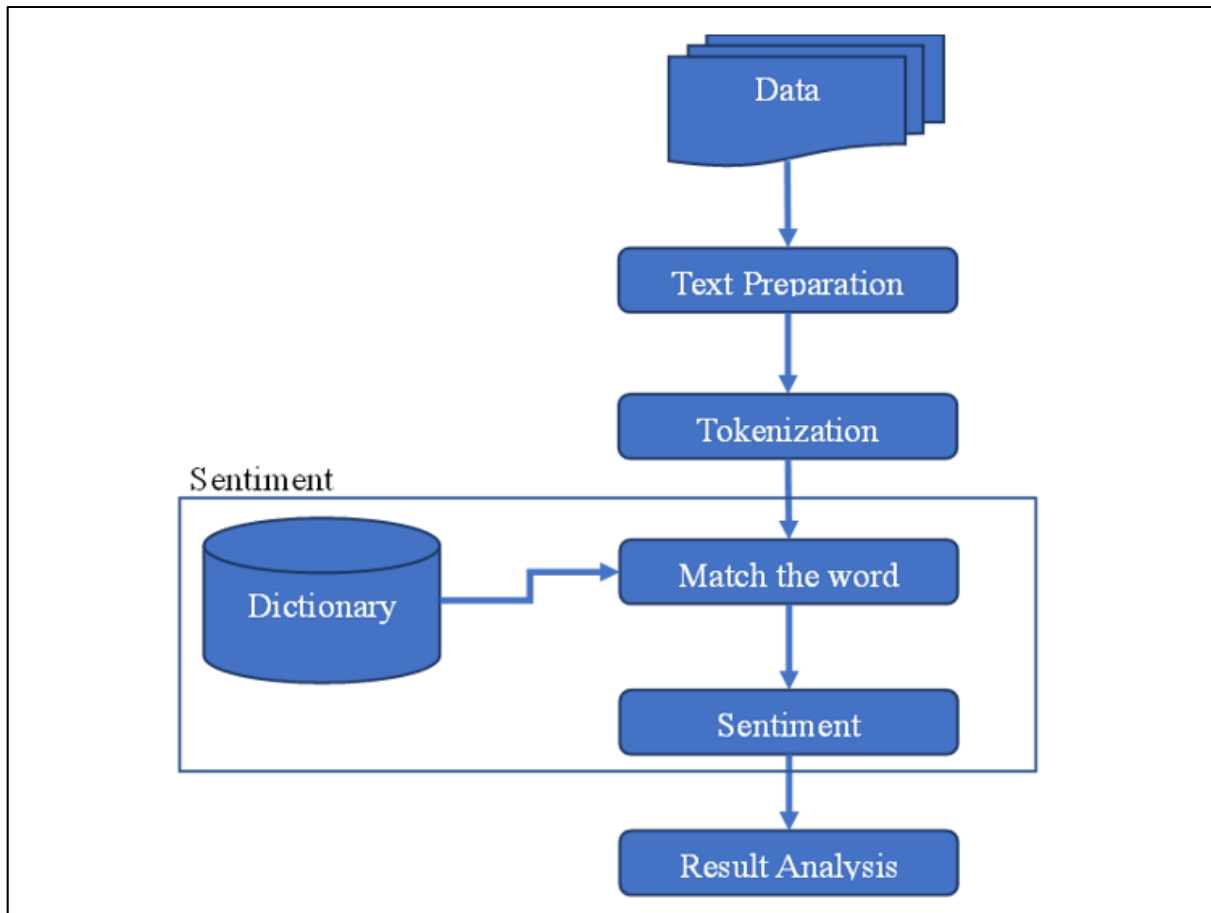
Fig. 3. **Lexicon-Based Sentiment Analysis Process on Financial News**
Source: H.A. Shehu et al. [24].
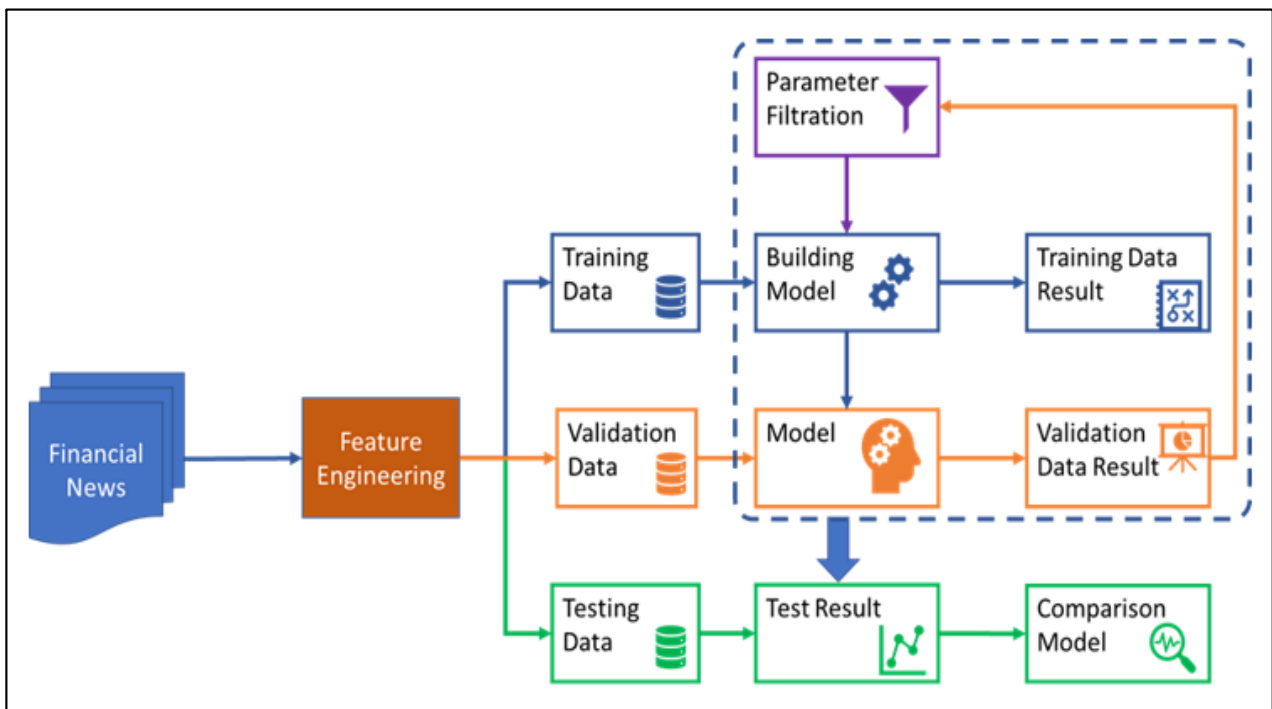
Fig. 4. **Machine Learning-Based Sentiment Analysis Process**
Source: E. Alpaydin [25].

Summary of the Technologies and the Overall Accuracy Level

Cloud Platform	Technology	Output	Accuracy Level
IBM Cloud1	Natural Language Understanding	Score inside the interval [−1,1]	97%
Microsoft Azure2	Text Analytics	Score inside the interval [0,1]	94%
Google Cloud2	Natural Language	Score inside the interval [−1,1]	90%

Source: Based on the de Las Heras-Pedrosa C. et al. [27], Carvalho A., Xu J. [28].

results for the input data. This eliminates the infrastructure challenges of creating the models and deep knowledge of technical programming.

The IBM Watson Natural Language Understanding has an overall accuracy of 97% for natural language processing. "Its performance has been compared with other systems as well as humans, and in either case, the result is very satisfactory" (see *Table*) [27].

The accuracy testing is conducted by Carvalho & Xu. In their research, they tested the accuracy of each of the above systems with 14 605 tweets and 3,209 Facebook posts. As per the result, they concluded that IBM Watson's accuracy is better than other systems [28].

Figure 5 depicts the process flow for sentiment analysis of texts using the IBM Watson Natural Language understanding API services.

Various documents or web contents related to the financial market or stock-specific news feed into IBM Watson through the Natural Language understanding API services. Then the result has been provided with a sentiment score in a range of −1 to 1, where −1 represents Negative, 0 represents Neutral and 1 represents positive.

The IBM Watson Natural Language platform also provides additional flexibility through custom training of specific domains to the system, where custom training data in an Excel file can be fed to the system to increase the accuracy of the system for a specific domain. With this approach, additional documentation is provided with the sentiments provided to the machine to learn more about the specific domain as humans do.

After the development of Machine Learning Algorithms and related concepts, various researchers

and academics turned their focus on predicting the stock price using this technology. Most of the research was conducted to predict stock prices based on their previous price through various machine learning Algorithms such as long- and short-term memory, Artificial Neural network, etc. [29–32].

In the recent study by M. Obthong et al. [33], they did a survey of literature on Machine learning algorithms and related models to predict the price of the stock market based on previous prices. They found the accuracy of these systems ranges from 55% to 65%. They concluded to increase the accuracy of the prediction models, not only the previous price of the stock but also additional information such as Sentiment towards the stock will be needed.

The news information related to stocks provides sentiment towards the stock price, and it helps in the price movement reflected on the stock price. With recent technological developments in natural language understanding, the sentiment analysis of these news stories provides a vital input to predicting the stock price.

The results from the work by H. Rich et al. [34] are quite encouraging, where they created a model to use the New York Times published information related to renewable energy sector companies to extract sentiments, and then they used the stock market data in their machine learning algorithms to predict the renewable energy index price. With their approach, they have achieved an accuracy of 75% in the predictability of the NASDAQ renewable energy index trend. Similar research was performed by G.G.-R. Wu et al. [35] to understand the stock market returns from the Taiwan stock exchange using the new-based sentiment analysis
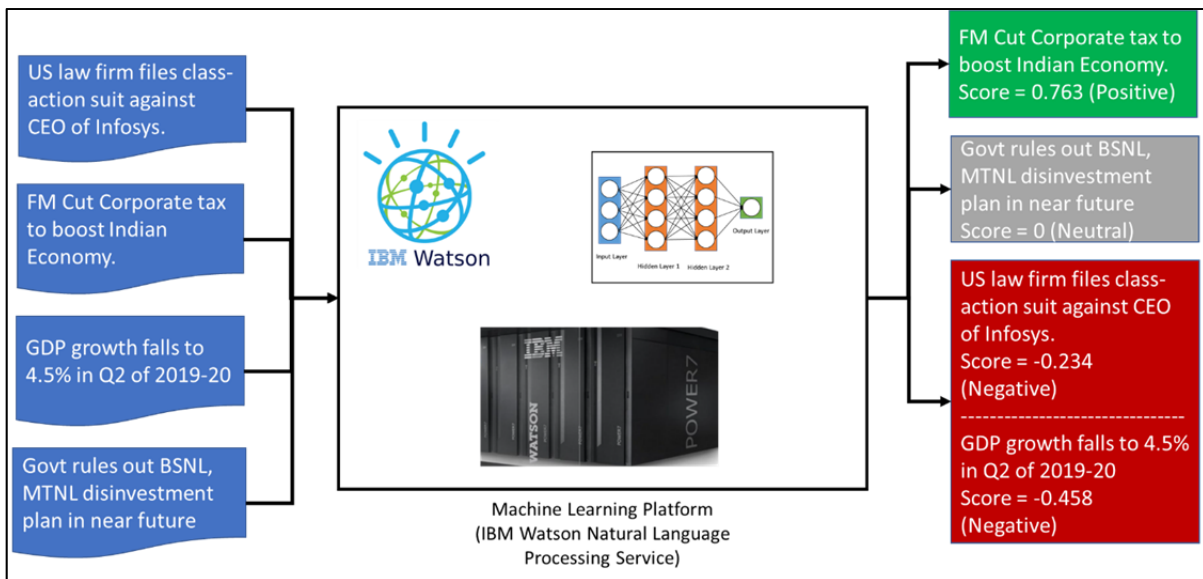
Fig. 5. **Data Flow for Sentiment Analysis of Texts Using the IBM Watson Natural Language Understanding API Services**
Source: A. Carvalho, J. Xu [28].

and market data. They concluded that the news variable provides useful information for predicting the Taiwan market returns.

REVIEW OF SENTIMENT ANALYSIS FOR INDIAN STOCK MARKET

Researchers are continuously working on the technological advancement of sentiment analysis using AI-driven systems and machine learning algorithms to provide better accuracy in predicting the price movement of stocks. Though limited studies were performed on Indian stock markets compared to the US and world stock markets, the Indian stock market behaves very poorly. Market efficiency and prediction opportunities exist in the Indian stock market [5].

It is evident from the sentiment of investors on the news of any new product announcement for the BSE 500 index companies that there is a significant impact of the news of new products on the stock price. With the information of the new product launch, the trend of stock price changes and abnormal returns are generated on the event day [15].

Macroeconomic factors such as Industrial Production (IIP), inflation, the rate of interest, the price of gold, rate of exchange, FII, and supply of money have an impact on the BSE Sensex index price movement. There exists a causal relationship between the information related to macroeconomic variables and the price movement of BSE Sensex. Also, the impact of macroeconomic variables such as foreign portfolio investors' sentiment influences positively the movement of NIFTY returns [13, 15].

R. Yadav et al. [23] in their study, created an event-based sentiment analysis model to predict the Indian stock market prices. They have implemented the Lexicon-based sentiment analysis model to predict the sentiment for the news feed. They found the model provided an additional aid while deciding on an investment.

The research by N. Rani et al. [36] on the NIFTY 50 index stocks of the Indian stock exchange provides a significant relationship between the index price movement and the sentiment score. In their study, they collected new information from Twitter and published news, using an available machine learning model to predict the sentiment. They measure the NIFTY 50 index returns based on the sentiment score. They concluded that there is a significant relationship between the sentiment score and the NIFTY 50 index return on a 10-day moving average.

CONCLUSION

From our research and review of articles, it is evident that the Indian stock market behaves

weakly in terms of market efficiency and prediction opportunities. In the previous research work, various prediction models were created to predict the trend or price of stocks in the global as well as Indian stock markets using machine learning algorithms. The majority of this research was aimed at using the past stock price alone, which is not sufficient to predict the trend or price accurately. They do not provide the complete sentiment of the investors towards that stock price movement.

From the studies, it has been concluded that the sentiments of investors from the microeconomic and macroeconomic information related to the stock have an impact on the price movement of the stock. So, to predict the future trend or price, the sentiment analysis on the available financial information is needed. The machine learning approach to extract sentiment from the financial information is more accurate than the Lexicon-Based sentiment analysis.

We have reviewed various off-the-shelf technologies available for sentiment analysis using machine learning. IBM Watson Natural Language Understanding is one such platform from IBM, which provides sentiment analysis on financial information with a great accuracy of 97% and can be trained further for specific domains to increase the accuracy. Also, this tool is commercially less expensive compared to its peers.

A future study is needed to understand the sentiment analysis using off-the-self technology such as IBM Watson Natural Language Understanding on the available financial information on both microeconomic and macroeconomic level of stocks in the Indian stock market and its impacts on the stock price movement in Indian stock market. New researchers can work further on this topic to create new forecasting models based on the latest machine learning algorithms and the sentiment analysis score from IBM Watson, along with the historical price of the stock. The prediction models will provide greater results than the previous models.

REFERENCES

1. Edwards R.D., Magee J., Bassetti W.H.C. Technical analysis of stock trends. New York, NY: AMACOM, a division of American Management Association; 2007. 840 p.

2. Nicholson C. Building wealth in the stock market: A proven investment plan for finding the best stocks and managing risk. Milton, Qld: John Wiley & Sons Australia, Ltd; 2009. 352 p.

3. Thomsett M.C. Practical trend analysis: Applying signals and indicators to improve trade timing. Boston, MA: Walter de Gruyter Inc.; 2019. 350 p.

4. Fama E.F. The behavior of stock-market prices. *The Journal of Business*. 1965;38(1):34–105. DOI: 10.1086/294743

5. Nagpal A., Jain M. Efficient market hypothesis in Indian stock markets: A re-examination of calendar anomalies. *Amity Global Business Review*. 2018;13(1):32–41.

6. Black F. Noise. *The Journal of Finance*. 1986;41(3):528–543. DOI: 10.1111/j.1540–6261.1986.tb04513.x

7. De Long J.B., Shleifer A., Summers L.H., Waldmann R.J. Noise trader risk in financial markets. *Journal of Political Economy*. 1990;98(4):703–738. URL: https://scholar.harvard.edu/files/shleifer/files/noise_trader_risk.pdf

8. Baker M., Wurgler J. Investor sentiment and the cross-section of stock returns. *The Journal of Finance*. 2006;61(4):1645–1680. DOI: 10.1111/j.1540–6261.2006.00885.x

9. Baker M., Wurgler J. Investor sentiment in the stock market. *Journal of Economic Perspectives*. 2007;21(2):129–151. DOI: 10.1257/jep.21.2.129

10. Kumari J., Mahakud J. Does investor sentiment predict the asset volatility? Evidence from emerging stock market India. *Journal of Behavioral and Experimental Finance*. 2015;8:25–39. DOI: 10.1016/j.jbef.2015.10.001

11. Kumari J., Mahakud J. Investor sentiment and stock market volatility: Evidence from India. *Journal of Asia-Pacific Business*. 2016;17(2):173–202. DOI: 10.1080/10599231.2016.1166024

12. Pang B., Lee L. Opinion mining and sentiment analysis. *Foundations and Trends in Information Retrieval*. 2008;2(1–2):1–90. URL: https://www.cs.cornell.edu/home/llee/omsa/omsa.pdf

13. Misra P. An investigation of the macroeconomic factors affecting the Indian stock market. *Australasian Accounting Business & Finance Journal*. 2018;12(2):71–86. DOI: 10.14453/aabfj.v12i2.5

14. Kumar P., Gupta S.K., Sharma R.K. An empirical analysis of the relationship between FPI and Nifty returns. *IUP Journal of Applied Economics*. 2017;16(3):7–24.

15. Mann B.J.S., Babbar S. Stock price reaction around new product announcements: An event study. *IUP Journal of Management Research*. 2017;16(3):46–57.

16. Heston S.L., Sinha N.R. News vs. sentiment: Predicting stock returns from news stories. *Financial Analysts Journal*. 2017;73(3):67–83. DOI: 10.2469/faj.v73.n3.3

17. Allen D.E., McAleer M., Singh A.K. Daily market news sentiment and stock prices. *Applied Economics*. 2019;51(30):3212–3235. DOI: 10.1080/00036846.2018.1564115

18. Johnman M., Vanstone B.J., Gepp A. Predicting FTSE 100 returns and volatility using sentiment analysis. *Accounting & Finance*. 2018;58(S 1):253–274. DOI: 10.1111/acfi.12373

19. Chan S.W.K., Chong M.W.C. Sentiment analysis in financial texts. *Decision Support Systems*. 2017;94:53–64. DOI: 10.1016/j.dss.2016.10.006

20. Uhl M.W. Emotions matter: Sentiment and momentum in foreign exchange. *Journal of Behavioural Finance*. 2017;18(3):249–257. DOI: 10.1080/15427560.2017.1332061

21. Rani S., Singh J. Sentiment analysis: A survey. *International Journal for Research in Applied Science & Engineering Technology.* 2017;5(8)1957–1963. DOI: 10.22214/ijraset.2017.8276

22. Xing F.Z., Cambria E., Welsch R.E. Natural language based financial forecasting: A survey. *Artificial Intelligence Review*. 2018;50(1):49–73. DOI: 10.1007/s10462–017–9588–9

23. Yadav R., Kumar A., Kumar A.V. Event-based sentiment analysis on futures trading. *The Journal of Prediction Markets*. 2019;13(1):57–81. DOI: 10.5750/jpm.v13i1.1731

24. Shehu H.A., Tokat S., Sharif H., Uyaver S. Sentiment analysis of Turkish Twitter data. *AIP Conference Proceedings*. 2019;2183:080004. DOI: 10.1063/1.5136197

25. Alpaydin E. Introduction to machine learning. Cambridge, MA: The MIT Press; 2014. 537 p.

26. Carvalho A. Harris L. Off-the-shelf technologies for sentiment analysis of social media data: Two empirical studies. In: Americas conf. on information systems (AMCIS 2020). (August 15–17, 2020). Atlanta, GA: Association for Information Systems. 2020. URL: https://aisel.aisnet.org/amcis2020/social_computing/social_computing/6

27. de las Heras-Pedrosa C., Sánchez-Núñez P., Peláez J.I. Sentiment analysis and emotion understanding during the COVID-19 pandemic in Spain and its impact on digital ecosystems. *International Journal of Environmental Research and Public Health*. 2020;17(15):5542. DOI: 10.3390/ijerph17155542

28. Carvalho A., Xu J. Studies on the accuracy of ensembles of cloud-based technologies for sentiment analysis. In: Americas conf. on information systems (AMCIS 2021). (August 9–13, 2021). Atlanta, GA: Association for Information Systems. 2021:1462. URL: https://aisel.aisnet.org/amcis2021/art_intel_sem_tech_intelligent_systems/art_intel_sem_tech_intelligent_systems/12

29. Ince H., Trafalis T.B. A hybrid forecasting model for stock market prediction. *Economic Computation and Economic Cybernetics Studies and Research.* 2017;51(3):263–280. URL: http://www.eadr.ro/RePEc/cys/ecocyb_pdf/ecocyb3_2017p263–280.pdf

30. Cocianu C.L., Grigoryan H. Machine learning techniques for stock market prediction. A case study of Omv Petrom. *Economic Computation and Economic Cybernetics Studies and Research*. 2016;50(3):63–82. URL: https://www.researchgate.net/publication/308719462_Machine_learning_techniques_for_stock_market_prediction_Acase_study_of_OMV_Petrom

31. Moghaddam A.H., Moghaddam M.H., Esfandyari M. Stock market index prediction using artificial neural network. *Journal of Economics, Finance and Administrative Science*. 2016;21(41):89–93. DOI: 10.1016/j.jefas.2016.07.002

32. K.-S., Kim H. Performance of deep learning in prediction of stock market volatility. *Economic Computation and Economic Cybernetics Studies and Research*. 2019;53(2):77–92. DOI: 10.24818/18423264/53.2.19.05

33. Obthong M., Tantisantiwong N., Jeamwatthanachai W., Wills G. A survey on machine learning for stock price prediction: Algorithms ♦ and techniques. In: Proc. 2nd Int. conf. on finance, economics, management and IT business (FEMIB 2020). Vol. 1. Setúbal: Science and Technology Publications (SciTePress); 2020:63–71. DOI: 10.5220/0009340700630071

34. Rich H., Scott D., Franck B. Evaluating predictability of financial markets using New York Times sentiments and market data. 2017. URL: https://github.com/IBM/powerai-market-sentiment#readme

35. Wu G.G.-R., Hou T.C.-T., Lin J.-L. Can economic news predict Taiwan stock market returns? *Asia Pacific Management Review*. 2019;24(1):54–59. DOI: 10.1016/j.apmrv.2018.01.003

36. Rani N., Kaushal A., Shakir M.B. Social media and sentiment analysis of Nifty 50 Index. *Journal of Prediction Markets*. 2019;13(1):50–56. DOI: 10.5750/jpm.v13i1.1710

ABOUT THE AUTHORS

Anupa S. Dash — PhD Scholar, MIT College of Management, MIT Art, Design & Technology University, Pune, India
https://orcid.org/0000-0001-6359-2160
Corresponding author:
anups.dash@gmail.com

Ujjwal Mishra — PhD, Prof. of Finance, academician, MIT College of Management, MIT Art, Design & Technology University, Pune, India
https://orcid.org/0000-0002-3291-0143
ujjwalmmishra@gmail.com

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 02.09.2022; revised on 02.10.2022 and accepted for publication on 26.10.2022.
The authors read and approved the final version of the manuscript.

Investments in the Digitalization of Service Companies as a Source of Well-Being of the Population of the Regions

V.A. Yakimova, S.V. Khmura
Amur State University, Blagoveshchensk, Russia

ABSTRACT

The article assesses the impact of investments in the digitization of service organizations on population well-being indices across Russia's regions. The **relevance** of the study is reduced to the fact that in the context of digitalization of the economy there is a dynamic development of the service sector, which becomes a driver of the growth of the quality and standard of living of the population. The **purpose** of the study is to determine the presence of economic effects from investments in digitalization that contribute to the improvement of the level and quality of life of the population in the region. The objectives of the study are theoretically justify the selection of indicators for assessing the well-being of the regional population, investments in the digitalization of service organizations depending on the type of region, and the calculation of digital effects. Methods of assessment of par correlations, typology, and panel data used to conduct spatial-time analysis. 85 regions of Russia were selected as the objects of study, and the research period includes the pre-pandemic and pandemic period, the impact of which led to an increase in investment in digital technologies in the service sector. The study tested the scientific hypothesis that investment in the digitalization of the service sector contributes to an increase in the volume of services, their availability and their quality, which, in turn, leads to an increase in the well-being of the population. The analysis carried out did not allow us to fully confirm the hypothesis, since there are differences between regions and types of services. The **novelty** of the study is in the formed spatial-time models, reflecting the relationship between investment in the digitalization of the services sphere and the factors determining the quality of life of the population of the regions of Russia. The analysis did not fully support the hypothesis, as there were differences between regions and types of services. It **concluded** that the investment increased the population's use of computer equipment and service volumes, as well as their ability to save more money and use services for managing their personal finances.

Keywords: service economy; digitalization of the service sector; welfare of the population of the region; indicators of quality of life; welfare economics; investments in digitalization; digital infrastructure for quality of life; digitalization indices

INTRODUCTION

The transition to the new economy is accompanied by the rapid development of services. For example, in developed countries, the services sector accounts for a substantial share of GDP: in the USA — about 80%, in Japan — over 70%. These trends contribute to a new phenomenon, the service economy, which allows individuals to save money on transaction costs connected with e-services while maintaining access to reliable public services. At the priority level of the State, the goal of the development of the service economy is set in the national project "Digital economy", according to which the basis of development of society is the provision of "new quality of life, business and public services". I. N. Tkachenko and E. N. Starikov [1] argue that the digital economy causes socio-economic transformations of public life. S. Xiang et al. [2], A. Grybauskas et al. [3], M. Spence [4] considers that services-oriented regions are not experiencing poor quality of life by leveraging the benefits of digitalization. Instruments of the system for improving the welfare of the population are the services of organizations — telemedicine, distance education, e-government and financial services.

While digitalization contributes to the welfare of individuals in developed countries, it does not in developing countries. The causes of the imbalances are negative factors such as digital divides, income polarization, insufficient digital literacy among the public, increasing morbidity as a result of the COVID-19 pandemic, social conflict, cyber fraud etc.

A. V. Vorontsovskiy notes that the development of Internet services may not contribute to the growth of public welfare, although the welfare of individuals may increase [5]. The studies noted the absence of effects from digitization on the quality of life of the population [6, 7], which is caused, in the opinion of the authors, by the Russian economy in the initial phase of digitization. In the development phase, investment in service organizations, i.e. investment of financial capital for the acquisition and implementation of digital technology and software, is an important catalyst. The consideration of digital effects at the regional level is due to the fact that the region is a "complexly functioning economic-socio-environmental system with individual economic, socio-demographic, infrastructural and other features" [8]. In the regions, conditions and opportunities for the living of the population in the given territory are formed. Regions' unequal investment, policy effectiveness and differences in governance tools determine the need to study regional differentiation of welfare. The purpose of the study is to assess the relationship between the growth of investment in the digitalization of services and the indicators characterizing the welfare of the population. The objectives of the study are:

• identification of a set of indicators for assessing the welfare of the population that may change as a result of digital transformation in the regions;

• assessment of investment in the digitization of service organizations depending on the typology of regions and the quality of life of the population;

• determination of digital effects by identifying the relationship between investment in the digitization of service organizations of the region and indicators of the welfare of the population through spatial-time analysis.

EVALUATION OF THE DIGITAL IMPACT ON THE WELFARE OF THE POPULATION OF THE REGION

Welfare economics has been developed in Bergson-Samuelson's paper (the approach of general welfare and the theory of social choice), A. Baujard's concept of "welfarism" [9], from the point of view of classical utilitarians (welfare as prosperity and happiness), T. Grüne-Yanoff's behavioral welfare theory

[10] (the study of the preferences of economic agents and social justice). M. S. Pecherkina, I. V. Korobkov [8] reveals the category of "welfare of the region" from the perspective of the quality of life of the individual and socio-economic development of the area, and indicators include the general economic, structural, social and economic, demographic, economic, environmental and financial spheres. Welfare represents the extent to which a society provides services to meet its needs. The growth mechanism of the region's welfare is based on efficient reproduction due to the image of the area and the availability of service services to the population in the region. Economic and material conditions (monetary income, ratio of consumption and savings), human capital indicators (housing conditions, employment, health and education system), the state of the economy, public administration, and the environment comprise some of the criteria used to assess the welfare of the region's population [6, 11–13].

Regional welfare is achieved by improving the quality of life of the population. The category "quality of life" is sufficiently researched and is considered from the perspective of components that reflect important aspects of people's life activities [14]. The standard of living as a measure of the welfare of the population is characterized by the "degree of satisfaction of material needs" [6]. Quality of life, as an indicator of socio-economic development of the region, includes objective and subjective factors, such as health, life expectancy, living conditions and comfort, social environment, safety, etc. [15, 16]. V. V. Okrepilov, N. L. Gagulina [17] among the characteristics of quality of life, apart from those listed, are material welfare, the development of regional infrastructure, the comfort of climatic conditions and the political environment.

Although indicators and measurement methodologies have been examined, indicators must be chosen to assess the influence of digital transformation on the welfare of the region's population. G. P. Litvintseva and I. N. Karelin [7] introduces the concept of "digital quality of life", which means the digital component is measured by the availability of digital competences, the quality of the labor sphere, e-government services and Internet security. The digital effect on the population's quality of life has both an objective (access to digital infrastructure, digital platforms) and subjective (social comfort through the use of digital technology) scope [16].

The influence of digitalization on service organizations was studied by Yu. I. Seliverstov [18], noting the creation of ways of serving customers and effective forms of interaction with them. According to A. V. Vorontsovskiy [5], digitalization includes online services, online stores, allowing for the extraction of income through the processing of information for the operation of services. O. V. Artemova et al. [14] consider the digital component of quality of life, expanding the possibility of meeting needs in digital form. Social and financial services, the Internet, mobile phones are being made available to rural and low-income populations [19]. The development of the G. P. Litvintseva and I. N. Karelin [7] correlation models has shown the positive impact of e-government services on the welfare of society. Positive impacts identified include the expansion of the boundaries of accessibility and convenience of services, receiving real-time education and increasing productivity.

It has research aimed at segmenting of the service sphere and identifying the peculiarities of its segments. K. S. Friesenbichler and A. Kügler [20] assessed the relationship between the share of services (market, financial, high-technology science-intensive services) and productivity growth and changes in employment structure. It was found that when the region's economy develops, the share of the service economy increases, service services in production expand, and science-intensive services limit

factor productivity growth. U. Witt and C. Gross [21] based on the construction of the production function model identified the peculiarities of the sphere of services in the efficient use of digital technologies and energy savings. In the service sector, unit labour costs are higher than in industry, and productivity is growing at a slow pace. Improved competitiveness conditions favor equalization of labour productivity and wages in the sectors. Examples of indicators suggest that a universal methodology for assessing the welfare of the region with regard to the digitalization of the services sector has not been developed, so it is proposed to identify indicators and assess the relationship between variables.

RESEARCH METHODICS
In order to conduct the study, it is proposed to use investments in the digitization of service organizations, an integral indicator of quality of life, published by the rating agency "RIA Rating" in the regions of Russia. The indicators considered are classified as follows: quality of life, population well-being, working life quality, social sphere, and life safety. Selected statistics represent indicators that are to be digitized.

Panel analysis is chosen as a method to establish space-time relationships. Fixed variable of the study — period 2017–2021, object of study — region. The choice of the period is because digital effects can be manifested, starting in 2017, during the period of activities during the implementation of the national program "Digital Economy of the Russian Federation" and adopted strategies of digital transformation of regions. Since 2017, the statistical database has been improved and indicators for measuring digital effects have been introduced.

A greater interest for the study is the fixed-effect model, as it is applied to the general aggregate objects (regions) and explains the dependent variable (K_{ijk}) of the general average, the differentiated effects of the effects of factors

and their combination. Changes develop repeatedly in different places through different periods. A fixed variable model describes estimates of individual effects, which are variable coefficients. Effects are defined using a basic model:

$$K_{ijk} = const + \mu + \alpha_i + \beta_1 K_1 + \beta_2 K_2 + \\ + \beta_3 K_3 + \ldots + \beta_n K_n + (\alpha\beta)_{ij} + \varepsilon_{ijk},$$

where μ — total average; α_i, β_j — effect (fixed or random) on the i- levels of influence of factors; $(\alpha\beta)_{ij}$ — effect of their interaction; ε_{ijk} — residues in normally distributed model.

REGIONAL ECONOMIC SERVICES DISBALANS: THE IMPACT OF THE COVID-19 PANDEMIC
The share of the services sector in the Russian economy has a special significance, starting from 2019 there is a gradual growth in the structure of the GRP. Services accounted for 43% in 2017 and 44.3% in 2020. Investments in the range of activities of service organizations are presented in *Fig. 1*.

The increase in the share of services is due to the impact of COVID-19, which is caused by a decline in production and increased investment in digital hardware and video communication programs for the provision of services in remote format. The service sector recovered at a faster rate than industry during the pandemic. The largest share of investments in digitalization is recorded in the sector of communications organizations, and since 2019, it has grown significantly. Growth is attributable to the importance of the telecommunications sector for digital transformation and the functioning of all subsystems of the economy.

The second largest investment sector is financial and insurance, with the growth rate of digitalization in 2020–2021 higher than in other sectors. This fact is due to the development of online-services, allowing obtaining part of the services without physical visit to the offices of banks and
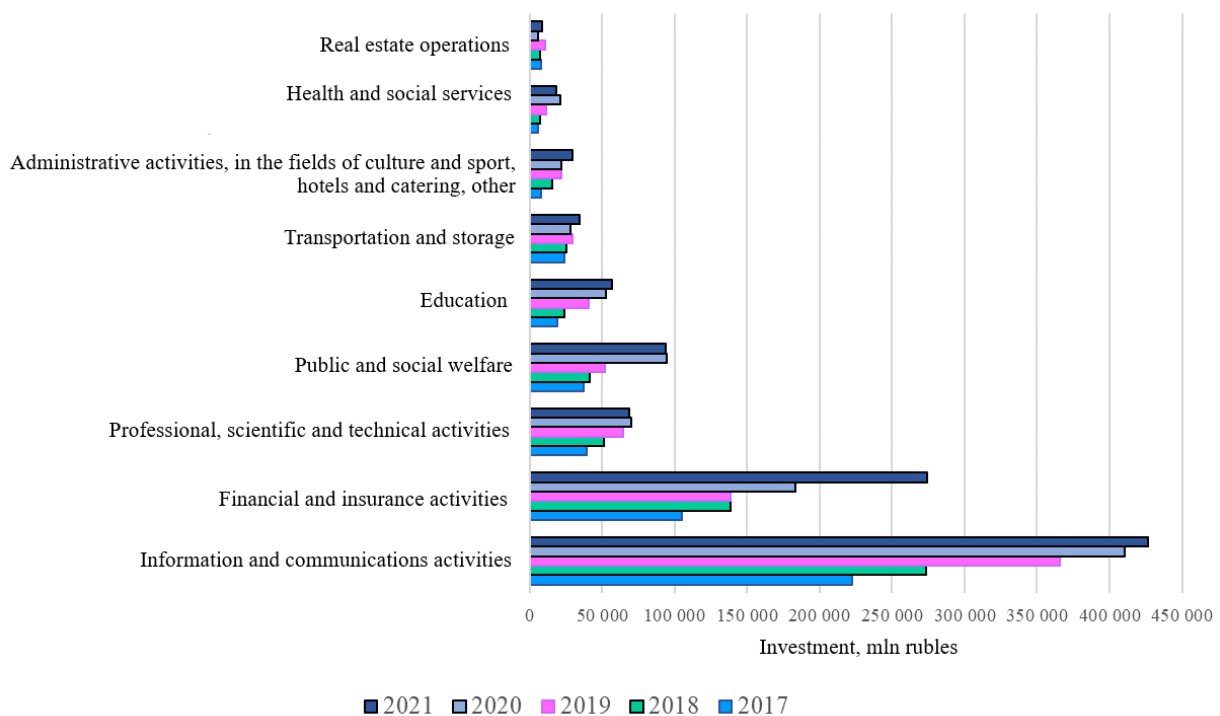
Fig. 1. **Investments in ICT of Service Organizations (According to Russia) for 2017–2021**
Source: Compiled by the authors.

insurance companies. At the third place in the share of investments — organization of science and technology activities and public services. The growth of investment in the digitization of the public sector is linked to the increased demand for services — receiving incentives, social payments and vaccination certificates. During the pandemic, healthcare, transportation and tourism organizations were significantly affected, and remote technologies compensated for the losses.

Online consulting, pharmaceutical applications, diagnosis and testing of COVID-19 have increased in healthcare. In education, investments are aimed at projects on the recording of personal data, the creation of electronic textbooks, the digitization of plans and the widespread use of distance learning methods. At the same time, despite the high demand, less investment has been directed to the digitization of healthcare facilities, their digital technologies. In addition, the financing of the digital infrastructure of cultural institutions, libraries, and museums is at a low level, which leads

to a low level of digitalization in this area, including due to significant restrictions on the functioning of these institutions in 2020.

Fig. 2 shows an assessment of the relationship between investment in digital technologies in the services sector and the quality of life of the population of the regions.

The interrelationship of the factors studied is at an average level with a correlation coefficient of 0.44, indicating the high differentiation of digitalization of the regions. The large gap between Moscow and St. Petersburg as centers of digital standard of living, from other regions is due to the effect of programs of development of health care, electronic history of illness, high level of digitization of education programs, digitalization of materials with cultural value, online services in tourism. In Moscow, the "Smart City — 2030" project is currently performed, which provides a wide range of chances for digital economy training and urban planning optimization.

The uniqueness of digital agglomerations is associated with the creation of growth points
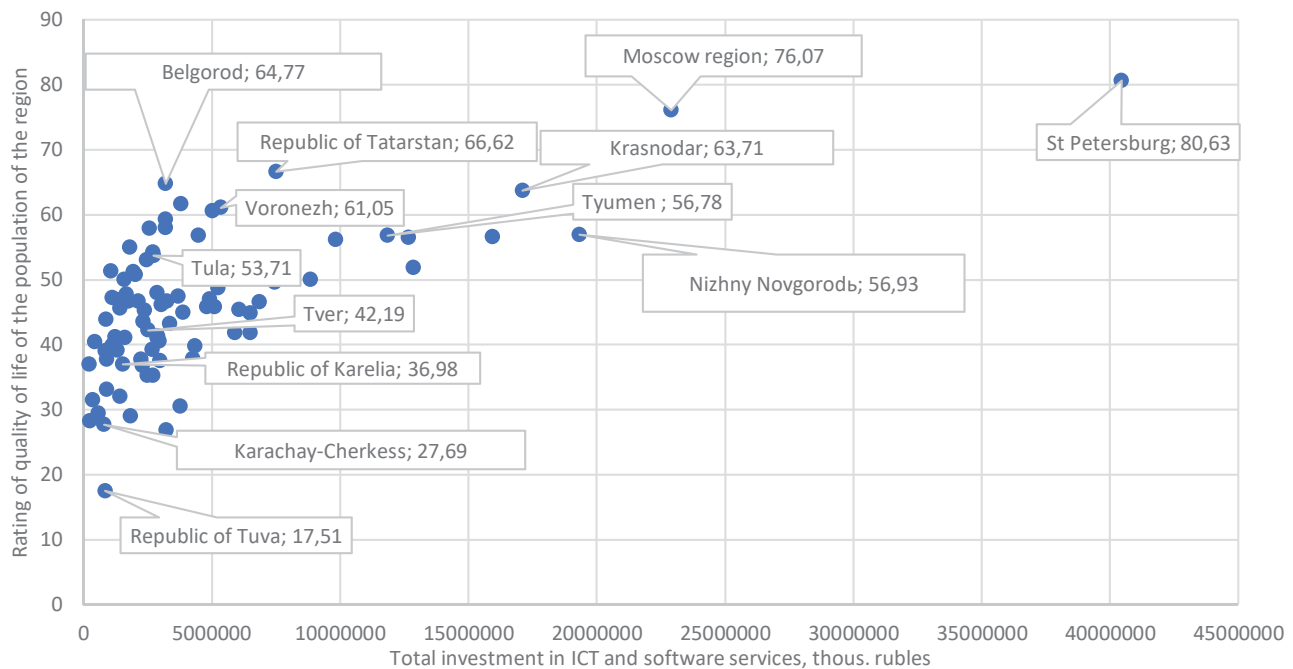
Fig. 2. **Scatterplot for Assessing the Correlation Between Investment in ICT of Service Organizations and the Rating of Quality of Life in the Region**

Source: Compiled by the authors.

Note: The city of Moscow, which has the highest amount of investment in the ICT sector, is excluded due to strong differences from other regions.

and the development of system projects that become a transfer for application throughout Russia and are designed to improve the welfare of the population in other regions. Four types of regions have been identified based on quality of life indicators and the amount of investment (*Table 1*).

A group of regions with a high quality of life includes regions that serve as centers of service promotion. Regions with low quality of life mainly include actors with national and cultural characteristics, as well as low levels of service development. Investments in service digitization are higher in high quality of life regions due to high levels of economic development. The differences are a result of regional infrastructure and the context of institutions. Despite low investment in ICT and software for service companies, the Republic of Tuva has the lowest population rating of quality of life, owing to the insufficient initial contribution of programs to improving life quality. Unequal investment

in service digitization across regions may have negative socioeconomic effects.

IMPACT OF INVESTMENTS IN THE DIGITALIZATION OF SERVICE ORGANIZATIONS ON WELFARE INDICATORS

Investing in the digitalization of service organizations contributes to both increased service volumes and improved service quality. To examine the impact of digitalization investments, a correlation matrix has been developed, identifying the type of relationship between investments and population welfare indicators for Russia's regions in 2021 (*Table 2*).

Investments in digital technology are responsible for an increase in health, education, postal, and courier services; the pandemic period increased this trend significantly by creating a need for social separation. The growth of telecommunications services is linked

Typology of Regions in Terms of the Quality of Life of the Population and Investments in the Digitalization of Service Organizations for 2021

Type of region by quality of life	Region examples	Average level of investment in ICT and software in the service sector, thousand rubles.	Average level of quality of life of the population
With high	Moscow, St. Petersburg, Moscow Region	188081867	79.62
Elevated	Republic of Tatarstan, Belgorod region, Krasnodar region, Voronezh region, Khanty-Mansiysky district, Kaliningrad region, Lipetsk region, etc.	6756234.8	56.91
Average	Kamchatka region, Ryazan region, Republic of Bashkortostan, Khabarovsk region, Yaroslavl region, Vladimir region, Ulyanovsk region, Orenburg region, Orel region, Primorsky region, etc.	2982218.6	42.22
Low	Republic of Kalmykia, Kabardino-Balkar Republic, Republic of Ingushetia, Kurgan region, Republic of Altai, Republic of Buryatia, Jewish Autonomous Region, etc.	1389574	28.57

Source: Compiled by the authors.

to the need to support other services in online form. The high level of correlation between the volume of investments in ICT of educational organizations and variables (number of computers, volume of services, including telecommunications) is due to the increased level of technical and information equipment and computer literacy of the population. Professors' involvement in remote training programs was made possible by investments in the digitalization of education.

There is a strong link between investment in digitalization of services and population savings, which is caused by the improvement of the quality of financial services of banks through online applications and the desire of the population to accumulate funds rather than spend on consumption during economic crises. The economic return from investments in the digitalization of the financial sector is demonstrated by the correlation factor with the share of the finance sector in the structure of the GDP — 0.65. Investments in financial institutions' ICTs lead to improved software for accessibility of financial and insurance instruments. This will contribute to increased deposits of individuals, as well as increased demand for health services through insurance. Simultaneously, demand for electronic

Table 2

Ranking Pearson's Correlation Coefficients According to the Degree of Significance of the Factor Dependence of Investments and Indicators of the Well-Being of the Population

Variable	Investments in fixed capital of ICT and software of large and medium-sized organizations in the field:				
	services	financial and insurance sector	public administration	healthcare	education
Factors reflecting the relationship between variables					
Volume of deposits of individuals in banks	0.969**	0.946**	0.958**	0.916**	0.969**
Number of personal computers	0.921**	0.889**	0.910**	0.933**	0.974**
Number of registered diseases in patients diagnosed for the first time in their lives, un.	0.904**	0.870**	0.892**	0.927**	0.958**
Amount of medical services provided	0.938**	0.910**	0.930**	0.929**	0.958**
Volume of educational services	0.931**	0.903**	0.921**	0.935**	0.958**
Volume of telecommunication services	0.930**	0.898**	0.918**	0.936**	0.974**
Postal and courier services	0.909**	0.879**	0.903**	0.913**	0.951**
Resident population of the region	0.719**	0.670**	0.712**	0.877**	0.848**
Volume of deposits of individuals in banks per capita	0.656**	0.630**	0.648**	0.630**	0.709**
Share of financial sector and insurance in GRP	0.674**	0.653**	0.646**	0.696**	0.672**
Factors reflecting low or no dependence					
Number of educational staff participating in additional general education programmes	0.349**	0.290**	0.347**	0.596**	0.586**
Retail turnover per capita	0.441**	0.409**	0.445**	0.534**	0.561**
Migration growth	−0.593**	−0.594**	−0.570**	−0.475**	−0.506**
Average monthly nominal wage per employee per full range of organizations	0.303**	0.297**	0.308**	0.241*	0.353**
Ratio of monetary income of the population to the value of a fixed set of consumer goods and services	0.285**	0.263**	0.241**	0.262**	0.349**
Number of Internet users per 100 inhabitants	0.238*	0.220*	0.265*	0.240*	0.349**
Natural population growth	−0.247*	−0.206	−0.220*	−0.440**	−0.322**
Life expectancy at birth (annual rate)	0.272*	0.264*	0.269*	0.266*	0.298**
Unemployment rate	−0.148	−0.123	−0.142	−0.278**	−0.254*
Share of health and social services in GRP	−0.139	−0.126	−0.145	−0.197	−0.231*
GRP per capita	0.117	0.118	0.117	0.045	0.158
Labour productivity index	0.014	0.027	0.043	−0.079	−0.086
Expenditure of the population on goods and services	−0.062	−0.077	−0.061	0.111	−0.021

Source: Compiled by the authors.

Dynamic Spatial Model of the Dependence of Investments in ICT Organizations in the Service Sector and Variables that Determine the Level of Well-Being of Russian Regions

Factor / Variable	Model 1		Model 2		Model 3	
	Investments in digitalization of service organizations	t (p)	Investments in digitalization of service organizations	t (p)	Investments in digitalization of service organizations	t (p)
Constant	0.000001 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Resident population of the region	−12.1 (1.01)	−12 (0)	−	−	−	−
Number of personal computers	60.91 (13.34)	4.57 (0)	87.22 (15.64)	5.58 (0)	83 (8.77)	9.46 (0)
Volume of deposits of individuals in banks	5.57 (0.5)	11.24 (0)	5.11 (0.57)	9.08 (0)	6.66 (0.51)	12.97 (0)
Postal and courier services	12.77 (1.84)	6.95 (0)	12.22 (1.88)	6.52 (0)	−	−
Telecommunication volume	−0.44 (0.11)	−4.05 (0)	−0.89 (0.11)	−7.94 (0)	−1.39 (0.08)	−18 (0)
Number of educational staff participating in additional general education programmes	−	−	−1185 (132)	−9 (0)	−	−
Natural population growth	−	−	589 (96)	6.13 (0)	−	−
Migration growth	−	−	8025 (1974)	4.07 (0)	−	−
Retail turnover per capita	−	−	−18.22 (8.32)	−2.19 (0.03)	−	−
Number of registered diseases in patients diagnosed for the first time in life	−	−	−	−	−22.44 (2.46)	−9.1 (0)
Volume of medical services provided	−	−	−	−	1.17 (0.05)	21.57 (0)
Repeated measurements (dispersion)	−	−	−	-		
-2 Log- credibility	11965		12018		11878	
Akaike information criterion (AIC)	11981		12040		11894	
Hurwicz − Cai criterion (AICC)	11982		12040		11894	
Bozdogan criterion (CAIC)	12020		12093		11932	
Bayesian information criterion (BIC)	12012		12082		11924	

Source: Compiled by the authors.

Note: Standard errors are indicated in parentheses. The level of significance is indicated in parentheses for the *t*-statistic (at $p < 0,05$ the factor is significant). The dependent variable may be repeated in the period 2017–2020. In *F*-statistics, all models have the inequality $F_{набл} > F_{кр}$ at a 5% significance level and the corresponding number of degrees of freedom.

Table 4

Models for the Types of Regions Identified Depending on the Quality of Life Rating

Factor Variable	Model for a type of region with a high level of quality of life		Model for a type with an average level of quality of life	
	Investments in digitalization of service organizations	t (p)	Investments in digitalization of service organizations	t (p)
Constant	0.000000 (0)	0 (0)	–	–
Number of personal computers	192.22 (8.15)	8.17 (0)	–	–
Amount of medical services provided	1.43 (0.18)	7.87 (0)	–	–
Number of registered diseases in patients diagnosed for the first time	–30.07 (9.85)	–3.05 (0.013)	–	–
Volume of deposits of individuals in banks	–	–	0.97 (0.08)	11.96 (0)
Postal and courier services	–	–	1.78 (0.31)	5.72 (0)
Migration growth	–	–	4509.8 (1087.95)	4.14 (0)
Property purchase expenses	–	–	–109168.44 (48291.51)	–2.26 (0.03)
-2 Log- credibility	441		5835	
Akaike information criterion (AIC)	453		5865	
Hurwicz — Cai criterion (AICC)	469.8		5868	
Bozdogan criterion (CAIC)	461.9		5929	
Bayesian information criterion (BIC)	455.9		5914	

Source: Compiled by the authors.

banking services and financial literacy of the population is increasing.

There is a low level of correlation between the volume of investment in ICT in different fields and financial indicators of welfare — average monthly wages, retail trade turnover, GDP per capita — which is due to the direction of investment, and which is not to increase the number of services, but to improve their availability and quality. The purchasing power of the population in most regions remained unchanged during the period under review, and investments in digitization did not affect the growth of the people's monetary income.

To assess the impact of factors on the welfare of the population, a model of panel data with fixed effects (objects — 85 regions of Russia) based on a step-by-step selection of factors to determine the significance of the model was developed (*Table 3*).

The models are compared by quality level: the lower the value of the criteria (AIC, AICC, CAIC, BIC), the more adequate the model is to assess the spatial-time relationship between variables. The resulting values of significance p indicate the high significance of coefficients in models. The third model, which describes the return of investments in the digitalization of the services sector, expressed in increasing the provision of digital infrastructure (personal computers), the financial capacity of the population of the region to accumulate funds, the increase in the volume of health services, is the lowest in statistical estimates. At the same time, the inverse relationship of investment is observed with the volume of communications services that are decreasing in those regions where the investment in the digitalization of service organizations is higher, as well as with the number of registered diseases.

The first model demonstrates the relationship between savings growth, the population (service consumers), postal services, telecommunications, and investments in service organizations' digitalization. In the second model, in addition to the factors listed, there is the reverse effect of investments on the number of teaching staff, which can indicate the replacement of labor with digital capital in the field of education. At the same time, investments in the digitization of service organizations are noted in regions with migration and natural growth, i.e. with a high level of welfare. Since there is differentiation between regions, models with high and medium quality of life have been developed, including most of the regions (*Table 4*).

In terms of quality, the first model (*Table 4*) has the best statistical indicators, indicating the high correlation of investment in digitalization in economically prosperous regions with indicators of computer equipment, the volume of health services, and the number of illnesses identified (reverse dependence). For regions with average quality of life, the inflow of investment in digitalization explains the increased savings capacity of the population and the decreased expenditure on the purchase of real estate, the volume of postal services, and the increase in migration. More developed regions provide more favorable employment conditions; therefore, the introduction of distant employment may slow the population flow from areas that are less developed. On the other hand, distant employment can increase the burden on workers and reduce their quality of life. The services sector's digitalization makes public goods readily available and satisfies social requirements, resulting in improved living and working conditions.

REFERENCES

1. Tkachenko I.N., Starikov E.N. Digital economy: Key trends and development objectives. *Izvestiya Saratovskogo universiteta. Novaya Seriya. Seriya: Ekonomika. Upravlenie. Pravo = Izvestiya of Saratov University. New Series. Series: Economics. Management. Law.* 2020;20(3):244–255. (In Russ.). DOI: 10.18500/1994–2540–2020–20–3–244–255

2. Xiang S., Rasool S., Hang Y., Javid K., Javed T., Artene A.E. The effect of COVID-19 pandemic on service sector sustainability and growth. Frontiers in Psychology. 2021;12:633597. DOI: 10.3389/fpsyg.2021.633597

3. Grybauskas A., Stefanini A., Ghobakhloo M. Social sustainability in the age of digitalization: A systematic literature review on the social implications of Industry 4.0. *Technology in Society*. 2022; 70:101997. DOI: 10.1016/j.techsoc.2022.101997

4. Spence M. Government and economics in the digital economy. *Journal of Government and Economics*. 2021;3:100020. DOI: 10.1016/j.jge.2021.100020

5. Vorontsovskiy A.V. Digitalization of the economy and its impact on economic development and social welfare. *Vestnik Sankt-Peterburgskogo universiteta. Ekonomika = St. Petersburg University Journal of Economic Studies (SUJES)*. 2020;36(2):189–216. (In Russ.). DOI: 10.21638/spbu05.2020.202

6. Yakimova T.B. Digital economy and its impact on the level and quality of life of the population. *Russian Economic Bulletin*. 2022;5(1):245–250. (In Russ.).

7. Litvintseva G.P., Karelin I.N. Effects and risks of the digital quality of life in Russian regions. *Ekonomika regiona = Economy of Regions*. 2022;18(1):146–158. (In Russ.). DOI: 10.17059/ekon.reg.2022–1–11

8. Pecherkina M.S., Korobkov I.V. Assessment of the risks impacting the regions' welfare. *Ekonomika regiona = Economy of Regions*. 2019;15(4):1077–1087. (In Russ.). DOI: 10.17059/2019–4–9

9. Baujard A. Values in welfare economics. GATE Lyon St-Étienne Working Paper. 2021;(2112). URL: https://shs.hal.science/halshs-03244909/document

10. Grüne-Yanoff T. What preferences for behavioral welfare economics? *Journal of Economic Methodology*. 2022;29(2):153–165. DOI: 10.1080/1350178X.2022.2061721

11. Bulgakov V.V. Methodological aspects of social welfare analysis. *Vestnik Saratovskogo gosudarstvennogo sotsial'no-ekonomicheskogo universiteta = Vestnik of Saratov State Socio-Economic University*. 2020;(2):26–29. (In Russ.).

12. Pakhomov E.V. Analysis of approaches to assessing the impacts of digitalization on people's well-being. *Upravlencheskii uchet = The Management Accounting Journal*. 2021;(12–1):198–206. (In Russ.). DOI: 10.25806/uu12–12021198–206

13. Hausmann R., Schetter U. Horrible trade-offs in a pandemic: Lockdowns, transfers, fiscal space, and compliance. CID Faculty Working Paper. 2020;(382). URL: https://www.hks.harvard.edu/sites/default/files/centers/cid/files/publications/faculty-working-papers/2020–06-cid-wp-382-pandemic-trade-offs.pdf

14. Artemova O.V., Melen'kina S.A., Savchenko A.N. The main approaches and methodological tools for estimating the quality of life of the population. *Vestnik Chelyabinskogo gosudarstvennogo universiteta = Bulletin of Chelyabinsk State University*. 2022;(4):10–20. (In Russ.). DOI: 10.47475/1994–2796–2022–10402

15. Erokhina E.V., Gretchenko A.I. Basic accents and starting conditions for the development of the digital economy in Russia (on the materials of the regions of the Central Federal District). *Vestnik NGUEU = Vestnik NSUEM*. 2019;(4):41–58. (In Russ.). DOI: 10.34020/2073–6495–2019–4–041–058

16. Teske G.P. Methodology for researching of the digital component of the quality of life. *Vestnik Chelyabinskogo gosudarstvennogo universiteta = Bulletin of Chelyabinsk State University*. 2020;(11):79–84. (In Russ.). DOI: 10.47475/1994–2796–2020–11109

17. Okrepilov V.V., Gagulina N.L. Development of estimating quality of life of regional population. *Zhurnal ekonomicheskoi teorii = Russian Journal of the Economic Theory*. 2019;16(3):318–330. (In Russ.). DOI: 10.31063/2073–6517/2019.16–3.1

18. Seliverstov Yu.I. The impact of the digital economy on the competitive environment: Opportunities and risks. *Belgorodskii ekonomicheskii vestnik*. 2022;(3):3–10. (In Russ.).

19. Kaplinsky R., Kraemer-Mbula E. Innovation and uneven development: The challenge for low- and middle-income economies. *Research Policy*. 2022;51(2):104394. DOI: 10.1016/j.respol.2021.104394

20. Friesenbichler K.S., Kügler A. Servitization across countries and sectors: Evidence from world input-output data. *Economic Systems*.2022;46(3):101014. DOI: 10.1016/j.ecosys.2022.101014

21. Witt U., Gross C. The rise of the "service economy" in the second half of the twentieth century and its energetic contingencies. Journal of Evolutionary Economics. 2020;30(2):231–246. DOI: 10.1007/s00191–019–00649–4

ABOUT THE AUTHORS

Vilena A. Yakimova — Cand. Sci. (Econ.), Assoc. Prof., Department of Finance, Amur State University, Blagoveshchensk, Russia
https://orcid.org/0000-0001-5866-5652
Corresponding author:
vilena_yakimova@mail.ru

Sergey V. Khmura — graduate student, Amur State University, Blagoveshchensk, Russia
https://orcid.org/0000-0003-0704-8755
sergey.khmura@gmail.com

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The Managerial Aspect of Accounting ESG Factors in Assessing the Value of a Company

I.S. Belik[a], A.S. Dutsinin[b], N.L. Nikulina[c]
[a] Ural Federal University, Yekaterinburg, Russia;
[b] JSC "Trust Technologies — Audit", Yekaterinburg, Russia;
[c] Institute of Economics of the Ural Branch of RAS, Yekaterinburg, Russia

ABSTRACT

The subject of the study is ESG factors (Environment, Social, Government) and their inclusion in the value of Russian companies. The purpose of the paper is to reveal the theoretical and methodological aspects of taking into account ESG factors when assessing the value of companies. The relevance of the study is determined by the influence of the ESG rating of companies on changes in their value. The scientific novelty of the study lies in the development of a general scheme, which includes four stages: substantiation of key external and internal factors influencing ESG-assessments of the company's value; analysis of the nature of the impact of key factors on ESG assessments; assessment of the impact of the ESG-factor on the elements of value creation (forecast period, discount factor, cash flows, post-forecast growth rates); building a financial model for assessing the value of companies taking into account ESG factors. Methods: general scientific methods (comparative analysis, generalization, formalization) and empirical (observation, comparison, modeling). The DCF (discounted cash flow) approach was proposed as the main method for assessing the value of a company, which allows not only to estimate the value of a company over a specific period of time, but also acts as a cost management tool. An analysis of scientific and theoretical points of view and methodological approaches to assessing the influence of ESG factors on the value of companies was carried out, significant factors influencing the ESG assessment of the company's value were identified, and a financial model for assessing the value of the company taking into account ESG factors was proposed. The model for assessing the impact of ESG on cash flow generation elements was tested using the example of PJSC Polymetal. It is concluded that the ESG assessment of a company's value is influenced by both external factors (international regulation, country specifics, industry specifics) and internal ones (specifics of the capital structure, specifics of production). The developed financial model for assessing the value of a company makes it possible to take into account ESG factors in the output forms of reporting: balance sheet, profit and loss statement, cash flow statement. The proposed model is addressed to top managers of the company for the purpose of using it in the process of assessing the degree of influence of ESG factors on the cost of equity capital, potential investors and appraisers.

Keywords: ESG-factors; company value; company; discounted cash flow; financial model of the company

INTRODUCTION

In the current conditions of geopolitical change, there is a slowing of the movement towards sustainable development and a suspension of the solution to this problem in Russia. However, as A. Sharonov notes, even after reorienting to Asian and Middle Eastern markets, Russia remains subject to stringent *ESG* requirements.[1] For this reason, Russian companies are forced to continue to adapt global *ESG* practices to the national market. Among the most important factors in determining the necessity of the *ESG* agenda are the following: a reduction in the number of investments in companies with low *ESG* ratings; consideration of companies' *ESG* ratings when lending to banks; and the possible impact of *ESG* factors on the company's valuation.

The research was done in accordance with the initial hypothesis on the impact of *ESG* factors and the possibility of including them in the valuation of Russian companies. The purpose of the study is to reveal the theoretical and methodological aspects of *ESG* factors in the valuation of companies. In order to achieve this goal, tasks related to the analysis of theoretical studies of the impact of *ESG* factors on the value of companies were consistently addressed; identifying the significant factors affecting the *ESG* valuation; and developing a financial model for the valuation of companies taking into account *ESG* factors.

THEORETICAL PROBLEMS OF RESEARCHING

The scientific literature presents a large number of works devoted to the research of the impact of *ESG* factors on the activities of companies.

S. Wu et al. explored the relationship between *ESG* factors and the value of Chinese production companies listed on the stock exchange. Authors have concluded that *ESG* efficiency is important for increasing the value of the company, management responsibility and institutional responsibility have a positive and significant impact on the company's value [1].

M. Aydoğmuş et al. studied the impact of environment, social and governance indicators (*ESG*) on the value and profitability of a company. As a result, they concluded that the total combined *ESG* score was positively and significantly linked to the value of the company [2].

E. Saygili et al. examined the impact of environment, social and governance (*ESG*) practices on corporate financial performance (*CFP*) in Turkish companies listed on the stock exchange. The results of the study showed the negative impact of environmental disclosure on *CFP*. Provisions relating to shareholders' rights and the board of directors have a positive impact on *CFP* in terms of governance [3].

G. H. Ionescu et al. found that the management factor had the most important influence on the market value of companies regardless of the geographical region in which they were located [4].

G. Cohen analyzed the relationship between ESG sustainability indicators and company' ratings [5].

D. Ikbaev's study argues that companies with thoughtful proposals in the field of environmental protection, social development and corporate governance (ESG) can create higher value for shareholders and for society as a whole.[2]

V. V. Aleksandrov on the basis of econometric models showed linear

---

[1] What will happen to the Russian ESG agenda in the new conditions. URL: https://news.ecoindustry.ru/2022/10/chto-budet-s-rossijskoj-esg-povestkoj-v-novyh-usloviyah/ (accessed on 16.02.2023).

[2] Ikbaev D. How to increase the value of a company with ESG. Five leverages through which ESG factors affect company value and cash flows. URL: https://kapital.kz/experts/96039/kak-uvelichit-stoimost-kompanii-s-pomoshch-yu-esg.html (accessed on 16.02.2023).

dependency, as well as the degree of impact of *ESG* rating of oil and gas companies on capitalization indicators [6].

Research of the University of Perugia based on *ESG* rating data of Sustainable Corporate Governance 2020 and 2021 confirms the positive link between the level of sustainable corporate governance and the financial performance of the company.[3]

D. Yu. Zakhmatov and G. Sh. Valitov examined the relationship between the market value of Russian companies from different industries and their financial and non-financial information for the period 2018–2021. In the course of research, a reverse relationship was identified between the company's market capitalization and effective *ESG* policy [7].

A. V. Babkin and E. D. Malevskaia-Malevich found that securities of companies with high ESG ratings have increased investment attractiveness in the course of Socially Responsible Investment (SRI) because they act in synchronously with new development prospects [8].

D. V. Ovechkin found that ESG *goals* are not always in conflict with profit maximization, and that companies with high *ESG* ratings tend to be more profitable [9].

The impact of *ESG* factors on the financial position and investment attractiveness of companies was also considered by N. N. Shash, N. D. Dosaeva [10], I.S. Belik, A. S. Dutsinin, N.L. Nikulina [11], G. Friede, T. Busch, A. Bassen [12], S. S. Galazova [13], I. N. Tkachenko, L. A. Ramenskaya [14], Y. Abdi, X. Li, X. Càmara-Turull [15], S. V. Kibovskaya, K.P. Malikova, N.V. Emelyanova, O.A. Kurda [16] etc.

A discounted cash flow approach is used in the great majority of studies on measuring the influence of the *ESG* factor on value creation aspects [17–22].

In practice, among the many *ESG* indicators, those that have a significant impact on the performance and cost of companies are updated. Thus, the consulting company McKinsey&Company concludes that the five *ESG* factors are the most effective.[4] According to the paper's authors, when determining key elements affecting the company's *ESG* value estimates, they should be classified into two groups: unmanaged factors are external, and controlled factors are internal. *External factors* are linked to the following:

– *international regulation,* which includes the regulatory requirements of foreign governmental bodies and international non-governmental organizations. In this context, companies are forced to comply with the norms and principles of conducting business in international markets, which is especially relevant for export-oriented Russian companies and/or with production outside Russia;

– *country characteristics*. This aspect requires us to consider the rules and restrictions of doing business in a specific state, such as regulatory and legal requirements, tax and environmental regulations, etc. Furthermore, this group considers non-financial factors such as the region's poor environmental situation, social destitution, reaction to the state's foreign policy, etc.;

– *industry specificity*. The factor is decisive in the *ESG* rating of the company, as for some industries, the most important issue in the subject of *ESG* is the environment and the company's contribution to the socio-economic development of the region of presence, for others with low capital

---

[3] Corporate governance in the context of ESG: a new understanding of sustainability. Moscow, 2021. 31 p. URL: http://corptransparency.ru/documents/corporate-governance-in-the-context-of-esg.pdf (accessed on 28.02.2023).

[4] Getting the most out of your sustainability program // McKinsey&Company, 2015. URL: https://www.mckinsey.com/industries/retail/our-insights/getting-the-most-out-of-your-sustainability-program (accessed on 16.02.2023).

intensity, — corporate governance, the degree of social responsibility.

Internal factors:

– *specifics of capital structure*. Consideration of this factor in *ESG* estimates of company value is key. Thus, the *G*-factor rises as a result of the borrowed-to-own capital ratio, because, on the one hand, the presence of an important percentage of loan financing promotes companies to become more transparent, respect to anti-corruption rules, implement frequent auditing practices etc. On the other hand, a study of one of the largest consulting companies *MSCI*[5] shows that more advanced *ESG* companies on average "saving" on the value of equity by almost 1%, and on the cost of borrowing — 1.5%. At the same time, the most significant increase in profits occurs in companies with poor *ESG* performance, as the improvement of their *ESG* activity causes a decrease in the interest rate on loans and the required rate of return on investments in shares, thereby reducing the cost of debt service and increasing their market value;

– *specifics of production*. Factors reflect the features of the company's functioning, the parameters of the organizational structure, and the relationship between employees (communication, corporate culture, etc.).

MATERIALS AND METHODS OF RESEARCH

Traditionally, the basis of the financial approach to estimating the value of a firm is the analysis of discounted cash flows (further —*DCF*). Its fundamental purpose is to evaluate the cash flows available for distribution among the main stakeholders (shareholders and creditors) in real time and adapt the calculated money flows to the level of risk.

[5] ESG and the cost of capital. MSCI, 2020. URL: https://www.msci.com/www/blog-posts/esg-and-the-cost-of-capital/01726513589 (accessed on 21.02.2023).

The advantage of the *DCF* model is not only in estimating the company's value in the current and forecast periods, but also as a tool for managing the value of the firm, as it works at all levels of the management process: formulation of strategy, setting of target standards, organization of promotional systems and evaluation of performance. For this reason, this approach is used in the work of assessing the impact of *ESG* factors on key value creation elements, which means such elements of the *DCF* model as cash flows, discount rate and project lifetime.

According to the *DCF* approach, the valuation of the company for shareholders is made using the following expression:

$$EV = \sum_{t=1}^{n} \frac{FCFE_t}{(1+r_e)^t} + \frac{FCFE_{n-1}(1+g)}{r_e - g}, \quad (1)$$

where *EV* — enterprise value; *FCFE* — cash flows for shareholders; r_e — discount rate reflecting the value of equity (e. g. calculated using the *CAPM* model); *g* — average rate of revenue growth in the post-forecast period; *t* — discount period; *n* — number of discount periods.

The *CAPM* model, developed in the 1960s by W. Sharpe [23], J. Lintner [24] and J. Treynor [25], is the most common.

The estimated value of the company for all capital suppliers is determined by the expression (2):

$$EV = \sum_{t=1}^{n} \frac{FCFF_t}{(1+WACC)^t} + \frac{FCFF_{n-1}(1+g)}{WACC - g}, \quad (2)$$

where *FCFF* — cash flows for all capital holders; *WACC* — weighted average value of capital.

RESULTS OF THE RESEARCH

A scheme to assess the impact of *ESG* factors on value elements has been developed, the order of which is presented in *Fig. 1*.

Identification of significant factors affecting *ESG* assessments		
Internal		External

International regulation	Country characteristics	Industry specificity	Specifics of production	Specifics of capital structure

Analysis of the *ESG* sphere			

Comparison with international competitors	Comparison with national competitors	Comparison with requirements and norms	Comparison with previous periods

Assessment of the impact of *ESG* factors on the elements of value			

over the forecast period	on discount factor	on cash flows	on post-forecast growth rates

$$EV = \sum_{t=1}^{n} \frac{FCFE_t}{(1+r_e)^t} + \frac{FCFE_{n-1}(1+g)}{r_e - g}$$

Fig. 1. **General Scheme of the Impact of the ESG Factor on the Value of the Company**
Source: Compiled by the authors.

The evaluation of the scheme is based on the principles of *substantiality, comparability* and *measurability*.

According to the *ESG* factor influence scheme (*Fig. 1*), the first level confirms the importance of external and internal factors influencing the company's *ESG* valuation.

In the second phase, compare the *ESG* performance of the company with that of *international competitors*, identifying best practices in this field. The analytics database is constructed directly from the non-financial reports of international corporations, as well as aggregated data provided by significant news organizations. In the future, industry and international averages will be calculated, and a regression analysis with financial indicators, specifically *FCFF*, will be performed. An investigation of the state of circumstances in the *ESG* sphere at the *national level* is being carried out in the second phase (*Fig. 1*). In terms of the importance of the results obtained, this analysis is comparable to international competitors, since creditors, institutional and private investors are considering alternatives in the national market.

$$EV = \sum_{t=1}^{n} \frac{FCFF_t}{(1 + (1 - T_c) * r_D * \frac{D}{V} + r_E * \frac{E}{V})^t} + \frac{FCFF_{n-1}(1 + g)}{WACC - g}$$

Factors of decline	Factors of increase	Factors of decline	Factors of increase	Factors of decline	Factors of increase
1.Reduce the risk of default through more sustainable business practices 2. *ESG* increases the money that can be used to repay loans 3. Monetary system promotion of *ESG*-advanced companies	1. Overinvestment in *ESG* projects, which will reduce the cash flow for lenders and increase the risks of the borrower 2. Non-compliance with the *ESG* covenant under the loan agreement 3. Cases of "greenwashing" detection by the company in order to overvaluation positive indicators and create an impression of high *ESG* achievements	1. Reduction of stock price volatility 2. Stable dividend payments through the introduction of quality corporate governance practices 3. Promotion of the company in reputable *ESG* ratings	1. Pressure from financial indicators 2. Price volatility of a company with a lower *ESG* rating 3. The presence of a "green" premium that affects the final value of equity	1. Increased risks of problems with public authorities on *ESG* related issues 2. Significant reduction in company revenue due to global trend failure 3. Closure of key counterparties from long-term cooperation	1. Active environmental care will enable the company to use the main mining facilities for longer periods of time 2. Company can use *ESG* penetration into consumption culture to increase revenue growth 3. The implementation of *ESG* will take consideration of the interests of many steakholders, allowing the company to remain in the market for a longer period of time.

Fig. 2. **Scheme of Potential Assessment of the Impact of ESG on the Discount Factor**

Source: Compiled by the authors.

Fig. 3. **Scheme of the Impact of ESG Factors on Cash Flows and Financial Model of PJSC Polymetal**

Source: Compiled by the authors.

Characteristics of ESG-Indicators (PJSC Polymetal)

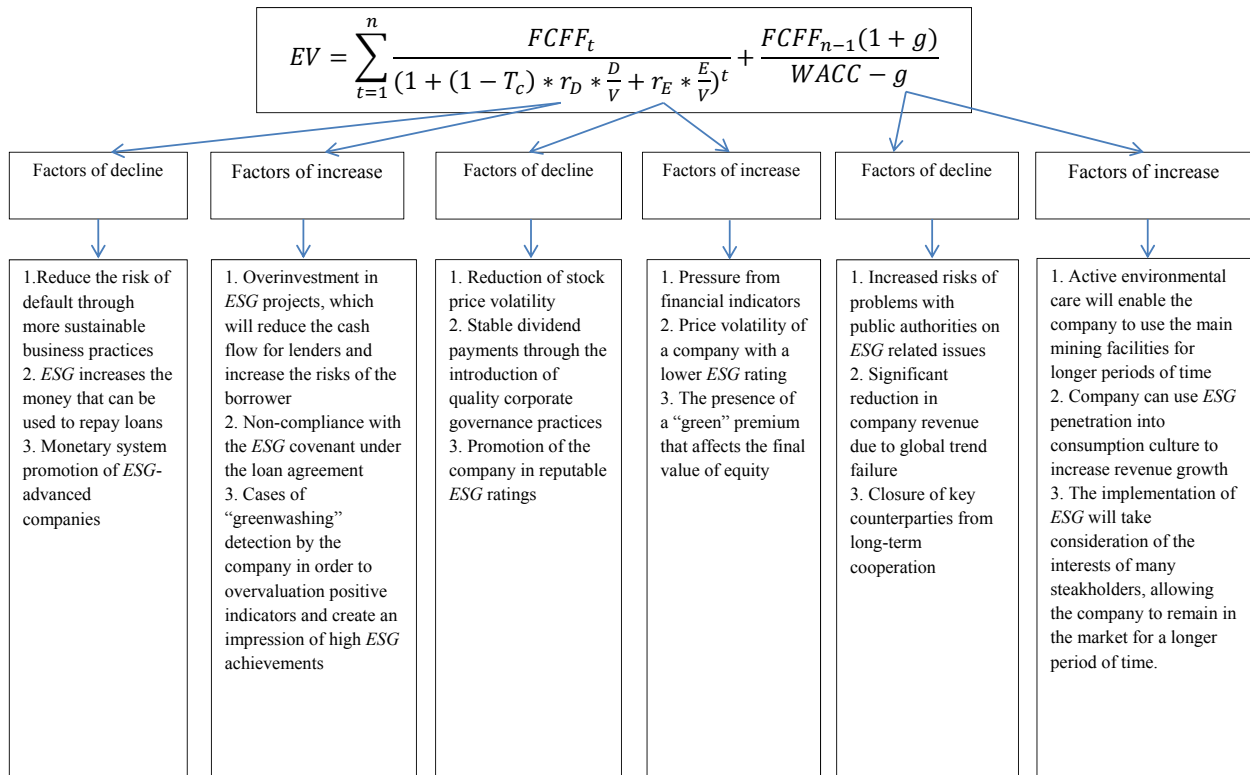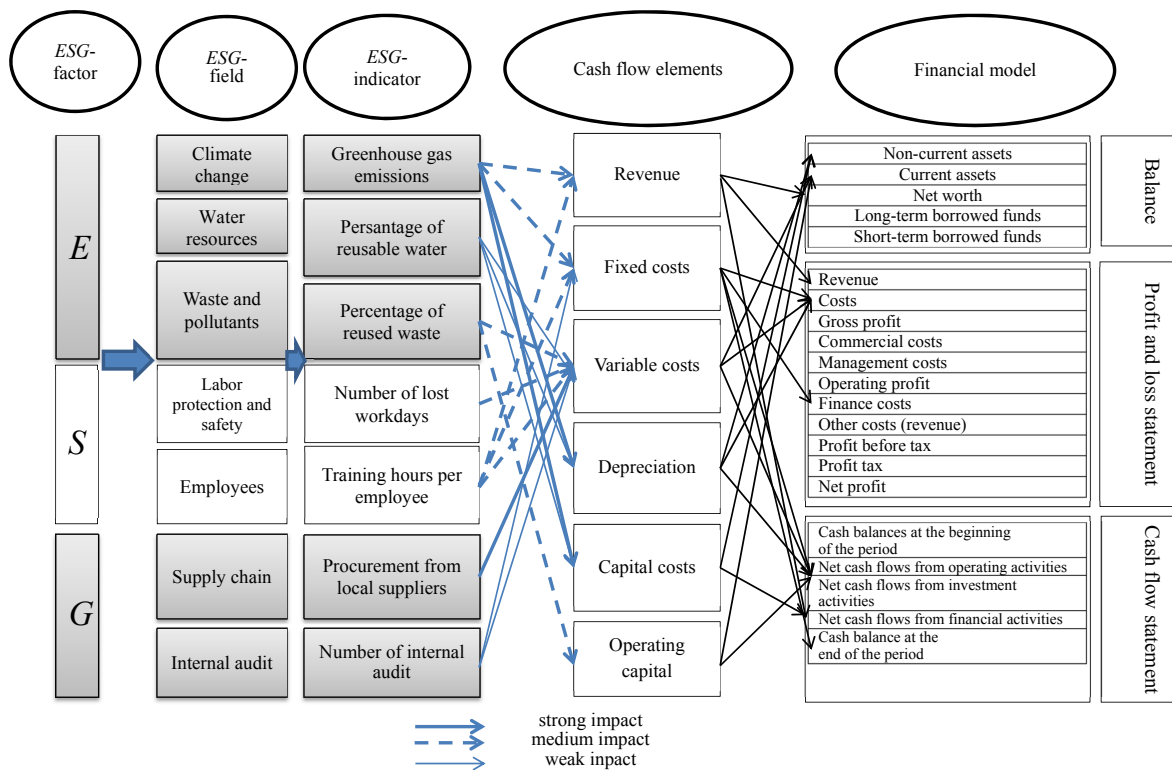| Elements of FCFF formation	ESG indicators	The format of the impact on cost elements
Revenue	Greenhouse gas emissions	Some buyers may refuse to buy from excessively polluting suppliers
	Training hours per employee	By investing in the professional growth of its employees, the company increases revenue through competent analytics, improved production efficiency and increased staff productivity
Fixed costs	Greenhouse gas emissions	Attracting climate-related special loans, reflected in the increased cost of servicing such debts
	Training hours per employee	By increasing employee competence, the company increases the possibility of discovering new methods of production optimization and cost savings.
	Number of internal audit	Internal checks help to detect ineffective disruptions and reduce them
Variable costs	Percentage of water reused	The company can reduce operating costs for the purchase (mining) of new similar materials
	Percentage of recycled waste	By reusing already spent resources, the company can reduce operating costs for the purchase (mining) of new similar materials
	Number of lost workdays due to disability	The company is forced to incur additional costs for disability compensation and has alternative costs when the injured employee is not useful
	Training hours per employee	By increasing the competence of the employee, the company hopes to find ways to improve the efficiency of the use of operating resources
	Procurement from local suppliers	The company saves on transportation costs and uses the possibility of discount for purchases
	Number of internal audit	Internal auditor will help to find inefficient "meta" of the use of operating funds
Depreciation	Greenhouse gas emissions	Deductions for additional depreciation due to the adoption of ecologic equipment and technology
	Percentage of water reused	Introduction of water management equipment/technologies in water management projects is reflected in the annual report*
Capital costs	Greenhouse gas emissions	Increase in capital expenditures for acquisition and/or construction of treatment plants, upgrading of equipment, renewable energy sources
	Percentage of water reused	Capital investments in water projects as reflected in the annual report *
Operating capital	Percentage of recycled waste	An increase in recycling decreases the requirement for additional material purchases, lowering operating costs while preserving or increasing production

Source: Compiled by the authors.

Note: * Integrated Annual Report of PJSC Polymetal for 2021. URL: file:///C:/Users/qwer/Downloads/Polymetal_integrated-report-2021%20(1).pdf (accessed on 25.01.2023).

Also in the second phase, the *requirements* and *norms* put forward by the main capital suppliers (creditors, institutional investors) to specific industries (mining, oil and gas industry, banking) are analysed.

The *dynamic analysis* of indicators carried out in the second phase is implemented in the study of almost all economic phenomena, including *ESG*. An idea of how the company develops in the *ESG* sphere allows it to establish the change in its indicators, to link the direction of the dynamics of the development of *ESG* indicators with internal and external processes, identify gaps, and to form recommendations to improve its position in this field.

In the third phase, according to the scheme (*Fig. 1*), the description of valuation indicators and the nature of their impact on value creation elements are carried out.

In the fourth phase, a financial model of the impact of *ESG* factors on value creation elements is formed on the evaluation of the use of the *DCF* approach (*Fig. 1*). The financial model identifies three types of reporting: balance sheet, profit and loss report, and cash flow report.

The scheme for integrating *ESG* into the company's valuation is presented in *Fig. 2*. *ESG* factor accounting is carried out through a premium or discount when assessing the company's net worth according to the *CAPM* model, since it demonstrates the firm's position in the field of sustainable development.

$$r_{green\,equity} = r_f + \beta\left(r_m - r_f\right) + r_{green}\,, \quad (3)$$

where $r_{green\,equity}$ — cost of net worth with ESG factor; r_f — risk-free rate of return; r_m — market returns; β — beta-coefficient of a specific share; r_{geen} — net worth premium for low *ESG* ratings or discount for high *ESG* ratings and investor's willingness to provide a discount on company's successes in *ESG*.

In this case, the "green disccount" (r_{green}) is valued by the method of estimating the value of intangible assets or an integral goodwill. The latter is an excess of the market value of net assets over their balance value. In order to obtain the "green discount" of the company, it is necessary to combine additional costs in the form of capital investments in treatment plants, filters, etc., and operating costs for the conduct of *ESG* events, the purchase of more environmentally friendly materials, etc.

All these additional costs affect the elements of cash flow generation, in particular *Capex* (capital costs), *NWC* (net operating capital) and *DA* (calculated wear and depreciation).

ESG factors also affect the cost of borrowing, as they can increase cash flows from capital providers, because they reduce the value of loan financing through various preferential programs, special credit lines, and discounts from banks to *ESG* advised companies.

APPLICATION OF RESULTS ON THE EXAMPLE OF PJSC "POLYMETAL"

Polymetal is a public joint-stock company operating in Russia and Kazakhstan. Active implementation of *GRI* standards since 2014, disclosure according to the Sustainability Accounting Standards Board (*SASB*), and from 2021 to publish information on the recommendations of the Task Force on Climate Related Financial Disclosures (*TCFD*).

In the scheme shown in *Fig. 3*, the first three columns show the area and indicators selected by groups of *ESG* factors affecting the elements of cash flows. The description of *ESG* indicators relevant to the company and the nature of their impact are given in *Table*.

The fourth and fifth pillars reproduce the links between the value creation elements

of the company and the financial model and reflect their impact on reporting (information important to investors and traders).

CONCLUSION

A four-stage general scheme was developed to assess the impact of *ESG* factors on value elements:

1) justification of the importance of external and internal factors on the *ESG* value estimates of the company;

2) analysis of the state of the *ESG* sphere;

3) assessment of the impact of *ESG* factors on the elements of value creation;

4) construction of a financial model of valuation of companies with an *ESG* factor.

The scheme of the impact of *ESG* factors on the elements of cash flow generation was tested on the example of PJSC "Polymetal".

The conclusion is that by increasing its position in the *ESG* field, the company decreases the risks of doing business, working with unreliable counterparties, having tax inspection problems, etc. At the same time, investors assume that the company is focused on long-term growth by such actions, so the investment in it is more likely to pay off compared to *ESG* neutral companies. In this situation, the value of borrowed capital decreases due to increased cash flows that can be directed towards debt repayment and reduced risks.

The research provided in this case will help to establish a comprehensive methodology for assessing the impact of *ESG* factors not only on the company's value, but also on its investment attractiveness. Companies can use the results of the research to develop management strategies to help them progress toward sustainable development.

REFERENCES

1. Wu S., Li X., Du X, Li Z. The impact of ESG performance on firm value: The moderating role of ownership structure. *Sustainability*. 2022;14(21):14507. DOI: 10.3390/su142114507

2. Aydoğmuş M., Gülay G., Ergun K. Impact of ESG performance on firm value and profitability. *Borsa Istanbul Review*. 2022;22(Suppl.2): S 119-S 127. DOI: 10.1016/j.bir.2022.11.006

3. Saygili E., Arslan S., Birkan A. O. ESG practices and corporate financial performance: Evidence from Borsa Istanbul. *Borsa Istanbul Review*. 2022;22(3):525–533. DOI: 10.1016/j.bir.2021.07.001

4. Ionescu G. H., Firoiu D., Pirvu R., Vilag R. D. The impact of ESG factors on market value of companies from travel and tourism industry. *Technological and Economic Development of Economy*. 2019;25(5):820–849. DOI: 10.3846/tede.2019.10294

5. Cohen G. The impact of ESG risks on corporate value. *Review of Quantitative Finance and Accounting*. 2023;60(4):1451–1468. DOI: 10.1007/s11156–023–01135–6

6. Alexandrov V. V. Analysis of foreign and domestic sustainable development ratings of (ESG) of the world's leading oil and gas companies. Assessment of the impact of the ECG rating on the capitalization of the company. *Ekonomicheskie nauki = Economic Sciences*. 2021;(204):44–53. (In Russ.). DOI: 10.14451/1.204.44

7. Zakhmatov D. Yu., Valitov G. Sh. The influence of ESG factors on the market capitalization of Russian companies. *Sibirskaya finansovaya shkola = Siberian Financial School*. 2022;(3):183–192. (In Russ.). DOI: 10.34020/1993–4386–2022–3–183–192

8. Babkin A. V., Malevskaia-Malevich E. D. Impact of socially responsible investment on the value of innovatively active industrial enterprises. *Nauchno-tekhnicheskie vedomosti Sankt-Peterburgskogo gosudarstvennogo politekhnicheskogo universiteta. Ekonomicheskie nauki = St. Petersburg State Polytechnical University Journal. Economics.* 2021;14(4):82–94. (In Russ.). DOI: 10.18721/JE.14406

9. Ovechkin D. V. Responsible investment: Impact of ESG rating on firms' profitability and expected return on the stock market. *Nauchnyi zhurnal NIU ITMO. Seriya: Ekonomika i ekologicheskii menedzhment = Scientific Journal NRU ITMO. Series: Economics and Environmental Management.* 2021;(1):43–53. (In Russ.). DOI: 10.17586/2310–1172–2021–14–1–43–53

10. Shash N. N., Dosaeva N. D. Impact of socially responsible investment on the company's financial performance and value. *Revistă ştiinţifică progresivă.* 2020;3(2–4):27–32. (In Russ.). DOI: 10.46591/PSJM.2020.0302.0005

11. Belik I. S., Dutsinin A. S., Nikulina N. L. Financial state and investment attractiveness of Russian public companies: The effect of ESG factors. *Upravlenets = The Manager.* 2022;13(6):44–55. (In Russ.). DOI: 10.29141/2218–5003–2022–13–6–4

12. Friede G., Busch T., Bassen A. ESG and financial performance: Aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance & Investment.* 2015;5(4):210–233. DOI: 10.1080/20430795.2015.1118917

13. Galazova S. S. Influence of ESG-factors on sustainable development of companies and financial performance of corporate esctor. *Vestnik Rostovskogo gosudarstvennogo ekonomicheskogo universiteta (RINKh) = Vestnik of Rostov State University of Economics.* 2018;(4):81–87. (In Russ.).

14. Tkachenko I. N., Ramenskaya L. A. Corporate social responsibility effect on the company capitalization (the results of an empirical study). *Upravlencheskie nauki = Management Sciences in Russia.* 2016;6(3):85–94. (In Russ.). DOI: 10.26794/2304–022X-2016–6–3–85–94

15. Abdi Y., Li X., Càmara-Turull X. Exploring the impact of sustainability (ESG) disclosure on firm value and financial performance (FP) in airline industry: The moderating role of size and age. *Environment, Development and Sustainability.* 2022;24(4):5052–5079. DOI: 10.1007/s10668–021–01649-w

16. Kibovskaya S. V., Malikova K. P., Emelyanova N. V., Kurda O. A. Development of responsible investment in oil and gas business based on ESG-factors. *Problemy ekonomiki i upravleniya neftegazovym kompleksom = Problems of Economics and Management of Oil and Gas Complex.* 2020;(1):28–34. (In Russ.). DOI: 10.33285/1999–6942–2020–1(181)-28–34

17. Fulton M., Kahn B., Sharples C. Sustainable investing: Establishing long-term value and performance. *SSRN Electronic Journal.* 2012. DOI: 10.2139/ssrn.2222740

18. Margolis J. D., Elfenbein H. A., Walsh J. P. Does it pay to be good? A meta-analysis and redirection of research on the relationship between corporate social and financial performance. 2007. URL: https://www.researchgate.net/publication/237455609_Does_it_pay_to_be_good_A_meta-analysis_and_redirection_of_research_on_the_relationship_between_corporate_social_and_financial_performance (accessed on 10.01.2023).

19. El Ghoul S., Guedhami O., Kim H., Park K. Corporate environmental responsibility and the cost of capital: International evidence. *Journal of Business Ethics.* 2018;149(2):335–361. DOI: 10.1007/s10551–015–3005–6

20. Barth M. E., Konchitchki Y., Landsman W. R. Cost of capital and earnings transparency. *Journal of Accounting and Economics.* 2013;55(2–3):206–224. DOI: 10.1016/j.jacceco.2013.01.004

21. Bauer R., Hann D. Corporate environmental management and credit risk. *SSRN Electronic Journal.* 2010. DOI: 10.2139/ssrn.1660470

22. Schramade W. Integrating ESG into valuation models and investment decisions: The value-driver adjustment approach. *Journal of Sustainable Finance & Investment.* 2016;6(2):95–111. DOI: 10.1080/20430795.2016.1176425

23. Sharpe W. E. A simplified model of portfolio analysis. *Management Science*. 1963;9(2):277–293. DOI: 10.1287/mnsc.9.2.277

24. Lintner J. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *The Review of Economics and Statistics*. 1965; 47(1):13–37. DOI: 10.2307/1924119

25. Treynor J. L. Toward a theory of market value of risky assets. In: Korajczyk R. A., ed. Asset pricing and portfolio performance. London: Risk Books; 1999:15–22.

ABOUT THE AUTHORS

Irina S. Belik — Dr. Sci. (Econ.), Prof., Department of Economic Security of Industrial Complexes, Ural Federal University, Yekaterinburg, Russia
https://orcid.org/0000-0001-7405-3226
irinabelik2010@mail.ru

Anton S. Dutsinin — Consultant, JSC "Trust Technologies — Audit", Yekaterinburg, Russia
https://orcid.org/0000-0002-1799-9725
anton.s.dutsinin@tedo.ru

Natalia L. Nikulina — Cand. Sci. (Econ.), Senior Researcher, Laboratory for Modelling of Spatial Development of Territories, the Institute of Economics of the Ural Branch of RAS, Yekaterinburg, Russia
https://orcid.org/0000-0002-6882-3172
Corresponding author:
nikulinanl@mail.ru

Authors' declared contributions:
I.S. Belik — problem statement, development of the article concept, formation of research conclusions.
A.S. Dutsinin — collection of statistical data, tabular and graphical representation of results, development of methodological tools, description of results.
N.L. Nikulina — critical analysis of literature, formation of research conclusions.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 12.05.2023; revised on 11.06.2023 and accepted for publication on 26.06.2023.
The authors read and approved the final version of the manuscript.

Current Waste Management in Banks from 11 Asian Countries vs Sberbank ESG Reporting

J. An[a], A. Yu. Mikhaylov[b]

[a] College of Business, Hankuk University of Foreign Studies; Seoul, South Korea;
[b] Financial University, Moscow, Russia;
Financial Research Institute of Ministry of Finance of the Russian Federation, Moscow, Russia

ABSTRACT

The **relevance** of the topic lies in the fact that the level of competitiveness of a bank in waste management will have an increasing impact on its ESG ratings in the future. The **purpose** of this paper is to improve waste management in a bank (mainly faulty office equipment and paper waste). However, not all banks use active management methods in waste management, so this article offers recommendations for the successful management of key indicators. The article uses data on waste from banks in Bangladesh, China, Indonesia, Kuwait, India, Malaysia, Nepal, Pakistan, Sri Lanka, the UAE, and Vietnam. The **objectives** of the study include: identification of the essence of the competitiveness of waste management in a bank; consideration of the types of competitiveness of waste management; assessment of the impact of blockchain technology on the competitiveness of waste management; assessment of minimizing waste management costs in a bank. A **method** for waste composition and waste export based on statistical analysis and a regression model. It used data about the current waste management activities of a bank. This study uses data from an annual time series covering the period from 2013 to 2021. The **results** of the study confirm that the problem of electronic waste of banks in Asia can be solved by increasing financing and a complete analysis of bank waste. There are points of novelty in the article: (1) the essence of the competitiveness of waste management in a bank is determined, which consists in the recycling of most waste and not in their disposal; (2) the ideas of the competitiveness of waste management are considered in Sberbank; (3) the impact of blockchain technology on the competitiveness of waste management in banks is assessed; (4) an assessment of the competitiveness of waste management in a commercial bank is given. In order to better understand the factors influencing the production of e-waste in the region, the study **focuses** on the significance of addressing the rising problem of e-waste in Asia and the need for better collection and analysis of waste data in a bank. The main **conclusion** is the need to recycle waste and increase recycling costs in the future, which is the most environmentally friendly option compared to incineration.

Keywords: ESG ratings; banks; waste management; electronic waste; recycling; competitiveness; economic analysis; blockchain; financing

INTRODUCTION

With the advent of new technologies and devices, more and more electronics are produced around the world every year. The UNITAR estimates that more than 50 million tons of e-waste are generated worldwide every year, and this volume continues to grow. This is a serious problem because e-waste, or "e-waste", can contain harmful chemicals such as lead, cadmium and mercury, which pose a threat to the environment and human health [1].

With electronics becoming an increasingly integral part of our lives, it is necessary to take measures to manage and recycle e-waste. In this context, various countries are developing and implementing laws and policies for the collection, recycling and disposal of e-waste in order to minimize their negative impact on the environment and public health [2, 3].

The paper has novel points: (1) to identify the essence of competitiveness of waste management; (2) to consider the types of competitiveness of waste management in banks; (3) to evaluate the impact of blockchain technology on the competitiveness of waste management in banks; (4) Evaluate the competitiveness of waste management in banks.

The object of the paper is current waste management activities in banks. The subject of the work is the

improvement of blockchain technology while increasing the competitiveness of waste management in banks.

The main research methods in the work include: comparison of indicators, data analysis, generalization, and horizontal and vertical analysis. This study uses annual time series data covering the period from 2013–2021 [4–6].

The paper proves the need to recycle such waste in banks, which is the most environmentally friendly option compared to incineration.

LITERATURE REVIEW

These indicators help banks determine the success of applying their chosen strategy in their work, determine their leading positions, identify areas for improving certain aspects of their work, and assess the bank's role in the energy system [7–10].

The main strategies used in banks include the following: integrated growth strategy; diversification strategy; risk management strategy; and asset management strategy. Thus, based on the presented subgroups of quantitative indicators that affect the work of banks, it can be noted that there are various coefficients that assess the current position of the bank [11–14].

In the competitiveness of waste management, it is customary to define the main advantage, which is the loyal provision of waste management for the client, which implies a low cost [15–19]. All the advantages of competitive waste management discussed above allow us to conclude that the bank strives to consider the financial situation of its clients, their lifestyle, and their preferences in relation to waste management, and should also be of particular value to its clients. Nevertheless, banks need to pay attention to various areas of activity, namely: marketing activities of the bank; financial activity of the bank; technologies of working in the bank; HR work in the bank. Together, managing these areas allows you to gain additional competitive advantages and be competitive in comparison with other banks. It can be noted that the bank that has received all the opportunities to maintain its competitive position becomes absolutely competitive. In the current conditions, the competitiveness of a bank should be carried out in conjunction with improving the competitiveness of waste management, since these processes are influenced by the same factors [20, 21].

The problem of waste management in Russian banks has not received much attention due to the high cost of the most environmentally friendly solution compared to bank the cost of operations in 2012–2023. However, a number of authors' studies confirm the study's main hypotheses [20–24].

There are many factors that affect the competitiveness of waste management in Russian banks as main ESG factor [22–24].

Sberbank launched its own ESG transformation and approved the ESG strategy, which became an integral part of the company's development strategy until 2023. The committee includes top management and representatives of all functional blocks of the bank. The ESG agenda is aimed at different stakeholders: customers, employees, shareholders, investors, society and the state [20–22].

Gazprombank created the Council for the Implementation of the Principles of Sustainable Development to systematize projects in this area, which are implemented with the support of the bank, as well as to form goals and objectives in social, environmental and economic areas. In March 2021, Gazprombank adopted a Sustainable Development Policy. The document defines common approaches in three areas — economic, social and environmental, and also establishes approaches to responsible investment and financing, including setting goals and objectives in the main areas of activity [22, 23].

In 2019, Sovcombank joined the UN initiative, signed the principles of responsible banking, and chose priority goals out of 17 Sustainable Development Goals. Almost immediately, policies in the fields of sustainable development and responsible financing were introduced, and changes were made to the credit policy. For ESG loans, the bank has a reduced rate of funding. The bank is ready to count on a smaller margin, which allows us to consider ESG projects more accordingly [25, 27]. Among the priorities, the bank identifies projects related to renewable energy and zero-emission energy carbon, clean water and energy efficiency.

An ESG framework strategy has been developed by Credit Bank of Moscow (MKB), and it is based on three areas where efforts have been consolidated. The first direction is the improvement of the internal infrastructure for the development of ESG banking, that is, the development of infrastructure for green financing, the

introduction of the green bank concept, an independent assessment of the ESG progress of the bank. The second direction is customer support in terms of providing and organizing green financing, special offers for social categories of citizens, support for small and medium-sized businesses, support for businesses in general within the framework of restructuring programs [20, 21].

METHODS

Taking into account forecast data, analyzed statistics and available factors, including obsolescence and obsolescence of equipment, it is necessary to perform the following actions: intra-industry diversification; digital transformation with the use of AI learners in the branches of the fuel and energy complex, which will result in a transition to a new level of automation and robotization of all processes not only in the energy sector, but also in others, respectively; reducing the level of negative impact of the fuel and energy segment of the market on living conditions and the world around us, as well as their adaptation to global warming and other changes, by diversifying available energy sources in the direction of "green energy" [17–19].

The analysis includes the following factors: waste composition and waste export. Public authorities are more vulnerable to risk when choosing a positive outcome than when choosing a negative one. It was confirmed that there is a difference in the frequency of the choice of patterns in relation to the population of the country. As a result, the work recommends government measures that affect all renewable energy producers [20, 21].

The analysis also yielded additional results: the largest reduction in financing of waste production occurred in countries with a high percentage of the urban population. Sberbank as well as various restrictive strategies reduced the steady demand for renewable energy sources, led to a drop in economic growth, and caused a slowdown in the growth of COVID-19 infections in 2020.

Other scientists understand energy competition as a dynamic process of competition between energy market entities to secure strong positions in this market. Modern competitive relations in the energy services market are diverse and include the following levels:

• competitive relations between commercial banks;

Table 1

E-waste Generation Rate

Country	E-waste generation rate (kg/cap/day)
Bangladesh	0.15–0.56
China	0.33
Indonesia	0.44
Kuwait	1.37
India	1.38–1.49
Malaysia	5.72
Nepal	0.2–0.87
Pakistan	1.66
Sri Lanka	1.79
UAE	2.58
Vietnam	0.90

Source: Compiled by the authors.

• competitive relations of banks with non-credit institutions;

• competitive relations of banks with other financial intermediaries;

• competitive relations of banks with non-financial organizations.

This division can also be used for interbank competition. According to the number of subjects participating in the confrontation, interbank competition can be divided into individuals (between some banks) and groups (between associations of private credit and financial institutions). Interbank competition can also be classified according to other criteria.

So, you can systematize interbank competition by various criteria. In fact, similar features are also used in the systematization of other types of competition. In general, the systematization of interbank competition consists of identifying the characteristics and features associated with the specifics of competition in the energy sector. It is customary to distinguish between intra-industry and inter-industry competition based on the industry affiliation of competitive entities. Intra-industry competition is competition between organizations in the same industry that produce similar products or services that meet the same customer need, but differ in cost, quality, and product range. Inter-industry competition is competition between organizations of different industries. Because energy is not a separate branch, but an area of the economy

Largest Banks in 11 Asian Countries by Assets

Rank	Bank name	Total assets, bln USD	Share of bank in total E-waste of 11 Asian countries, %	Expenses for recycling, thousands USD
1	DBS Bank	509.1	2.5	1272.75
2	OCBC Bank	402.2	2.1	844.62
3	United Overseas Bank	340.7	2.2	749.54
4	Maybank	213.2	2.0	426.4
5	CIMB	149.3	1.9	283.67
6	Bangkok Bank	130.7	1.8	235.26
7	Kasikornbank	124.3	1.8	223.74
8	Bank Mandiri	121.1	1.7	205.87
9	Bank Rakyat Indonesia	117.7	0.9	105.93
10	Public Bank Berhad	111.1	0.9	99.99
11	Krung Thai Bank	107.7	0.8	86.16
12	Siam Commercial Bank	101.4	0.8	81.12
13	Bank Central Asia	87.7	0.7	61.39
14	Bank for Investment and Development of Vietnam	77.3	0.5	38.65
15	BDO Unibank	69.5	0.4	27.8
16	RHB Bank	69.5	0.2	13.9
17	Bank Negara Indonesia	67.7	0.8	54.16
17	Vietinbank	67.2	0.7	47.04
19	Hong Leong Bank	66.7	0.5	33.35
20	Vietcombank	62.1	0.2	12.42
21	TMB Bank	53.8	0.1	5.38
22	Metropolitan Bank and Trust Company	49.1	0.1	4.91

Source: Authors based on the data [21].

that includes a huge number of different industries, this systematization also applies to banks. Thus, the concept of "interbank competition" is rather difficult and has certain characteristics. In Russian legislation, there is no specific interpretation of this concept due to the presence of quite a significant number of points of view on the definition of this term. You can systematize interbank competition by various criteria. When determining the essence of interbank competition, it is necessary to emphasize that it is a process that

takes place over time and has certain characteristics that are not typical of other types of competition, which is aimed at supporting monetary stability and brings a positive effect only when a certain level is reached.

Eleven Asian countries (Bangladesh, China, Indonesia, Kuwait, India, Malaysia, Nepal, Pakistan, Sri Lanka, the UAE, and Vietnam) were chosen for the analysis, which the authors divided into three groups based on certain factors. For the reliability of the study and the results obtained, the countries were divided

Table 3

E-waste Generated, kg Per Capita

Country	2014	2015	2016	2017	2018	2019	CAGR
Malaysia	7.6	9.6	10	10.4	10.7	11.1	6.52%
Kuwait	17.2	15.9	16	16	15.9	15.8	−1.41%
UAE	17.2	13.4	14	14.4	14.7	15	−2.26%
Bangladesh	0.8	0.9	0.9	1	1.1	1.2	6.99%
China	4.4	5.9	6.2	6.5	6.9	7.2	8.55%
India	1.3	1.5	1.7	1.9	2.1	2.4	10.76%
Pakistan	1.4	1.9	1.9	2	2	2.1	6.99%
Sri Lanka	4.2	5.6	5.8	6	6.1	6.3	6.99%
Vietnam	1.3	1.9	2.1	2.3	2.5	2.7	12.95%
Indonesia	4.3	5.4	5.6	5.6	5.8	5.9	5.41%
Nepal	0.5	0.7	0.8	0.8	0.9	0.9	10.29%

Source: Compiled by the authors based on the data [21].

Table 4

Statistic Summary for E-waste Generation Per Capita for Country Groups 1–3

Group	1	2	3
Average	13.606	2.717	3.500
Standard mistake	0.163	0.178	0.201
Median	13.683	2.763	3.625
Standard deviation	0.399	0.436	0.492
Excess	0.314	1.095	3.137
Asymmetry	0.798	−0.903	−1.666
Interval	1.033	1.250	1.375
Minimum	12.967	1.975	2.575
Maximum	14	3.225	3.950
Sample variance	0.159	0.190	0.242

Source: Compiled by the authors.

into three groups. The first group included Malaysia, Kuwait, the UAE, as the countries with the highest GDP per capita at PPP and the formation of waste financing. The second group consisted of Bangladesh, China, India, Pakistan, according to the prevalence of population. In the third group of countries, the authors included the remaining countries, the socio-economic indicators of which can be fairly used for country analysis. The third group includes Sri Lanka, Vietnam, Indonesia. The limitation of this study can be called the unavailability of data for Asian countries on the production of electronics for a long period of time. This fact contributed to the chosen time period of 2014–2019. Despite the lack of data, the study provides insight into the situation of e-waste management in Asian countries.
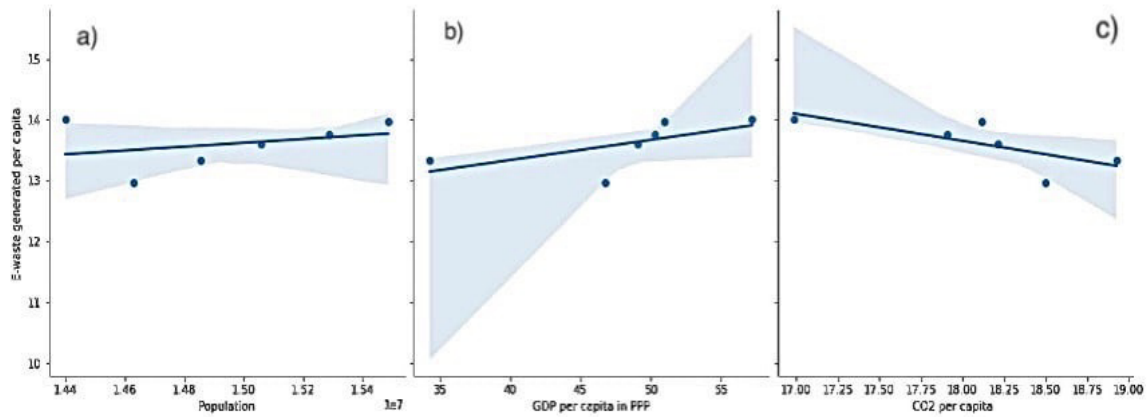
Fig. 1. **Relationship for Group 1 of Countries in 2014–2019 between (A) E-Waste Generated Per Capita and Population, kg and 10 000 People; (B) E-Waste Generated and GDP Per Capita in PPP, kg and 1 000 Current International Dollar; (C) E-Waste Generated Per Capita and CO_2 per Capita, kg and *t***

Source: Author's calculations.

The accuracy of the study is indicated by the fact that all data were taken from verified sources. To analyze the relationship of the indicators selected in the study, the authors used the method of constructing a linear regression. The study has a dependent variable Y and a set of independent variables $X_1, X_2, ..., X_3$. The linear regression model looks like this:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \varepsilon, \quad (1)$$

where $\beta_0, \beta_1, \beta_2, ..., \beta_3$ — regression coefficients; ε — random error.

Correlation is used to measure the degree and direction of a linear relationship between two variables. One of the most common correlation coefficients is the Pearson coefficient (r), which measures the linear relationship between two continuous variables.

The formula for the Pearson coefficient is:

$$r = \frac{\Sigma(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\Sigma(X_i - \overline{X})^2}\sqrt{(Y_i - \overline{Y})^2}}, \quad (2)$$

where X_i and Y_i — values of the corresponding observations; $\overline{X}$ and $\overline{Y}$ — the mean values of variables X and Y.

The coefficient of determination shows what percentage of the variance of the dependent variable is explained by the regression model.
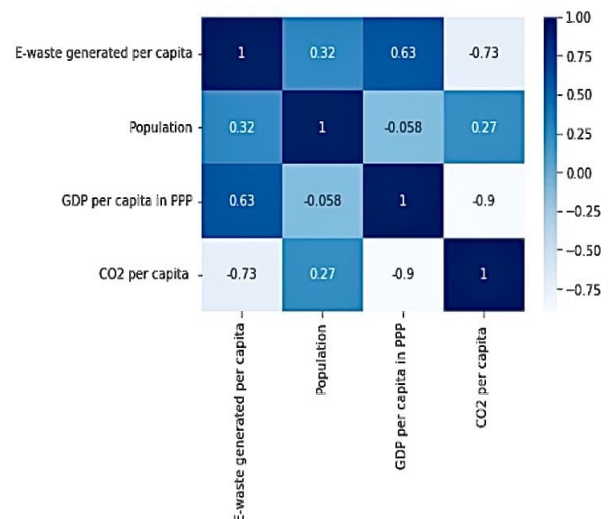
Fig. 2. **Correlation Coefficients between Indicators Such As E-Waste Generated Per Capita, Population, GDP Per Capita in PPP and CO_2 Per Capita for Group 1 of Countries in 2014–2019**

Source: Author's calculations.

The formula for R-squared:

$$R^2 = \frac{SSR}{SST}, \quad (3)$$

where SSR — explained sum of squares; SST — total sum of squares.

RESULTS

In modern conditions, most banks use various criteria in their activities. Digital transformation in the energy

Fig. 3. **Relationship for Group 2 of Countries in 2014–2019 between (a) E-Waste Generated Per Capita and Population, kg and 10 000 People; (b) E-Waste Generated and GDP Per Capita in PPP, kg and 1 000 Current International Dollar; (c) E-Waste Generated Per Capita and CO$_2$ Per Capita, kg and *t***

Source: Author's calculations.

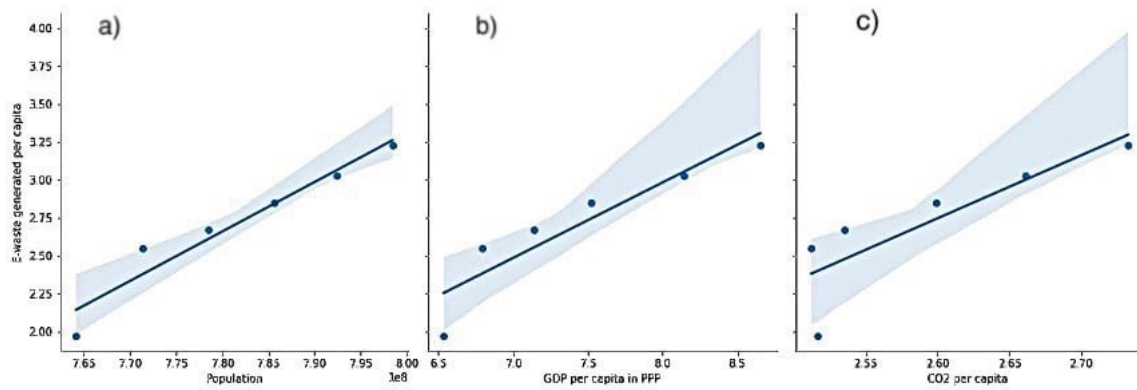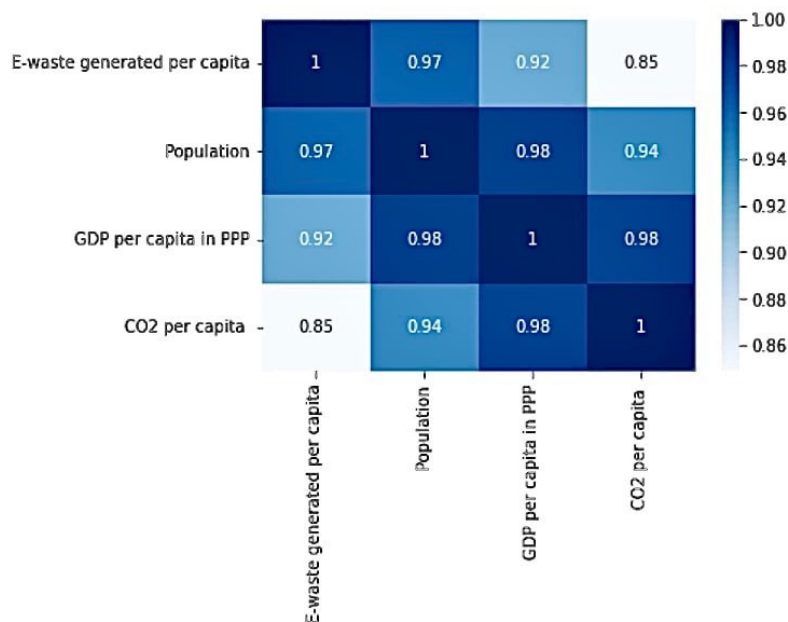*Fig. 4.* **Correlation Coefficients between Indicators Such As E-Waste Generated Per Capita, Population for Group 2 of Countries in 2014–2019, GDP Per Capita in PPP and CO$_2$ Per Capita**

Source: Author's calculations.

system in modern conditions (for example, various criteria) depends on solving various tasks in a single information and logical accounting environment. The structure of the technology can be described as a continuous sequential chain of blocks built according to certain rules, containing constantly updated information (records). Each block is linked to the previous one cryptographically to ensure confidentiality, data integrity, authentication, and encryption. The encryption process is performed using the "Hash" function and is called

hashing. Each subsequent block is added at the end of the chain after it is verified by all network participants. Unlike regular databases, once a block is attached, it becomes impossible to make changes to information. Only new records and new information can be added. Information is updated simultaneously on all nodes of the computer network. Blockchain is a completely new way to store and protect data. For effective implementation and application of the technology, the following conditions must be met: favorable political environment; government support and

compliance with the legal framework; a well-developed business ecosystem; appropriate qualifications of technology users, i.e. theoretical knowledge and practical skills are required to work in systems using blockchain technology; technically developed environment; growing investment opportunities.

We can distinguish the following areas where blockchain technology in waste management has already become widespread: military waste industry/cybersecurity; defense waste industry; waste in public services; waste in healthcare (Novartis); renewable energy (Shell); waste in food/agriculture (Nestle, DANONE); waste in IT (Microsoft, IBM, Intel).

Meanwhile, in Russia, the blockchain is already used by some organizations, including banks, and solves a range of different tasks. Let's consider the process of using blockchain technology to increase the competitiveness of waste management. When using this technology, the transaction is recorded twice, i.e. the double-entry method is used. Let's look at the advantages and disadvantages of using blockchain in banks while increasing the competitiveness of waste management. Let's start with the benefits. So, for example, it should be noted that this particular technology, by ensuring the protection of information from distortion, makes it possible to simplify and make relationships with customers more secure, especially if there is no trust in them. Speaking about simplifying the audit system, it should be noted that in the world arena, when discussing the prospects for implementing various criteria.

In addition, it is important to emphasize that the minimization of fraud in the energy sector is possible due to the fact that the blockchain technology provides an expansion of the ability of the supervisory authorities to monitor the activities of banks for illegal activities. For example, one hundred percent detection of violations in the field of payment evasion becomes possible (*Table 1*). *Table 2* presents the largest banks in 11 Asian countries by assets.

Thus, in order to maximize profits, waste management will hire qualified waste management personnel as long as the marginal utility of victories exceeds the marginal value of their contracts. The factors that have a direct impact on the financial results of waste management include factors at the first level.[1]

Based on the aforementioned, Kuwait has the potential to increase its renewable production. In fact, it has to meet the demands of its future plans until 2030. Solid Waste (SW) has the appropriate means and is considered to be a sustainable feedstock that could easily replace conventional fossil fuels in order to reduce environmental burdens and provide renewable energy.

Table 3 presents e-waste per capita generation data for 2014–2019 for selected Asian countries. The authors also calculated the cumulative average annual growth rate, whose value allows us to estimate the growth rate of the selected parameters. The Compound Annual Growth Rate (CAGR) for Kuwait, the UAE is negative, which indicates a decrease in e-waste generation for the period under consideration. For the other 9 countries, we can see an increase in the indicator, indicating an increase in financing of waste generation. India, Nepal, and Vietnam showed the largest increase in the average annual growth rate of e-waste. *Table 4* has descriptive statistics for the three country groups for the e-waste generation per capita indicator.[2]

An analysis of the relationship of indicators such as E-waste generated per capita, population, GDP in PPP per capita, CO_2 per capita showed quantitative results for the three groups.

Figures 1, 2 show the relationship between the indicators for the first group of countries. The graphical relationship between them is shown in *Fig. 1*. This group of countries is characterized by a positive relationship between such indicators as e-waste generated per capita and population, GDP in PPP per capita. The inverse relationship is observed between such indicators as E-waste generated per capita and CO_2 per capita. *Figure 2* presents a heat map illustrating the correlation coefficients for the four selected indicators. The correlation coefficient is 0.63 for indicators such as e-waste generated per capita and GDP in PPP per capita, indicating a strong positive relationship between the factors. The correlations for e-waste generated per capita and CO_2 per capita are strongly negative at −0.73.

For the second group, the graphical results of the analysis are presented in *Fig. 3, 4. Figure 3* illustrates the positive relationship between all three socioeconomic indicators and e-waste generated per capita.

---

[1] SMB, 2022. Scrap metal buyers we buy scrap metals nationwide. URL: https://www.scrapmetalbuyers.com/current-prices (accessed on 20.06.2023).

[2] PST, 2022. Plastic trip. URL: https://www.plasticsouptrip.com/post/97791290765/what-can-the-pricesof-plastics-teach-us. (accessed on 20.06.2023).

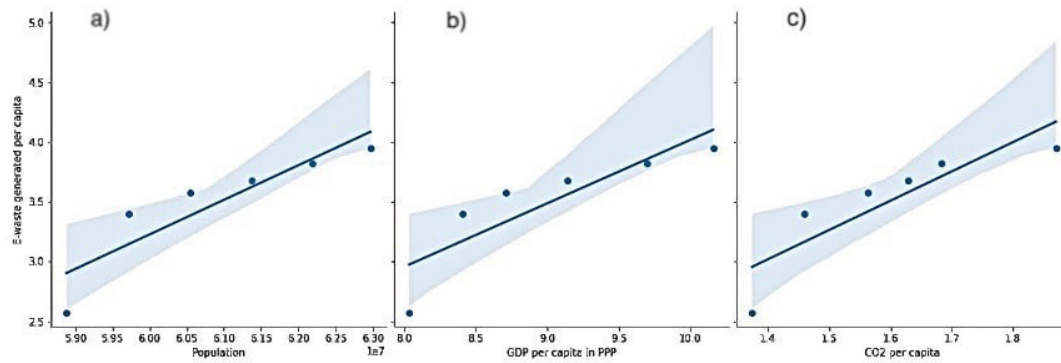*Fig. 5.* **Correlation Coefficients between Indicators Such As E-Waste Generated Per Capita, Population, GDP Per Capita in PPP and CO$_2$ Per Capita for Group 3 of Countries in 2014–2019**

Source: Author's calculations.

Table 5

Waste Generation and Treatment Structure of Sberbank, tons

Category	Waste				Waste for disposal				Waste for recycling			
	2019	2020	2021	2022	2019	2020	2021	2022	2019	2020	2021	2022
Hazardous waste	536	73	147	57	0	0	0	6	536	73	147	57
Class I	44	18	13	5	0	0	0	0	44	18	13	6
Class II	64	21	84	40	0	0	0	0	64	21	84	40
Class III	428	34	50	12	0	0	0	6	428	34	50	11
Low-hazard waste	52.497	51.823	51.317	49.335	42.187	37.963	36.013	32.896	10.270	13.783	15.159	13.798
Class IV	32.960	36.164	35.241	36.419	27.393	24.042	25.271	25.100	5.527	12.077	9.899	10.472
Class V	19.537	15.659	16.076	12.916	14.794	13.921	10.742	7.796	4.743	1.706	5.260	3.326
TOTAL	53.033	51.896	51.464	49.392	42.187	37.963	36.013	32.902	10.806	13.856	15.306	13.855

Source: Sberbank, 2022. ESG report. URL: https://shareholder.sberbank.com/AR 22/en/docs/esg/sber-esg-data-book-ecology-en.pdf (accessed on 20.06.2023).

The correlation map in *Fig. 4* shows a strong correlation between e-waste generated per capita and population, e-waste generated per capita and GDP in PPP per capita, E-waste generated per capita and CO$_2$ per capita. The correlation coefficients were 0.97, 0.92, and 0.85, respectively.

Fig. 5 illustrates the positive relationship. The correlation map in *Fig. 5* shows strong correlations between E-waste generated per capita and population, E-waste generated per capita and GDP in PPP per capita, e-waste generated per capita and CO$_2$ per capita. The correlation coefficients were 0.9, 0.86, and 0.87, respectively.

DISCUSSION

Sberbank at the beginning of waste management

The level of customer orientation of the Russian banks, which consists of building trusting relationships between the bank and its customers as well as with potential customers. In this article it's important to emphasize that clients must have complete access to information about all waste management and service possibilities, and VIP services are given special consideration. The level of remote customer service of the Sberbank (about 50% of Russian banking assets), which consists not only in the development of special applications for the

convenience of customers, but also the availability of an official website with full information about the activities of the bank, its products and services [25–29].

This paper has recommendations for improving waste management in credit institutions (mainly faulty office equipment and paper waste). In any case, a bank that shows a higher return on investment in a group of comparable banks, which exceeds the cost of raising capital, can be considered the most competitive. Since profitability consists of interest margin, cost of risk, share of non-interest income, and operational efficiency, leadership in these indicators also confirms the bank's ability to win in competition [30–32].

In general, according to experts, the factors of competitiveness in the energy industry coincide with those used in relation to other industries. Some nuances include the fact that waste management in Russia often does not have substitutes, which allows them to control pricing to a greater extent. The total amount of capital that is immediately available to Sberbank allows it to more completely control its own risk appetite and diversify its client base, which is an important factor in the bank's fight for the customer [33–35].

It is therefore deduced that the waste accumulation in Sberbank, while posing a serious environmental threat, can also present itself as a sustainable feedstock for various opportunities in the near future [36–39]. These opportunities have their own challenges but can also be a route for altering the energy mix a country that relies solely on fossil fuels. The largest Russian bank — Sberbank — publishes an ESG report for 2020 (*Table 5*).

Analysis of the data makes it possible to establish a strong dependence between the waste management rating and the efficiency.

CONCLUSIONS

The newly announced plan in Sberbank based on official government sources, shows that incineration to produce energy is one of the main options considered viable and achievable in Sberbank within the next few years. To this end, a number of techno-economic factors will be combined to determine the internal rate of return on Sberbank based on recent results obtained in past studies and published sources. In our work, we aim to apply the standardized methodology based on ISO protocols, whereby a comparative assessment for various scenarios that will be compared based on different energy mixes obtained from different techniques will be developed.

In the future, we will proceed directly to the consideration of the concept of competitiveness of energy products. The competitiveness of energy product is a comparative analysis of several characteristics of a bank's product or service, as well as distinguishing features from additional financing of waste management provided by competitors. Overall, the findings suggest that economic growth and population growth are significant factors driving e-waste generation in Asia.

Practical significance is that policymakers in these countries should focus on promoting sustainable consumption and production practices, such as circular economy models and extended producer responsibility, to mitigate the negative environmental and health impacts of e-waste.

In conclusion, the study highlights the importance of addressing the growing e-waste problem in Asia and the need for more comprehensive data collection and analysis to better understand the factors driving e-waste generation in the region.

The main finding of paper is the need to recycle such waste, which is the most environmentally friendly option compared to incineration.

REFERENCES

1. Alassali A., Aboud N., Kuchta K., Jaeger P., Zeinolebadi A. Assessment of supercritical CO_2 extraction as a method for plastic waste decontamination. *Polymers*. 2020;12(6):1347. DOI: 10.3390/polym12061347

2. Aminoff A., Sundqvist-Andberg H. Constraints leading to system-level lock-ins — the case of electronic waste management in the circular economy. *Journal of Cleaner Production*. 2021;322:129029. DOI: 10.1016/j.jclepro.2021.129029

3. Baldé C.P., Wang F., Kuehr R., Huisman J. The global e-waste monitor 2014: Quantities, flows and resources. Bonn: United Nations University; 2015. 41 p. URL: https://i.unu.edu/media/ias.unu.edu-en/news/7916/Global-E-waste-Monitor-2014-small.pdf

4. Bruch J.-R., Bokelmann K., Grimes S.M. Process development options for electronic waste fractionation to achieve maximum material value recovery. *Waste Management & Research*. 2022;40(1):54–65. DOI: 10.1177/0734242X2098789

5. Li R., Li L., Wang Q. The impact of energy efficiency on carbon emissions: Evidence from the transportation sector in Chinese 30 provinces. *Sustainable Cities and Society*. 2022;82:103880. DOI: 10.1016/j.scs.2022.103880

6. Li R., Wang Q., Liu Y., Jiang R. Per-capita carbon emissions in 147 countries: The effect of economic, energy, social, and trade structural changes. *Sustainable Production and Consumption*. 2021;27:1149–1164. DOI: 10.1016/j.spc.2021.02.031

7. Li R., Wang Q., Wang X., Zhou Y., Han X., Liu Y. Germany's contribution to global carbon reduction might be underestimated — A new assessment based on scenario analysis with and without trade. *Technological Forecasting and Social Change*. 2022;176:121465. DOI: 10.1016/j.techfore.2021.121465

8. Li R., Wang X., Wang Q. Does renewable energy reduce ecological footprint at the expense of economic growth? An empirical analysis of 120 countries. *Journal of Cleaner Production*. 2022;346:131207. DOI: 10.1016/j.jclepro.2022.131207

9. Pan X., Wong C.W.Y., Li C. Circular economy practices in the waste electrical and electronic equipment (WEEE) industry: A systematic review and future research. *Journal of Cleaner Production*. 2022;365:132671. DOI: 10.1016/j.jclepro.2022.132671

10. Pedersen M. E-waste collection and transport. Marius Pedersen a.s. URL: https://www.mariuspedersen.cz/en/about-marius-pedersen/services/58.shtml (accessed on 22.05.2023).

11. Rajesh R., Kanakadhurga D., Prabaharan N. Electronic waste: A critical assessment on the unimaginable growing pollutant, legislations and environmental impacts. *Environmental Challenges*. 2022;7:100507. DOI: 10.1016/j.envc.2022.100507

12. Rocha T.B., Penteado C.S.G. Life cycle assessment of a small WEEE reverse logistics system: case study in the Campinas Area, Brazil. *Journal of Cleaner Production*. 2021;314:128092. DOI: 10.1016/j.jclepro.2021.128092

13. Sediqi M.M., Nakadomari A., Mikhaylov A., Krishnan N. Lotfy M.E., Yona A., Senjyu T. Impact of time-of-use demand response program on optimal operation of Afghanistan real power system. *Energies*. 2022;15(1):296. DOI: 10.3390/en15010296

14. Shittu O.S., Williams I.D., Shaw P.J., Global e-waste management: Can WEEE make a difference? A review of e-waste trends, legislation, contemporary issues and future challenges. *Waste Management*. 2021;120:549–563. DOI: 10.1016/j.wasman.2020.10.016

15. Tamashiro K., Alharbi T., Mikhaylov A., Hemeida A.M., Krishnan N., Lotfy M.E., Senjyu T. Investigation of home energy management with advanced direct load control and optimal scheduling of controllable loads. *Energies*. 2021;14(21):7314. DOI: 10.3390/en14217314

16. Tanrıverdi S. E-Waste and its types. Waste Advantage Magazine. URL: https://wasteadvantagemag.com/e-waste-and-its-types/ (accessed on 23.05.2023).

17. Wang Q., Su M., Li R., Ponce P. The effects of energy prices, urbanization and economic growth on energy consumption per capita in 186 countries. *Journal of Cleaner Production*. 2019;225:1017–1032. DOI: 10.1016/j.jclepro.2019.04.008

18. Wang Q., Zhang F. The effects of trade openness on decoupling carbon emissions from economic growth — evidence from 182 countries. *Journal of Cleaner Production*. 2021;279:123838. DOI: 10.1016/j.jclepro.2020.123838

19. Baboshkin P., Mikhaylov A., Sheikh Z.A. Sustainable cryptocurrency growth impossible? Impact of network power demand on Bitcoin price. *Finansovyi zhurnal = Financial Journal*. 2022;14(3):116–130. DOI: 10.31107/2075–1990–2022–3–116–130

20. Karginova-Gubinova V.V. Which shareholders are interested in the ESG-indicators of the company? *Finance: Theory and Practice*. 2022;26(5):173–185. DOI: 10.26794/2587–5671–2022–26–5–173–185

21. Efimova O.V., Volkov M.A., Koroleva D.A. The impact of ESG factors on asset returns: Empirical research. *Finance: Theory and Practice*. 2021;25(4):82–97. DOI: 10.26794/2587–5671–2021–25–4–82–97

22. Vasiliev S.A., Nikonova I.A., Miroshnichenko O.S. Banks, financial platforms and Big Data: Development trends and regulation directions. *Finansovyi zhurnal = Financial Journal*. 2022;14(5):105–119. (In Russ.). DOI: 10.31107/2075–1990–2022–5–105–119

23. Kranina E.I. China on the way to achieving carbon neutrality. *Finansovyi zhurnal = Financial Journal*. 2021;13(5):51–61. (In Russ.). DOI: 10.31107/2075–1990–2021–5–51–61

24. Bushukina V. Specific features of renewable energy development in the world and Russia. *Finansovyi zhurnal = Financial Journal*. 2021;13(5):93–107. (In Russ.). DOI: 10.31107/2075–1990–2021–5–93–107

25. Mikhaylov A., Dinçer H., Yüksel S., Pinter G., Shaikh Z.A. Bitcoin mempool growth and trading volumes: Integrated approach based on QROF multi-SWARA and aggregation operators. *Journal of Innovation & Knowledge*. 2023;8(3):100378. DOI: 10.1016/j.jik.2023.100378

26. Mikhaylov A. Efficiency of renewable energy plants in Russia. *Anais da Academia Brasileira de Ciências*. 2022;94(4): e20191226. DOI: 10.1590/0001–3765202220191226

ABOUT THE AUTHORS

Jaehyung An — Cand. Sci. (Econ.), College of Business, Hankuk University of Foreign Studies, 02450, Seoul, South Korea
https://orcid.org/0000-0001-5410-7506
jaehyung.an@hufs.ac.kr

Alexey Yu. Mikhaylov — Cand. Sci. (Econ.), Assoc. Prof., Financial University, Moscow, Russia; Senior Researcher, Financial Research Institute of Ministry of Finance of the Russian Federation, Moscow, Russia.
https://orcid.org/0000-0003-2478-0307
Corresponding author:
alexeyfa@ya.ru

Monitoring the Sustainable Development of the Electronic Industry

N.A. Kazakova[a], V.G. Kogdenko[b]
[a] Plekhanov Russian University of Economics, Moscow, Russia;
[b] National Research Nuclear University "MEPhI", Moscow, Russia

ABSTRACT

The **subject** of the study is the Russian electronic industry as a strategically important sector that ensures national security and cybersecurity in all areas of activity. The **relevance** of the study is due to insufficient efficiency and consistency of the results of the existing monitoring of the development of the electronics industry, which is related to the lack of comprehensive information and analytical tools for diagnosis of indicators of sustainable development of industry. The **purpose** of the study is to develop a flexible situational approach to monitoring the electronics industry, taking into account the industry strategy to expand production of civilian products, as well as to justify the effectiveness of financing tools and increasing the sustainable development of the industry. As a result, a monitoring technique based on data from industry statistics, the Spark-Interfax information resource, and big data analytics for organizations in the electronics industry, with eventual industry aggregation, was developed. The sectoral structure was examined in accordance with the methodology, the market situation and business models were evaluated, and the risks and shortcomings of financing the sector were identified. The approach ensures monitoring of the transformation of the industry, creation of a fair competitive market, increase in the share of efficient private Russian companies and their integration into the global ecosystem. The **scientific novelty** of the study lies in the selection of sectoral assessment indicators, the use of information resources and big data technology, which provide regular diagnostics of the industry. The **theoretical significance** of the study is the development and adaptation of industry analysis to the specifics of the electronics industry, as well as the inclusion of sustainable development indicators. The results of the study are of **practical significance** for the professional Association of organizations of the radio-electronic industry of Russia, government regulators and private investors interested in operational information about the state and trends of the development of the industry and its financing tools.

Keywords: sustainability; development; financing instruments; electronic industry; National security; monitoring; import substitution; sanctions

INTRODUCTION

The liberal policy of Russia during the period of the market economy has led to the country's high dependence on high-tech imports and has also contributed to the uncontrolled outflow of capital to the more developed countries. This has resulted in insufficient funding of electronic industry development, which, according to foreign experts, is typical of many, even developed, countries.[1] The current geopolitical situation, dependence on imports of electronic hardware and software create a threat to the national security and economic growth of Russia. At the same time, it serves as a powerful impetus for large-scale structural changes in the country on a qualitatively new basis and contributes to the accelerated transition to the sixth technological system, the core of which is the microelectronics industry and information and communication technologies (further — ICT) [1, 2]. According to expert estimates, "not fully covered by statistics, but sufficiently powerful ICT sector of Russia, especially in the area of contact software, can serve as a factor in accelerating its economic growth", as confirmed by the 2020 ranking of the world's most digital countries.[2] According to the Digital Evolution Scorecard, Russia is ranked in the group of "prospective countries" by criteria of "level of digital development" and "rate of digital growth".[3] However, the electronic industry is scientifically intensive, and its advanced development, especially in the context of sanctions, requires large investments.

The Russian scientists V. V. Ivanter et al. [3], S. D. Bodrunov [4], V. A. Cherkasova and G. A. Slepushenko [5], D. A. Artemenko and S. V. Zenchenko [6] consider attracting investment as one of the main dominants of the sustainable development of the Russian economy.

This is confirmed by the results of our study: import substitution policy, improvement of the system of public procurement, and financial support in general contributed to the growth of important indicators of enterprises in the electronic industry in the period 2017–2021 (equity, assets, share of capital, intangible assets, research and development). According to IEF RAS calculations [7] based on HSE data [8] for the period 2010–2021, gross domestic R&D expenditure in the ICT sector as a whole increased by 18 times. At the same time, in 2021 compared to 2020–2.1 times. There was a trend to accelerate the growth of production, the number of staff, the productivity of labour.

However, key areas of industry development require continuous monitoring to improve financing instruments in new economic conditions. Our analysis of the various monitoring methods confirmed their limitations based on the scope of the objectives, industry or regional specificities. Electronics manufacturers' ratings are insufficiently informative, as they are based only on two indicators of revenue and staffing.[4] The monitoring methodology of A. M. Batkovsky et al. [9] is focused on the evaluation of various processes of transformation and diversification of UICs. The paper also critiques current methods for evaluating government programs for the excessive use of standard indicators and the standard performance audit algorithm.

Our approach to monitoring methodology development is based on industrial analysis methodology, which is consistent with the research of G. B. Kleiner, who considers that it is difficult to "predict crises and prevent their consequences" by confining oneself to macro-

---

[1] Blank S. The Semiconductor Ecosystem Explained. Semiwiki 02–06–2022. URL: https://semiwiki.com/semiconductor-manufacturers/307494-the-semiconductor-ecosystem-explained (accessed on 02.02.2023).

[2] World's most digital countries: ranking of 2020. URL: https://hbr-russia.ru/innovatsii/trendy/853688 (accessed on 02.02.2023).

[3] MACROECONOMIC FORECASTING. URL: https://cebr.com/service/macroeconomic-forecasting (accessed on 02.02.2023).

[4] Rating of organizations of the radio-electronic industry of Russia. URL: https://www.instel.ru/upload/files/sec_doc_20/reiting-2020.pdf (accessed on 02.02.2023).

analysis [10]. J. A. Brander et al. [11] also applied a sector-specific approach to assessing the effectiveness of various enterprise financing tools in research-intensive sectors, with the highest efficiency observed in the IT sector (more than 40%) with private venture financing, in the electronic industry— with mixed financing (11.07%).

The importance of a company's environmental impact, as well as the availability of information about its environmental, social, and governmental responsibilities, have significantly increased the requirements of investors today (ESG). Studies by Russian scientists M.A. Fedotova, O.V. Loseva, V.V. Bogatyreva [12], E. Yu. Makeeva and others [13], foreign scientists Tensie Whelan, Elyse Douglas and others prove the impact of sustainable development indicators on business value and indicators of investment attractiveness.[5] Studies by Cornell University scientists S. Freytag et al. [14] estimate the impact of IT and electronics on the climate as approximately 1.8% to 2.8% of global greenhouse gas emissions. At the same time, scientists consider that the introduction of digital electronic systems will help improve energy efficiency, process productivity, reduce greenhouse gas emissions, and mitigate the effects of climate change.

A comprehensive analysis of existing monitoring methods revealed inefficiencies and, in some cases, contradicting results [7]. This is due to the absence of a complete information and analytical toolkit for analyzing indicators of the electronic industry's sustainable development at the objective level and in relation to strategic priorities. Thus, the purpose of the present study was to develop a flexible situation-based approach to monitoring the electronics industry, taking into account the industry strategy focused on expanding production

of civilian products, as well as to justify the effectiveness of funding instruments and increase the sustainability of industry development. At the same time, it should be noticed that complete compliance with all established indicators, including those influenced by different reasons, is impossible. In this regard, sustainability is determined by the correspondence of the main trend of development of the industry to the target in connection with directions and priorities on the basis of established indicators in the aspect of the general concept of sustainable development on the national economy. Monitoring should reflect the changes observed as a result of focused industry transformation measures; diagnose risks; and identify the most effective tools for financing and other government support of the electronic sector's implemented strategic development paradigm.

METHODOLOGY OF RESEARCH

The study focuses on key priorities of the Electronic Industry Development Strategy[6]: inflow of private Russian investments in the industry to develop large consortia, increase investment activity of companies; creation of a fair competitive environment (growth of output of Russian producers, their market share, increase of assets, the number of staff and productivity of labour); restructuring of the industry (increase of the share of Russian private companies, transition to an ecosystem based on a common technological platform or production resource) with gradual integration into the world eco-system [15]. The monitoring methodology is based on the principles of accuracy, regularity and efficiency of information, includes the analysis of big data on organizations of the

---

[5] Tensie Whelan, Elyse Douglas. The price of social responsibility. URL: https://hbr-russia.ru/biznes-i-obshchestvo/etika-i-reputatsiya/854831 (accessed on 02.02.2023).

[6] On the Strategy for the Development of the Electronic Industry of the Russian Federation for the period up to 2030 and the plan of activities for its implementation. Order of the Government of the Russian Federation from 17 January 2020 No. 20. URL: http://www.consultant.ru/document/cons_doc_LAW_52009/#cont (accessed on 02.02.2023).
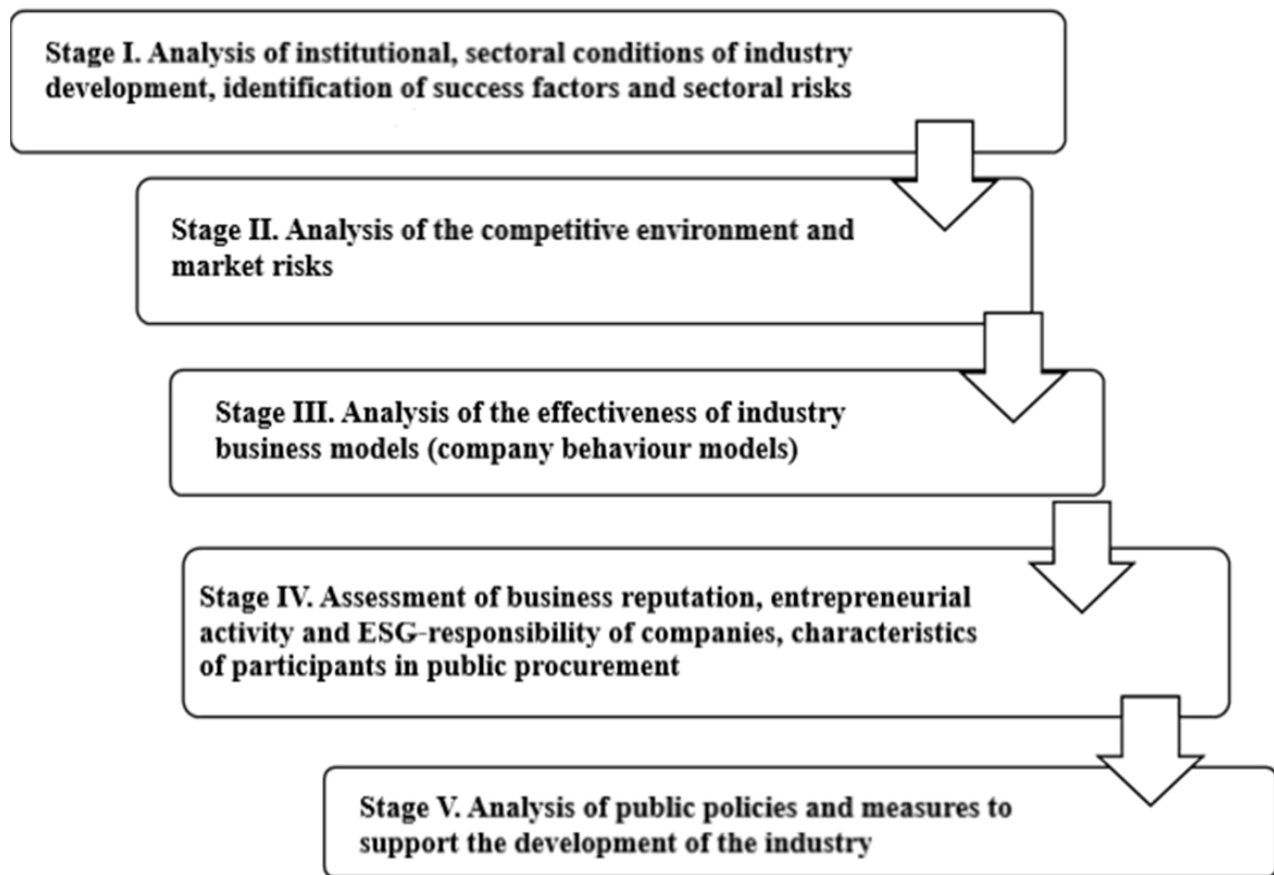
Fig. 1. **Methodology of Monitoring the Sustainability of the Development of the Electronic Industry in Russia**

Source: Compiled by the authors.

electronic industry (OKVED 26 Production of computers, electronic and optical products) and uses the information resource Spark-Interfax.[7] This confirms a more complete circle of monitoring, as opposed to Rosstat data, which is focused on large companies, and allows this methodology to be applied in the system of public procurement, priority area subsidization, and the most effective business models. The methodology stages are presented in *Fig. 1*.

RESULTS OF THE RESEARCH

The first phase of the study revealed that the electronic industry is developing in the form of manufacturing consortia in such segments as telecommunications equipment and communications; computing and

data storage systems; control devices and telematics; automotive electronics; medical electronics, security systems, etc.[8] At the same time, the share of civilian production by Russian manufacturers is 31% of total domestic revenue; by segments, the share varies from 7% in the most voluminous segment of telecommunications equipment and communications, which belongs to one of the key indicators of the strategy. There are numerous business models in the industry, but analysts consider vertically integrated companies, as well as innovation centers dedicated to market research, idea generation, science, developing, and producing new goods, to be the most promising [15].

According to the Ministry of Trade, in 2020 the industry included 1 652 organizations

---

[7] Spark-Interfax News. URL: https://spark-interfax.ru/ru/statistics (accessed on 02.02.2023).

[8] Electronics Developers and Manufacturers Association (EDMA). URL: http://arpe.ru/ (accessed on 02.02.2023).

Structure and Characteristics of the Electronics Industry by Type of Ownership

Type of ownership	Share of companies by number, %	Share of employees, %	Share in revenue, %	Asset share, %
State	0.94	6.51	4.73	10.93
With foreign participation	4.24	22.06	24.99	22.65
Private	94.82	71.43	70.28	66.42
Total	100	100	100	100

Source: Compiled by the authors.

with a total of 290 thousand employees. At the same time, experts have more than 3 thousand organizations, including state-owned companies that are part of ROSTEC; private small and medium-sized enterprises controlled by the JSRC "System"; companies with foreign participation, and representative offices of global corporations (*Table 1*).

From 2019 to 2020, the following developments happened in the structure of civilian product producers: quantitatively, the share of companies in the public sector and foreign companies has declined by around 1% in favor of the private sector, while the number of employees has increased significantly, with private enterprises employing more than 70% of the employees.

The second phase analyzes important sectoral risks related to falling behind the rest of the world, becoming vulnerable to sanctions, and confronting potential threats to sovereignty. According to experts, a significant proportion of the electronic component base of Russian equipment is imported; the technological lag of Russian manufacturers is from 5 to 20 years.[9] Electronic component manufacturing is characterized by a higher share of added value and is critically dependent on innovation. In this connection, investments in R&D of 15

to 20% of revenue are insufficient to finance industry development. According to Spark-Interfax, in 2020, the industry structure was characterized by the following parameters: the total number of employees — 380 thous. people, revenue — 1 915 mln rubles, assets — 2 407 mln rubles. Generally, it is difficult to identify the type of industry. The industry includes both manufacturing companies and research organizations (design centers). The sectoral market structure is characterized by fairly low competition: the concentration ratio of the three largest companies (CR-3) was 10.23%, the Herfindahl-Hirschman index was 67.11%. At the same time, it is important to remember that the market is divided into segments, and companies may have monopoly positions in individual market segments; that is, the variation of key indicators within the industry can be quite high. *Table 2* shows the calculated barriers to entry and age structures, categorized by specified enterprise groupings. Enterprises that have been in the sector for more than ten years provide the most substantial contribution to the industry in terms of assets, value created, and performance.

The sectoral economies of scale (*Table 3*), estimated on the basis of the enterprises of the industry by revenue, showed that the largest share in the number of enterprises, the size of the own capital, revenue, and net profit have enterprises falling into two groups: with

---

[9] Electronics slows without reforms. Industry is asked to support regulation. URL: https://www.kommersant.ru/doc/4323806 (accessed on 02.02.2023).

Table 2

Characteristics of the Age Structure of Electronic Industry Enterprises

Grouping of enterprises by duration of operation (age), years (upper limit – slightly more than the specified figure)	Number of enterprises by group	Average net assets by group, million rubles	Group share in equity capital by industry, %	Average assets groups by industry, million rubles.	Group's share of assets by industry, %	Average revenue groups by industry, million rubles.	Group share in industry revenue, %	Average net profit groups by industry, million rubles	Share of the group in net profit by industry, %
Less than a year	52	1	0	12	0.02	11	0.03	2	0.06
1–4	1 284	60	7.73	91	4.85	64	4.32	3	2.7
4–7	1 546	54	8.34	145	9.33	121	9.74	10	10.15
7–10	1 071	20	2.17	162	7.2	96	5.37	7	5.27
10–13	868	78	6.8	214	7.71	192	8.71	21	12.11
13–16	793	153	12.23	253	8.33	233	9.65	21	10.99
16–19	629	199	12.59	466	12.17	519	17.03	33	13.9
19–22	442	147	6.53	359	6.6	364	8.39	28	8.52
22–25	510	185	9.5	399	8.45	334	8.91	21	7.15
>25	1 007	336	34.12	845	35.33	529	27.84	43	29.17
Total	8 202	121	100	294	100	233	100	18	100

Source: Compiled by the authors.

Characteristics of the Sectoral Economies of Scale

Revenue, million rubles	Share of companies by number, %	Share in equity, %	Asset share, %	Share in revenue, %	Share in profit, %
1–50	65.59	8	6.96	4.02	0.68
51–100	10.57	2.99	2.94	3.26	2.52
101–999	19.92	28.5	25.01	26.05	29.41
1000–1999	2.17	14.06	15.24	12.8	17.32
2000–2999	0.59	4.89	5.04	6.08	7.12
3000–3999	0.29	4.18	3.53	4.23	4.2
4000–4999	0.18	2.95	2.9	3.56	4.11
5000–5999	0.18	3.44	4.32	4.31	2.73
6000–6999	0.13	4.38	4.04	3.33	3.99
7000–7999	0.1	1.49	3.03	3.14	1.41
8000–8999	0.01	0.69	0.32	0.45	0.23
10000–10999	0.04	1.31	2.77	1.67	4.26
11000–11999	0.04	0.93	2.09	1.84	-0.28
13000–13999	0.01	2.55	1.77	0.71	3.59
>15000	0.18	19.64	20.04	24.19	18.71
Total	100	100	100	100	100

Source: Compiled by the authors.

revenue from 100 mln rubles to 2 000 mln, as well as more than 15 000 mln.

The analysis will allow us to conclude that the most effective enterprises belong to groups with revenues that range from 100 to 1 000 mln rubles, 2 000 to 3 000 mln rubles, and 4 000 to 5 000 mln rubles, as demonstrated by their share of revenue above the share of assets and profit above the share of revenue. Furthermore, the analysis demonstrates the existence of significantly different producers in the industry, as well as the absence of a significant positive effect of scale.

The third phase assesses the effectiveness of industry business models on the basis of an analysis of operational, investment and financial activities, growth indicators and risks. For this purpose, enterprises were divided into 3 groups and average indicators were calculated on the sample as a whole by the largest enterprises and companies participating in public procurement (*Table 4*).

According to 2020, among the top 20 companies, 11 were private, 6 were foreign, and 3 were public. The result of the analysis revealed a high operating risk, as indicated by the high volatility of indicators as well as the rate of variation of the profit from sales above the benchmark, which indicates the instability of industry demand. At the same time, companies participating in public procurement are less vulnerable to market risks, as indicated by the lower rate of revenue

Performance Indicators of Sectoral Business Models of Electronics Enterprises

Indicator	Average values for all companies in the sample	Values for the 20 largest companies	Values for companies participating in government procurement	Benchmarks*
Variation coefficient of revenue	0.35	0.33	0.30	No data
Variation coefficient of sales profit	0.66	0.78	0.63	0.47
Share of fixed assets and intangible assets, %	9.61	6.78	7.3	28.3
Asset growth rate, %	8.36	14.28	7.18	No data
Revenue growth rate, %	1.68	23.06	2.38	4.73
Net profit growth rate, %	(13.77)	68.91	(9.37)	10.99
Return on invested capital	2.37	1.70	2.13	1.65
Profitability of sales on profit, %	6.84	9.22	7.94	13.5
Net sales profitability, %	4.24	5.80	5.24	3.74
Return on invested capital, %	16.36	14.63	14.71	7.88
Return on equity, %	20.62	19.17	17.42	7.46

Source: Compiled by the authors.

Note: * Indicators of electronics industry (general) for emerging markets. Website by A. Damodaran URL: http://pages.stern.nyu.edu/~adamodar (accessed on 02.02.2023).

variation. Higher indicators of profitability of own and invested capital compared to benchmarks against the background of declining rates of growth of profits negatively characterize the investment activities of companies. Table 5 presents operational, investment, and financial performance indicators, as well as growth and risk indicators.

Based on the analysis, it can be concluded that enterprises in the industry are characterized by small but generally positive operational efficiency: average increase in labor productivity— 4.14%, increase in revenue — about 5%, profitability of sales — 6.33%, yield exceeds the cost of resources by 1.5 times. Investment activity in 2020 was insufficient. This is demonstrated by the decline in non-current assets and the shortage of investment. At the same time, the rate of dividend payments increased and in 2020 reached 62.97%, which negatively affected

Table 5

Indicators of Operating, Investment and Financial Activity

Indicator	Averages (medians)
Operating activities	
Average annual revenue growth rate (2017–2020), %	4.96
Return on sales, %	6.33
Return on assets	1.45
Labor productivity, thous. rubles/people	2 960
Average annual salary, thous. rubles/people	689
Annual average labour productivity growth, %	4.14
Average annual growth rate of average annual salary, %	5.4
Net sales profitability, %	3.75
Share of organizations with losses (net financial result for the year), %	16.12
Investment activities	
Share of non-current assets, %	10.2
Investment (CAPEX) to revenue, %	1.41
Growth of non-current assets to revenue, %	(0.07)
Financial activities	
Share of equity in the source of financing, %	44.44
Share of organizations with negative equity, %	8.22
Share of long-term debt in sources of finance	12.67
Dividend payout ratio, %	62.97
Financial leverage	0.46

Source: Compiled by the authors.

the investment opportunities of private companies in the industry.

The fourth phase assesses the parameters of the business reputation of enterprises in the industry, including the participants in public procurement and the state of the entrepreneurial environment. *Table 6* data confirms the positive business reputation of enterprises: low due diligence index, indicating a low probability of one-day companies; their absence in all risk registers of Spark-Interfax; adequate tax burden (11.8%);

high loyalty rates of public procurement participants (above industry averages). At the same time, the index of entrepreneurial confidence in 2020, calculated by Rosstat, shows a negative value.

Analysis of the business reputation of enterprises in the industry from the ESG-responsibility perspective shows positive processes, which confirm the trends of reducing their environmental impact (*Fig. 2*), as well as increasing costs for environmental activities (*Table 7*).

Indicators of the Business Reputation of Organizations

Indicator	Averages	Values by government procurement participants
Business confidence index*, %	−6	–
Due diligence index	6	3
Share of companies included in risk registers, %	6.73	6.11
Share of companies with credit limit, %	55.50	55.92
Tax burden on revenue, %	10.84	11.54

Source: Compiled by the authors.

Note: * Business activity of organizations in Russia. URL: https://rosstat.gov.ru/storage/mediabank/89_01–06–2022.html (accessed on 02.02.2023).
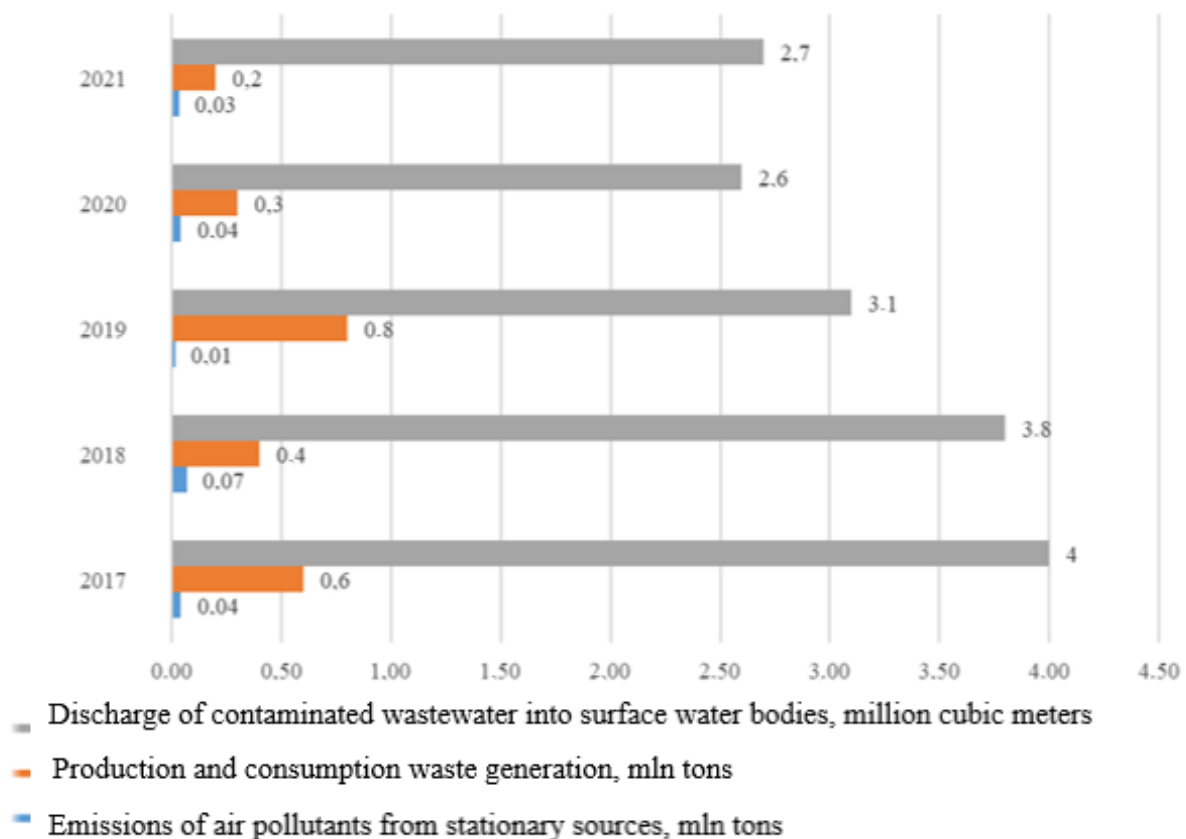

Fig. 2. **Dynamics of Environmental Impact Indicators of Electronic Industry Enterprises**

Source: Compiled by the authors based on Statistical Collection of. Rosstat "Environmental protection in Russia". Moscow; 2022. 113 p.

Current Expenditure on Environmental Protection (in Actual Prices, Million Rub.)

Current expenses	2016	2017	2018	2019	2020	2021
For environmental protection, total	1 389	1 408	1 464	1 493	1 445	1 638
Air protection and climate change mitigation	321	375	369	310	339	372
For wastewater collection and treatment	712	720	748	761	797	891
For waste management	240	258	275	339	218	267
Protection and rehabilitation of land, surface and groundwater	11	12	16	20	18	18
Conservation of biodiversity and conservation of natural territories	0.6	0.8	0.8	1	0.7	1

Source: Compiled by the authors based on Statistical Collection of. Rosstat "Environmental protection in Russia". Moscow; 2022. 113 p.

Industry-Average Indicators for the Implementation of the Electronics Industry Strategy-2030

Indicator	Industry averages for 2020 (medians)
Rate of increase in equity, %	9.39
Share of fixed assets, intangible assets, research and development in total assets, %	9.61
Asset growth rate, %	10.7
Revenue growth rate, %	3.79
Net profit growth rate, %	0.44
Labour productivity growth rate, %	2.9
Average wage growth rate, %	3.67
Share in GDP, %	1.79

Source: Compiled by the authors.

The fifth phase analyzes the direction and effectiveness of public policy in the industry. The positive results include agreed-upon support for ICT [17] and the electronic industry in 2021; the creation of a register of organizations providing services for the design and development of electronic component products and electronic products; tax reductions; and import substitution incentives.

For the analysis of the impact of public policy on the development of the industry, a system of indicators corresponding to the objectives of Strategy 2030 is proposed and as estimated indicators at the starting point — calculated industry averages for 2020 (*Table 8*).

CONCLUSION

The article discusses the author's approach to monitoring the sustainability of the development of the electronic industry, the benefit of which is the development of relevant industry indicators for assessing sustainable development, the use of information resources and big data technology, and ensuring regular diagnosis of the industry in the context of the ongoing transformation of the national economy.

According to the results of the 2020 monitoring, there was a decline in the sustainable development of the Russian electronics industry, as evidenced by high volatility and a decrease in the growth rates of key financial indicators. Among the positive aspects, assets grew by 10.7%, equity by 9.39% and equity, intangible assets, research and development by 9.61%. At the same time, there is no real (taking into account inflation) growth in revenue, net profit, labor productivity, or average wage. This reflects the impact of a pandemic, global stagnation, disturbances in supply chains, insufficient investment and government support. Only in 2021–2022 did integrated development with the ICT sector and actual budget financing, tax incentives, and active import substitution provide beneficial results. Although institutional and financial-economic processes are quite inertial, already in 2023, we can discuss the growth and sustainability of the development of the industry in a number of key directions of the strategy: exceeding other industries growth in 2022[10] in the field of computer, electronic and optical production; growth of the business confidence index, improved business reputation from the ESG responsibility position. For January-November 2022 compared to 2021, there is an increase in the volume of own production by 11.4% (in computer software development by 30.3%), wage growth by 14.4%.

The theoretical significance of the study is to develop and adapt the methodology of industry analysis to the specifics and needs of the monitoring of the electronic industry in order to ensure the sustainable development of the industry as a whole. The practical results represent value for the professional Association of organizations of the radio-electronic industry of Russia, state regulators and private investors interested in operational information on the state and trends of development of the industry. Further research on the development of monitoring methodology will be aimed at increasing the scope of the companies surveyed, grouping and studying their business models in more depth, and also developing forecasting models to justify the selection of the most effective companies for public procurement, forms of R&D financing, and industry development support.

---

[10] URL: https://rosstat.gov.ru/storage/mediabank/osn-11–2022.pdf (accessed on 02.02.2023).

REFERENCES

1. Glazyev S. Yu. Global transformations from the perspective of technological and economic world order change. *AlterEconomics*. 2022;19(1):93–115. (In Russ.). DOI: 10.31063/AlterEconomics/2022.19–1.6
2. Porfiryev B. N., Shirov A. A., Uzyakov M. N., Gusev M. S., Shokin I. N. The main directions of socio-economic development of Russia in 2020–2024 and for the period up to 2035. *Studies on Russian Economic Development*. 2020;31(3):245–253. (In Russ.: *Problemy prognozirovaniya*. 2020;(3):3–15.).

3. Ivanter V. V., Porfiryev B. N., Sorokin D. E., Eskindarov M. A., Maslennikov V. V., Shirov A. A. et al. How to boost the development of the Russian economy: Priority actions (suggestions for the main activities of the state until 2024). *Finance: Theory and Practice.* 2018;22(S 7):4–15. DOI: 10.26794/2587–5671–2018–0–0–4–15

4. Bodrunov S. D. Reindustrialization of the economy as a strategic priority of Russia's development. *Ekonomika kachestva*. 2014;(8):95–104. (In Russ.).

5. Cherkasova V. A., Slepushenko G. A. The impact of digitalization on the financial performance of Russian companies. *Finance: Theory and Practice.* 2021;25(2):128–142. DOI: 10.26794/2587–5671–2021–25–2–128–142

6. Artemenko D. A., Zenchenko S. V. Digital technologies in the financial sector: Evolution and major development trends in Russia and abroad. *Finance: Theory and Practice.* 2021;25(3):90–101. DOI: 10.26794/2587–5671–2021–25–3–90–101

7. Ganichev N. A., Koshovets O. B. Rethinking Russian digital economy development under sanctions. *Studies on Russian Economic Development*. 2022;33(6):645–654. DOI: 10.1134/S 1075700722060041 (In Russ.: *Problemy prognozirovaniya.* 2022;(6):94–108. DOI: 10.47711/0868–6351–195–94–108).

8. Abdrakhmanova G. I., Vasil'kovskii S. A., Vishnevskii K. O. et al. Digital economy 2022: Brief stat. coll. Moscow: NRU HSE; 2022. 124 p. (In Russ.).

9. Batkovsky A. M., Turko N. I., Fomina A. V. Controlling the diversification of the military-industrial complex enterprises. *Kontrolling = Controlling*. 2020;(1):2–11. (In Russ.).

10. Kleiner G. B. Industrial ecosystems: Foresight. *Ekonomicheskoe vozrozhdenie Rossii = Economic Revival of Russia*. 2018;(2):53–62. (In Russ.).

11. Brander J. A., Du Q., Hellmann T. The effects of government-sponsored venture capital: International evidence. *Review of Finance*. 2015;19(2):571–618. DOI: 10.1093/rof/rfu009

12. Loseva O. V., Fedotova M. A., Bogatyreva V. V. Impact of the value of intangible assets on the capitalization of food retailers for their sustainable growth. *Finance: Theory and Practice*. 2021;25(4):48–63. DOI: 10.26794/2587–5671–2021–25–4–48–63

13. Makeeva E. Yu., Ivashkovskaya I. V., Ruzhanskaya L. S., Popov K. A. Relationship between regional socio-economic development and corporate ratings of Russian companies. *Ekonomika regiona = Economy of Regions*. 2021;17(1):86–102. (In Russ.). DOI: 10.17059/ekon.reg.2021–1–7

14. Freytag S., Berners-Lee M., C. Widdicks K. et al. The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations. *Patterns*. 2021;2(9):100340. DOI: 10.1016/j.patter.2021.100340

15. Kogdenko V. G., Kazakova N. A., Sanzharov A. A. Monitoring the implementation of the strategy for development of the electronics industry of the Russian Federation. *Studies on Russian Economic Development*. 2021;32(6):683–688. DOI: 10.1134/S 1075700721060071 (In Russ.: *Problemy prognozirovaniya.* 2021;(6):135–143. DOI: 10.47711/0868–6351–189–135–143).

16. Solomennikova E. A., Lugacheva L. I., Musatova M. M. The strengthening of economic position of Russian electronics: Mechanisms and capabilities. *Zhurnal Sibirskogo federal'nogo universiteta. Seriya: Gumanitarnye nauki = Journal of Siberian Federal University. Humanities and Social Sciences*. 2020;13(11):1840–1852. DOI: 10.17516/1997–1370–0688

17. Dudin M. N., Shkodinsky S. V. Challenges and threats of the digital economy to the sustainability of the national banking system. *Finance: Theory and Practice*. 2022;26(6):52–71. DOI: 10.26794/2587–5671–2022–26–6–52–71

ABOUT THE AUTHORS

Natalia A. Kazakova — Dr. Sci. (Econ.), Prof., Plekhanov Russian University of Economics, Moscow, Russia
https://orcid.org/0000-0003-1499-3448
Corresponding author:
axd_audit@mail.ru

Vera G. Kogdenko — Dr. Sci. (Econ.), Assoc. Prof., Head of the Department of Financial Management, National Research Nuclear University "MEPhI", Moscow, Russia
https://orcid.org/0000-0001-9732-1174
vgkogdenko@mephi.ru

The Influence of the Competence Component of Intellectual Capital and Financial Efficiency on the Capitalization of Russian Manufacturing Companies

Yu. Yu. Savchenko
Altai State University, Barnaul, Russia

ABSTRACT

The **object** of the study is Russian industrial companies whose shares are traded on the Moscow Exchange. The study's **subject** is financial and financial connections in the field of using intellectual capital's competence component as an important factor in business growth. The **relevance of the study** is important for the increasing role of intellectual capital and its components as a determining factor in business growth, as well as the need to identify new determinants that influence company capitalization. In the context of overcoming the consequences of sanctions, intellectualization and digitalization of the economy, the problem of the study of the dependency of the capitalization of Russian companies on the state of the components of intellectual capital is significantly updated. The **purpose of the study** is to assess and model the impact of the competence component of intellectual capital and financial efficiency on the capitalization of Russian manufacturing companies. **Methods** of comparative and statistical analysis, calculation of financial and economic indicators, correlation and regression analysis, and the Farrar-Glauber test were used. According to correlation analysis, the capitalization of Russian public companies in the production sector is influenced by an internal factor such as patent activity. The constructed multifactor linear regression model allows for the conclusion that a 1% increase in the number of patents raises the company's market capitalization by 1.23% while all other factors remain constant. It is **concluded** that in the Russian market the importance of material assets as a factor in business growth significantly prevails over the influence of the competence component of intellectual capital. Recommendations are given, the implementation of which in the practice of Russian manufacturing companies will maximize their capitalization by taking into account the financial and economic advantages from the use of the competence component of intellectual capital.

Keywords: capitalization; Russian industrial companies; factors affecting capitalization; intellectual capital; intangible assets; return on assets; patent activity; financial efficiency

INTRODUCTION

The relevance of the study of the influence of the competent component of intellectual capital on the financial and economic indicators of the activities of Russian industrial companies is due to a number of socio-economic and political trends.

First, the transition from a "material" economy to a digital one based on an intelligent component requires a corresponding transformation of business processes. Companies that invest in the formation and development of organizational competencies get a competitive advantage. Competence is increasingly important in the development of both intellectual capital and business as a whole.

Second, innovation diffusion and supply of high-tech products have declined sharply in the sanctions area due to the breakdown of partnerships and disturbance of logistics. This greatly restricts economic development and requires a reorientation from the use of foreign intelligent products and technology to other sources. There is an increasing need to develop and implement one's own innovations. Competitive development of the Russian economy's industrial sector will be possible only if the competence component of intellectual capital is effectively developed and used.

Intellectual capital (IC) presupposes a specific asset capable of creating value. Traditionally, the structure of the IC is divided into three components: organizational, structural and human capital [1]. Economic transformations resulted in a modification in the structure of intellectual capital. As structural elements, it is advisable to identify three groups of capitalizable components of intellectual capital: competence, digital and convergent. The competence component is the driver of the development of others, allowing them to change business models and facilitating the search for innovative solutions.

M. A. Eskindarov examined intellectual capital through a view of the characteristics that form human capacities [2]. In the digital economy, there is an increase in the involvement of the intellectual and innovative component in financial and economic circulation. New forms of human capital are being formed, which allows us to talk about the need to allocate the competence component within the IC. If human capital is only partially separated from the individual, competitiveness is organizational competence, which is one of the defining assets of the company. Competence capital is intangible knowledge resources that are transformed into unique, innovative assets.

The purpose of the study is to evaluate and model the impact of the competitiveness component of intellectual capital and financial effectiveness on the capitalization of Russian industrial companies.

The scientific hypothesis of the study is as follows: competency capital as a component of intellectual capital has a positive impact on the capitalization of industrial companies.

LITERATURE REVIEW

The role of IC in improving the sustainability of modern companies and its impact on financial and economic results is reflected in the scientific literature on both a theoretical and practical basis. In particular, according to N. Bontis, W. C. Keow and S. Richardson, there is a difference between the company's balance sheet and market value, which can be explained by the profile of intellectual capital [3]. The authors of the evaluation of 107 Malaysian companies argued that there is a close relationship between IC and the results of the company, regardless of industry affiliation. In turn, J. Xu and J. Li, having examined the role of IC components in high-tech and low-tech industrial companies (respective 116 and 380 observation objects), concluded that there was a positive correlation between IC and financial indicators in both sectors. [4].

Companies have three components of IC: tangible (physical), financial and intangible

(intellectual). Despite the fact that intellectual capital is intangible and difficult to measure, it is in the modern economy that it becomes a key factor for sustainable growth and value formation of companies. Issues of the influence of IC on the market value and financial performance of companies are discussed in the papers [5–9]. According to A. Riahi-Belkaoui, if the market is efficient, investors will value companies with highly developed intellectual capital more [10].

It is important to note that research in the scientific literature has been provided that allows us to discuss the detrimental influence of IC on the financial results of company activities. Thus, an analysis of 96 Greek companies listed on the Athens Stock Exchange (ASE), from four different sectors of the economy observed over a three-year period, revealed a statistically significant link only between human capital efficiency and financial indicators [11]. F. Sardo and Z. Serrasqueiro's study of the impact of IC on the financial performance of Malaysia's 41st construction company revealed a positive impact on the performance of capital-only companies [12]. In the paper by P. Puntilla [13], there is no significant influence of IC on the performance of companies [13].

Special attention in the scientific literature is given to the management of the knowledge component [14, 15]. Competent capital is becoming increasingly important in a modern knowledge-based economy. According to K. Wiig, the purpose of knowledge management is to maximize its effectiveness and profit from it by constantly updating knowledge [9]. Individual and collective knowledge is an important factor in business growth in the modern economy. As noted by C. Diebolt and R. Hippe, the long-term impact of the knowledge component on present innovation and economic development must be considered [16]. After analyzing more than 5 000 French industrial companies, E. Kremp and J. Mairesse empirically established that when the intensity of knowledge management

increases by 1%, the tendency to innovate increases by 4% and productivity increases by 3% [17].

The most notable of the papers by Russian authors should be the studies of T. Andreeva and T. Garanina, A. A. Bykova and M. A. Molodchik, E. R. Baiburina, M. A. Fedotova and O. V. Loseva, N. R. Kelchevskaya, S. S. Rustam [18–21].

One of the first studies in the national scientific literature devoted to the question of the analysis of the impact of IC on the results of companies was the paper of T. A. Garanina, in which the impact on the market value of the shares of Russian companies of tangible assets and three components of intellectual capital is justified on the data of the Russian market [22].

The positive relationship between profits and returns from IC is established in the study of A. A. Bykova and M. A. Molodchik on the basis of a sample of 115 companies in the Perm region [23]. The conclusion about the significant influence of IC on the growth of fast-growing companies and the lack of significant dependence for slow-growing companies is supported in the paper by S. S. Rustam [24].

In general, it is necessary to note that, despite the presence of individual papers in the domestic scientific literature devoted to issues of empirical justification of the influence of IC on the results of activity and cost of Russian companies, the issues of interrelationship with individual components of IC did not receive proper development. This is what determines the relevance and necessity of study in this field.

MATERIALS AND METHODS
The theoretical basis of the study were the papers of Russian and foreign scientists devoted to the evaluation of the value of the business [24–26], the intellectual capital of companies [22, 23, 27–29], as well as the paper revealing the influence of intangible components on the cost of business, including corporate
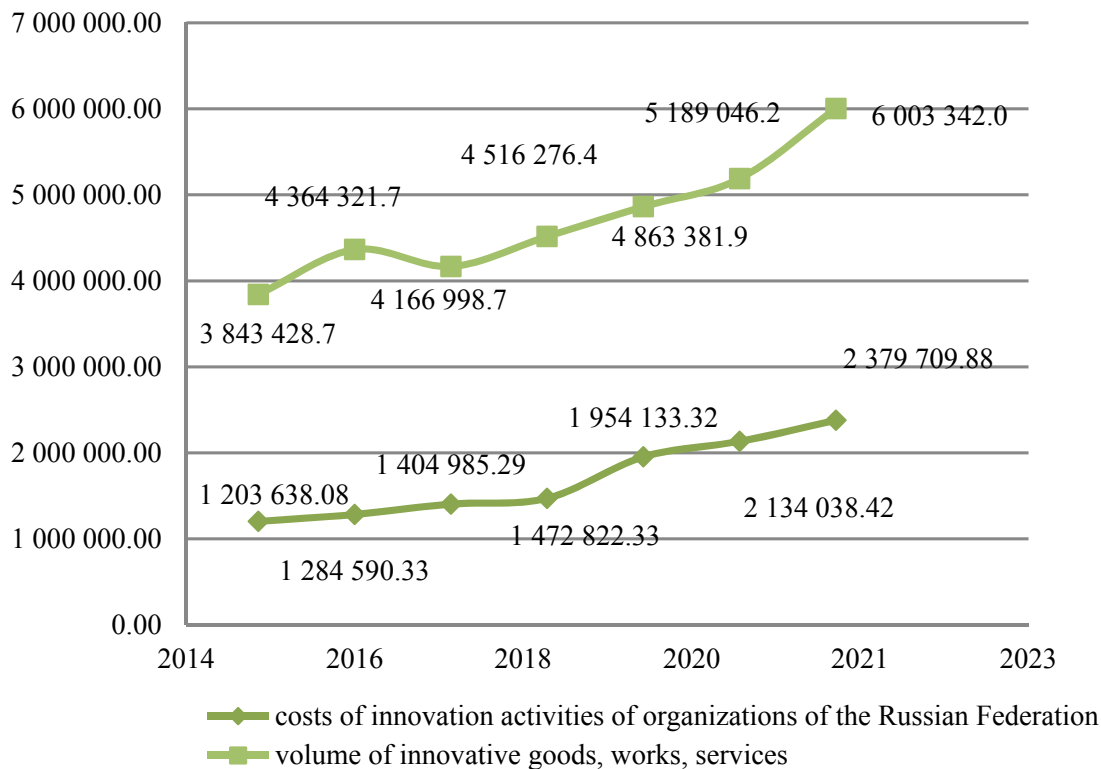
Fig. 1. **Dynamics of Indicators of Innovative Activity of Russian Companies, Mln Rubles**
Source: Rosstat data, gks.ru.

governance [30, 31], value of intangible assets [32], R&D costs [33], network capital [34], competences and dynamic abilities [35].

The information base of the study consisted of regulatory and legal documents, data from official statistics, and materials from internal company reports. In conducting the study, data from the information and analytical database of SPARK and the financial portal Smart-Lab were used.

Statistical and comparative analytic methodologies were used to conduct research on financial and economic indicators of company activities [36–38].

The multi-factor correlation-regression analysis was used to identify the indicators that have the largest influence on capitalization, as well as to determine the type of dependency between the variables to be investigated [38, 39].

The company's competence capital is reflected in the results of intellectual activity, including inventions and useful models. The increasing role of innovation as a key factor

of sustainable business development allows to view patent activity as an indicator of the state of the complementary component in the IC. The number of inventions and utility models (patents) is one of the significant manifestations of the competence component. Since the results of intellectual activity, according to FSBU 14/2022 "Intangible Assets"[1] are reflected exclusively in cost value due to the absence of an active market for most intangible assets (IAs), this indicator will also be considered as a result of the competence component.

RESULTS OF THE STUDY
Intellectual Capital of Russian Companies
Costs of innovative activities in the period 2015–2021 overall in the Russian Federation

---

Order of the Ministry of Finance of Russia from 30.05.2022 No. 86n "On approval of the Federal Standard of Accounting of FSB 14/2022 "Intangible Assets". URL: http://publication.pravo.gov.ru/ Document/View/0001202206280008?ysclid=lpwcowkldl36860099 (accessed on 28.09.2923).
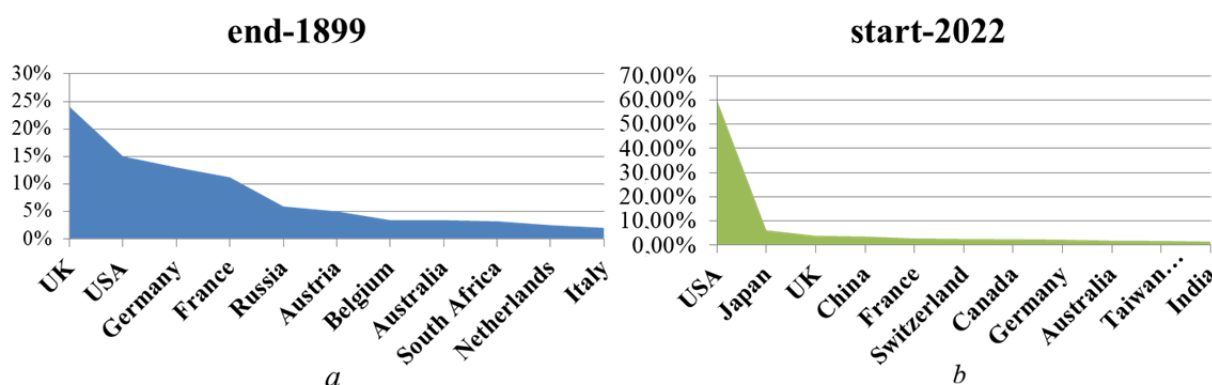
Fig. 2. **Relative Sizes of World Stock Markets, End-1899 (*a*) Versus Start-2022 (*b*)**

Source: Compiled by the author based on data from Credit Suisse Global Investment Returns Yearbook 2022 Summary Edition. URL: https://www.credit-suisse.com/media/assets/corporate/docs/about-us/research/publications/credit-suisse-global-investment-returns-yearbook-2022-summary-edition.pdf (accessed on 05.11.2023).

had a trend of growth (197.71%), as well as the indicator of the volume of shipped innovative goods, works and services (156.2%) (*Fig. 1*). But the level of innovation activity of Russian companies is not characterized by a sustained positive trend.

As a negative trend characterizing the unsatisfactory level of development of the competence component of intellectual capital, it is worth noting the decrease of the share of Russian companies in the capitalization of the world market. According to a review published annually by the Swiss investment bank Credit Suisse, if in 1899 the share of Russian companies in the world market capitalization was 5.9% (5th place in the value of companies), then in 2022 they fell only into the category "other"[2] (*Fig. 2*).

The innovation activity of Russian companies, which is characterized primarily by competency capital, is significantly inferior to the indicators of the leading countries across the entire spectrum of economies. In the Global Knowledge Index (GKI), determined annually since 2017,

Russia's position in the ranking has fallen to 52nd place, which is comparable to countries such as Romania, Malaysia, Egypt, Oman, Chile, Uruguay, Greece, Bahrain, Saudi Arabia, Costa Rica (*Table 1*).[3]

The analysis of the competence component of IC of Russian companies allows to speak of insufficient level of its development. For this reason, the capitalization of Russian companies is significantly lower than that of foreign companies. The management of Russian companies does not consider IC and its components as a factor that allows to increase market value.

Correlation and Regression Analysis of the Impact of Competent Capital on the Capitalization of Russian Industrial Companies

We will examine the impact of the identified indicators (patent activity and IA) on the capitalization of Russian industrial companies, as well as develop a dependency regression model. The data were collected for 24 companies leading in patentability, but their composition was adjusted to build a balanced model. Only those companies were included in the sample for which observations

---

[2] Credit Suisse Global Investment Returns Yearbook 2022 Summary Edition. URL: https://www.credit-suisse.com/media/assets/corporate/docs/about-us/research/publications/credit-suisse-global-investment-returns-yearbook-2022-summary-edition.pdf (accessed on 28.09.2923).

[3] Global Knowledge Index (GKI). URL: https://ru.knoema.com/aomssce/global-knowledge-index (accessed on 03.04.2023).

Position of Individual Countries in the Global Knowledge Index (GKI) in 2020–2022

Country	Country rank in 2022	Value of the Global Knowledge Index				
		2018	2019	2020	2021	2022
USA	1	68.5	69.7	71.1	69.9	68.4
Switzerland	2	72.7	73.2	73.6	71.9	68.3
Sweden	3	68.6	69.1	70.6	70.0	67.0
Finland	4	68.8	69.7	70.8	69.7	66.9
Ireland	20	65.7	69.4	66.1	63.7	61.1
Singapore	12	67.9	69.2	69.2	68.0	63.3
Denmark	7	65.3	67.6	68.3	68.5	66.0
UK	9	66.5	67.5	68.1	68.9	63.9
Norway	8	64.7	65.3	66.1	68.1	64.2
Iceland	14	64.4	64.7	65.2	67.0	62.9
UAE	25	61.9	63.7	66.1	63.1	58.9
Luxembourg	6	68.3	69.1	69.5	67.3	66.1
Germany	11	64.4	64.6	66.2	66.6	63.6
China	–	54.0	53.7	57.4	59.2	–
Russia	52	51.7	46.0	45.0	51.7	48.1

Source: Compiled by the author based on data from the Global Knowledge Index (GKI).

were obtained at each given time for all the indicators analysed. Fuel and energy complex companies were also excluded from the sample.

Despite the fact that metallurgy is traditionally classified as low-tech, leading companies in the industry are showing sufficient innovation activity. Public companies representing medium- and high-tech industries (aerospace, general mechanical engineering, chemical industry) have a low share of the total MOEX capitalization.

In the first phase of the study, the patent activity, the absolute value and the share of NMA in the non-current assets of the companies under investigation were analysed.

The largest number of patent leaders in the sample included in the metallurgy and chemical industries (*Fig. 3*).

A comparative analysis of the absolute value of IA and their share in non-current assets has led to the conclusion that among the PJSCs operating in the field of production, the leaders in absolute size of the IA are "Nizhnekamskshina" and "Alrosa". Analysis of the indicator of the size and share of IA, by which you can "see" intellectual capital in traditional financial reporting, allowed to conclude, first, the existence of problems with the reflection of the intangible
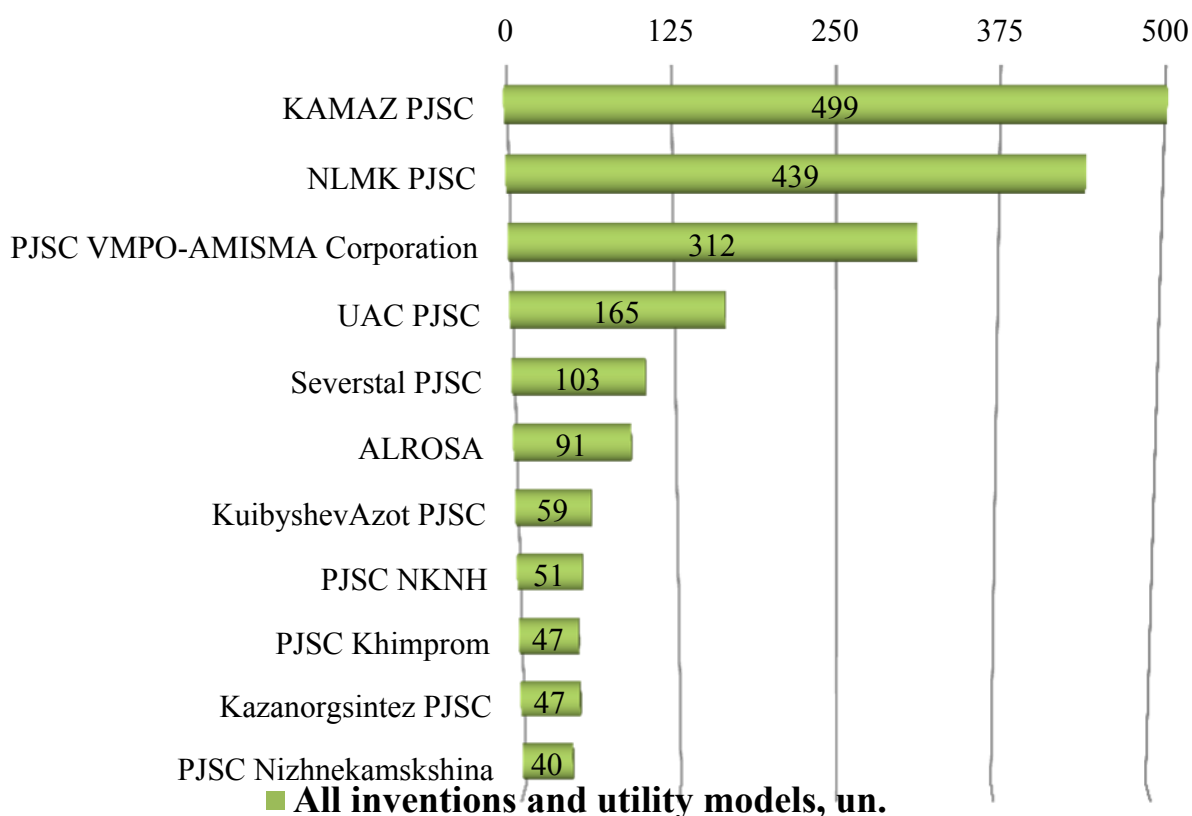
Fig. 3. **Indicators of Patent Activity of Russian Manufacturing Companies**

Source: Compiled by the author based on data from the Spark reference and analytical system.

component in the reporting and, secondly, the underestimation of Russian companies the role of IC as a source of value creation.

Analysis of the correlation between the time series of the number of patents and capitalization as a resulting indicator revealed a high degree between variables (correlation factor of 0.76). There is a close correlation between the IA balance sheet value and corporate capitalization, as the correlations are in the range 0.5-0.7 ($r = 0.66$).

The capitalization of companies is also influenced by factors related to material and financial capital. To clarify the contribution to the capitalization of Russian industrial companies of the competence component and its correlation with the influence of material capital, build a multi-factor model of regression. As variables characterizing the impact of physical and financial capital on capitalization, we will analyze the return on assets and EBITDA. For the valuation of

intellectual capital, most often we use Tobin's ratio (q), which will also be considered an influence variable.

A multi-factor correlation study was used to identify the financial and economic elements that have the greatest influence on company market capitalization (*Table 2*).

From the evaluation of the results obtained, it can be concluded that of all the factors studied, the value indicator IA has the closest relationship with the resulting indicator (market capitalization) ($R = 0.66$), return on assets ($R = 0.93$), EBITDA profitability ($R = 0.98$). A marked correlation is observed with patent activity ($R = 0.76$). The relationship between capitalization and the Tobin's ratio (q) is weak or moderate ($R < 0.5$), respectively, and this variable may be excluded from further consideration.

In the matrix, there are pairs of correlation ratios between independent variables greater than 0.7, indicating the presence

Table 2

Values of the Correlation Coefficient (R) Based on the Results of Multivariate Correlation Analysis

Indicator	IA	ROA	EBITDA margin	Patent activity	Tobin's ratio (q)	Capitaliza-tion
IA	1					
ROA	0.77	1				
EBITDA margin	0.68	0.89	1			
Patent activity	0.46	0.51	0.79	1		
Tobin's ratio (q)	−0.1	−0.01	0.44	0.60	1	
Capitalization	0.66	0.93	0.98	0.76	0.32	1

Source: Compiled by the author.

of multicollinearity. The determinant of the inter-factor matrix of R correlations (det[R] = 0.0001), found using the MDETERM function, is close to zero. We can make an assumption of the general multicollinearity of the entire set of explanatory variables. The Farrar-Glauber multicollinearity test was carried out. The observed value of Farrar-Glauber (FG) was 53.25. The actual value is compared to the table value (18.3) of the χ^2 criterion with a degree of freedom (10) and a level of significance $\alpha = 0.05$. The observed value is greater than the table, respectively, in the array of explanatory variables, which presents multicollinearity.

Since the analysis of the matrix of multicollinearity correlation pairs showed that EBITDA profitability is most strongly interrelated with the rest of the explanatory variables, let us exclude it from further analysis.

Build a three-factor model of their influence by taking into account the factors most closely connected with capitalization — the value of intangible assets, return on assets, and patent activity. The results of the regression analysis are presented in the *Table 3*.

Table 3 shows that the three-factor equation has statistically significant ratios for two factors: return on assets and patent activity. These factors are statistically significant. Variable (X_1) profit per share and free member are insignificant (p- value > 0.05). Excluding the variable X_1 from the analysis, we get the following model:

$$Y = 23.65 \times X_2 + 1.23 \times X_3,$$

where Y — capitalization of the company; X_2 — return on assets; X_3 — patent activity.

The determination factor for the two-factor model is approximately 97%, indicating that the quality of the model has improved, and that the change in the resulting feature by 97% is due to changes in the explanatory variables (return on assets and patent activity).

CONCLUSION

As a result of the hypothesis's example, specific conclusions can be drawn: market

Fragment of the Three-Factor Regression Analysis Protocol

Variable	Coefficient	Standard error	t-statistic	P-value
Y- cross	79.0506929	100.9913629	−3.01066036	0.0948841
Variable X_1	1.920973225	0.538378486	1.710642697	0.22927588
Variable X_2	23.64728178	4.16381638	6.887258988	0.0204377
Variable X_3	1.23065141	1.354525812	0.806215223	0.04784121

Source: Compiled by the author.

capitalization is acceptable as a comprehensive indication of investment attractiveness impacted by an intellectual capital component such as patent activity. Nevertheless, in the Russian market, the influence of tangible assets' fundamental value on the company's capitalization exceeds the importance of the ICT competence component.

The model obtained makes it possible to conclude that patent activity leads to capitalization growth and correlates strongly with other financial indicators of the company's activity.

For this sample of Russian companies, the presence of a close correlation between market capitalization and the number of patents may not be evident. The results for the investigated data set of companies allow for a development of recommendations on the management of intellectual capital components in order to improve capitalization:

• intellectual capital components should be considered as variables in improving market capitalization and sustaining long-term viability;

• patent activity is an internal non-financial factor for increasing market capitalization;

• necessary to assess existing patents in terms of their value-added impact and to disclose relevant information;

• require not only to include the development of intellectual capital components, including patent and publishing activity, the number of hours of training, the availability of digital duplicates, the involvement in digital and networking interactions, etc., but also to ensure that relevant reporting is developed;

• formulate a portfolio of objects based on individual components of intellectual capital and assess the potential benefits from them based on the needs of the company, consumers, and the market as a whole.

Following the recommendations based on the study's conclusions will contribute to the long-term development of Russian industrial companies and improve their market capitalization.

REFERENCES

1. Edvinsson L., Malone M. Intellectual capital: Realizing your company's true value by finding its hidden brainpower. New York, NY: HarperBusiness; 1997. 240 p. (Russ. ed.: Edvinsson L., Malone M. Intellektual'nyi kapital. Opredelenie istinnoi stoimosti kompanii. In: Inozemtsev V.L., ed. Novaya postindustrial'naya volna na Zapade. Antologiya. Moscow: Academia; 1999:429–447).

2. Eskindarov M.A. Development of corporate relations in the modern Russian economy. Moscow: Respublika; 1999. 302 p. (In Russ.).

3. Bontis N., Keow W.C.C., Richardson S. Intellectual capital and business performance in Malaysian industries. *Journal of Intellectual Capital.* 2000;1(1):85–100. DOI: 10.1108/14691930010324188

4. Xu J., Li J. The impact of intellectual capital on SMEs' performance in China: Empirical evidence from non-high-tech vs. high-tech SMEs. *Journal of Intellectual Capital*. 2019;20(4):488–509. DOI: 10.1108/JIC-04–2018–0074

5. Firer S., Williams S.M. Intellectual capital and traditional measures of corporate performance. *Journal of Intellectual Capital.* 2003;4(3):348–360. DOI: 10.1108/14691930310487806

6. Ginesti G., Caldarelli A., Zampella A. Exploring the impact of intellectual capital on company reputation and performance. *Journal of Intellectual Capital*. 2018;19(5):915–934. DOI: 10.1108/JIC-01–2018–0012

7. Chen M.-C., Cheng S.-J., Hwang Y. An empirical investigation of the relationship between intellectual capital and firms' market value and financial performance. *Journal of Intellectual Capital*. 2005;6(2):159–176. DOI: 10.1108/14691930510592771

8. Ali S., Murtaza G., Hedvicakova M., Jiang J., Naeem M. Intellectual capital and financial performance: A comparative study. *Frontiers in Psychology*. 2022;13:967820. DOI: 10.3389/fpsyg.2022.967820

9. Wiig K.M. Knowledge management: An introduction and perspective. *Journal of Knowledge Management*, 1997;1(1):6–14. DOI: 10.1108/13673279710800682

10. Riahi-Belkaoui A. Intellectual capital and firm performance of US multinational firms: a study of the resource-based and stakeholder views. *Journal of Intellectual Capital.* 2003;4(2):215–226. DOI: 10.1108/14691930310472839

11. Maditinos D., Chatzoudes D., Tsairidis C., Theriou G. The impact of intellectual capital on firms' market value and financial performance. *Journal of Intellectual Capital*. 2011;12(1):132–151. DOI: 10.1108/14691931111097944

12. Sardo F., Serrasqueiro Z. A European empirical study of the relationship between firms' intellectual capital, financial performance and market value. *Journal of Intellectual Capital*. 2017;18(4):771–788. DOI: 10.1108/JIC-10–2016–0105

13. Puntillo P. Intellectual capital and business performance. Evidence from Italian banking industry. *Korporativnye finansy = Journal of Corporate Finance Research*. 2009;3(4):97–115. DOI: 10.17323/j.jcfr.2073–0438.3.4.2009.96–115

14. Andriana D. Pengaruh Intellectual capital Terhadap Kinerja Keuangan Perusahaan. *Jurnal Riset Akuntansi dan Keuangan*. 2014;2(1):251–260. DOI: 10.17509/jrak.v2i1.6578

15. Suseno N.S., Hermina T., Ramdhani A., Utari L. The impact of intellectual capital on financial performance. *International Journal of Recent Technology and Engineering (IJRTE).* 2019;8(1S):359–365. URL: https://www.ijrte.org/wp-content/uploads/papers/v8i1S/A10520581S 19.pdf

16. Ruggeri G.C., Yu W. On the dimensions of human capital: An analytic framework. Department of Economics. University of New Brunswick. Working Paper Series. 2020;(05). URL: https://unbscholar.dspace.lib.unb.ca/server/api/core/bitstreams/6e0c7b08–3252–4d8c-b642-ce60363155fe/content

17. Diebolt C., Hippe R. The long-run impact of human capital on innovation and economic growth in the regions of Europe. *Applied Economics*. 2019;51(5):542–563. DOI: 10.1080/00036846.2018.1495820

18. Kremp E., Mairesse J. Knowledge management in the manufacturing industry. Les 4 Pages des statistiques industrielles. SESSI, DiFITIP, Ministère de l'Economie, des Finances et de l'Industrie. 2002;(169).

19. Andreeva T., Garanina T. Intellectual capital and its impact on the financial performance of Russian manufacturing companies. *Foresight and STI Governance*. 2017;11(1):31–40. DOI: 10.17323/2500–2597.2017.1.31.40 (In Russ.: *Forsait.* 2017;11(1):31–40).

20. Baiburina E.R. Methods for analyzing intellectual capital for modern sustainable development of a company. *Korporativnye finansy = Journal of Corporate Finance Research*. 2007;1(3):85–101. (In Russ.). DOI: 10.17323/j.jcfr.2073–0438.1.3.2007.85–101

21. Fedotova M.A., Loseva O.V. Cost of business and intellectual capital. In: Trachuk A.V., Linder N.V., Prokof'ev S.E. Sustainability management. St. Petersburg: Real'naya ekonomika; 2015:309–319. (In Russ.).

22. Degles H.S.M., Kelchevskaya N.R. The impact of intellectual capital on performance and investment attractiveness of Russian companies. *Journal of Applied Economic Research*. 2021;20(1):110–132. (In Russ.). DOI: 10.15826/vestnik.2021.20.1.005

23. Garanina T.A. Intellectual capital of an organization as a factor in creating business value: Definition, assessment and management. Cand. econ. sci. diss. Synopsis. St. Petersburg: St. Petersburg State University; 2009. 25 p. (In Russ.).

24. Bykova A.A., Molodchik M.A. The influence of intellectual capital on the results of the company's activities. *Vestnik Sankt-Peterburgskogo universiteta. Menedzhment = Vestnik of Saint Petersburg University. Management Series*. 2011;(1):27–55. (In Russ.).

25. Sattorzoda S.R. Research of the efficiency of intellectual capital as a growth of Russian companies. *Aziatsko-Tikhookeanskii region: ekonomika, politika, pravo = Pacific Rim: Economics, Politics, Law*. 2023;25(2):15–26. (In Russ.). DOI: 10.24866/1813–3274/2023–2/15–26

26. Ahonen G. Generative and commercially exploitable intangible assets. In: Gröjer J.E., Stolowy H., eds. Classification of intangibles. Jouy-en Josas: Groupe HEC; 2000:206–213.

27. Koller T., Goedhart M., Wessels D. Valuation: Measuring and managing the value of companies. 7th ed. Hoboken, NJ: John Wiley & Sons, Inc.; 2020. 896 p.

28. Normann R., Ramírez R. From value chain to value constellation: Designing interactive strategy. *Harvard Business Review*. 1993;71(4):65–77. (Russ. ed.: Normann R., Ramírez R. Ot tsepochki sozdaniya stoimosti k sozvezdiyu stoimosti. Razrabotka interaktivnoi strategii. In: Postroenie tsepochki sozdaniya stoimosti. Moscow: Alpina Business Books; 2007:186–220).

29. Kokh L.V., Kokh Yu.V., Daneykin Yu.V. Valuation of intellectual capital: An investor's view. *Ekonomika. Informatika = Economics. Information Technologies*. 2022;49(4):693–706. (In Russ.). DOI: 10.52575/2687–0932–2022–49–4–693–706

30. Katulskij E.D., Bespalova N.A. Methodological approaches and challenges in assessing the value of intellectual capital. *MIR (Modernizatsiya. Innovatsii. Razvitie) = MIR (Modernization. Innovation. Research)*. 2016;7(4):84–88. (In Russ.). DOI: 10.18184/2079–4665.2016.7.4.84.88

31. Kosorukova O.D. Analyzing the impact of corporate governance factors on enterprise value and capitalization. *Daidzhest-finansy = Digest Finance*. 2021;26(3):291–309. (In Russ.). DOI: 10.24891/df.26.3.291

32. Kuzmin E.A., Ibragimova L.A., Bautina E.V. The role of neuromanagement in the management of modern companies. *Tsifrovaya i otraslevaya ekonomika*. 2022;(1):13–21. (In Russ.).

33. Loseva O.V., Fedotova M.A., Bogatyreva V.V. Impact of the value of intangible assets on the capitalization of food retailers for their sustainable growth. *Finance: Theory and Practice*. 2021;25(4):48–63. DOI: 10.26794/2587–5671–2021–25–4–48–63

34. Chernova O.A., Mikhaylova E.L. The cost of research as a factor of development potential of capitalizing high-tech companies. *Azimut nauchnykh issledovanii: ekonomika i upravlenie = ASR: Economics and Management (Azimuth of Scientific Research)*. 2019;8(1):226–228. (In Russ.). DOI: 10.26140/anie-2019-0801–0050

35. Ustyuzhanina E.V., Evsukov S.G., Komarova I.P. Value chains: problems of formation and governance. *Menedzhment i biznes-administrirovanie = Management and Business Administration*. 2019;(3):132–150. DOI: 10.33983/2075–1826–2019–3–132–150

36. Molodchik M.A. Managing the knowledge potential of an organization: Methodology and practice. Doct. econ. sci. diss. Synopsis. Perm: Perm National Research Polytechnic University; 2021. 39 p. (In Russ.).

37. Lapo V. Methods and models for assessing value in economic decision-making and management. Moscow: Litres; 2023. 218 p. (In Russ.).

38. Plaskova N.S., Prokofieva E.V. Modern trends of development of economic analysis methods. *Uchet. Analiz. Audit = Accounting. Analysis. Auditing*. 2019;6(2):47–51. (In Russ.). DOI: 10.26794/2408–9303–2019–6–2–47–51

39. Orlov A.I. Probability-statistical models of correlation and regression. *Politematicheskii setevoi elektronnyi nauchnyi zhurnal Kubanskogo gosudarstvennogo agrarnogo universiteta = Scientific Journal of KubSAU*. 2020;(160):130–162. (In Russ.). DOI: 10.21515/1990–4665–160–011

ABOUT THE AUTHOR

Yuliya Yu. Savchenko — Assistant Prof., Department of the State and Municipal Administration and Law, Rubtsovsk Institute (branch), Altai State University, Barnaul, Russia
https://orcid.org/0000-0002-5121-5680
savtenko@rb.asu.ru

Financial Performance Analysis Using EVA, MVA, FVA, and REVA Methods for Telecommunication Sub-Sector Companies Listed on the IDX

M. Istan
Institut Agama Islam Negeri Curup, Curup, Bengkulu, Indonesia

ABSTRACT

The **purpose** of this study is to suggest an approach to analyzing the efficiency of telecommunications companies listed on the Indonesia Stock Exchange (IDX) using methods for determining Economic Value Added (EVA), Market Value Added (MVA), Financial Value Added (FVA), and Refined Economic Value Added (REVA). A summary of the relevant literature is formed on the bibliographic database. Statistical data based on information from the Indonesia Stock Exchange for four companies in the telecommunications sector over 5 years. Data from reports' balance sheets, including reports of profits and losses, is investigated. The **results** of the survey demonstrated that a telecommunications company had a positive EVA value, which meant that it succeeded in creating economic value. The three telecommunications companies had a positive MVA value, which meant that they provided value-added through market capitalization. In four telecommunications companies, a positive FVA indicated that management was successful in providing financial value-added for the company. One of the four telecommunications companies produced a positive REVA, which meant an increase in economic value after the company paid off all liabilities to creditors and shareholders. The use of various value-added measures to assess the performance of Indonesian businesses is a **scientific novelty** that contributes to the development of corporate finance theory.

Keywords: Financial Performance; Economic Value Added (EVA); Market Value Added (MVA); Financial Value Added (FVA); Refined Economic Value Added (REVA)

INTRODUCTION

Indonesia's tech industry, particularly smartphones and the internet, is rapidly expanding with the advent of 5G. In early 2022, the country had an astonishing 210 million internet users, mainly accessing social media on mobile devices. According to the "Indonesian Internet Profile 2022" by the APJII, 99.16% of users were aged 13–18. With an estimated population of 272.68 million, the internet penetration rate in 2022 reached 77.02%, up from 73.7% in 2020, connecting 196.71 million Indonesians. Key internet usage drivers include information access (92.21%), remote work/study (90.21%), public services (84.9%), email (80.7%), online transactions (79%), entertainment content (77.25%), online transportation (76.47%), and financial services (72.32%) (www.kompas.com).

Tech advancements impact Indonesia's economy. Companies must strategize to enhance shareholder and investor values. As noted by A. Horton [1], investors seek revenue by providing capital from owners and creditors. Companies must improve quantity and quality for expected benefits. Regular financial statement evaluations are vital for assessing financial health and ensuring survival, according to D. E. Kieso et al. [2]. Financial performance measurement is vital for assessing a company's goal achievement. Utilizing financial ratios derived from historical data is common. Yet, it has limitations due to subjectivity in accounting data, potentially leading to inaccurate and imprecise measurements, according to E. R. Rahadjeng [3].

Financial ratio analysis, while useful for assessing financial performance and guiding decisions, does not guarantee an entirely accurate representation of a company's true financial condition, according to N. Yoshino, F. Taghizadeh-Hesary [4]. Financial ratio analysis neglects a company's risk exposure by disregarding the cost of capital. To address this limitation in financial performance measurement,

a value-based approach has emerged, according to a paper by J. Choi et al. [5]. EVA and MVA assess corporate performance, cost of capital, and capital investment. Law No. 36/1999 and a 2002 government regulation enabled foreign mobile operators in Indonesia, heralding telecom industry liberalization.

PT Telekomunikasi Indonesia Tbk accelerated digitalization in response to COVID-19, offering ICT services and solutions to aid the nation and government. Despite challenges, Telkom Group improves digital infrastructure and services for an excellent customer experience. If traced back, the average EVA value for the telecommunication industry in Indonesia listed on the IDX for 2014–2018 grew significantly. In detail, the result of Economic Value Added (EVA) calculation for the telecommunications industry in Indonesia listed on the Indonesia Stock Exchange (BEI) in 2014 was negative, amounting to −514,684,002,483. However, in 2015, the value turned positive and experienced an increase to 1,978,484,129,235. Subsequently, in 2016, there was a decline, but still with a positive value, which was 922,333,214,645. In 2017, there was an increase again, reaching 1,142,095,810,347 with a positive value. Moreover, it increased again in 2018, with a positive value of 3,003,894,766,520. The average EVA value for the telecommunications industry in Indonesia listed on the BEI from 2014 to 2018 was positive, amounting to 1,306,424,783,653.

R.A. Masyiyan's and D. Isynuwardhana's research found that the results of the MVA calculation, the significance value of the MVA variable is 0,091 > 0,05 [6]. Judging from the five telecommunications companies listed on the Indonesia Stock Exchange from 2015–2020, all companies have positive MVA values, so telecommunications companies for the 2015–2020 period have succeeded in increasing company wealth. The purpose of this study is to analyze financial performance using the Economic Value Added (EVA), Market Value Added (MVA), Financial Value Added (FVA), and Refined Economic Value Added (REVA) methods in telecommunications sector companies listed on the Indonesia Stock Exchange.

LITERATURE REVIEW
This section provides some context on the concepts of theory behind multiple variables used in the present study. Such variables are composed of financial statements, economic value added, market value added, financial value added, and refined economic value added.

Financial Statements
Financial reports are reports that show the company's financial condition at this time or in a certain period, according to E.A. Osadchy et al. [7]. Financial statements present information about entities, which include: assets, liabilities, equity, income and expenses, including profits and losses, contributions from and distributions to owners in their capacity as owners and cash flows, as stated by R. Bergitta Sonia et al. [8]. According to C.E. Grigoraş-Ichim et al. a complete financial report usually includes a Statement of Financial Position, a Profit and Loss Report, a Statement of Changes in Equity, and a Statement of Cash Flows [9].

Financial reports aim to inform stakeholders about a company's financial status and performance during a specific period. According to Statement of Financial Accounting Standards (PSAK) No. 1 (2015: 3), these reports serve the purpose of offering information on the financial position, performance, and cash flows that are valuable to most users for making economic decisions. The financial performance, found in a company's financial statements, can be evaluated through analytical tools: S. Cantele, A. Zardini [10].

Economic Value Added (EVA)
EVA, distinct from accounting profit, estimates economic profit by subtracting the cost of capital from profits. This objective measure reflects compensation levels. EVA is calculated using the following formula:

$$EVA = NOPAT - (WACC \times IC),$$

where EVA — Economic Value Added; NOPAT — Net Operating Profit After Tax (After operating profit tax); WACC — Weighted Average Cost of Capital (Average cost of capital weighted average); IC — Invested Capital.

Market Value Added (MVA)
MVA is the difference between the total market value of the company's equity and the amount

of equity capital invested by investors, as stated by R. Bergitta Sonia, Z. A. Zahroh, D. F. Azizah [8]. Market Value Added is the difference between the company's market value and the invested capital. The following is the formula for MVA:

$$Market\,Value\,Added = Market\,Value - Invested\,Capital.$$

In this case, the measurements according to Rudianto as cited in D. L. Moezaque, A. Daito [11] are as follows:

MVA value > 0 or positive MVA shows management has succeeded in providing added value through growth.

MVA value < 0 or negative MVA shows management is unable to provide added value through the growth of the market capitalization value of the shares issued.

Financial Value Added (FVA)

FVA is a method for measuring company performance and added value. This method considers the contribution of fixed assets in generating the company's net profit, according to O. M. Olarewaju, T. S. Msomi [12]. Here's the FVA formula:

$$FVA = NOPAT - \left(ED - D\right),$$

where FVA — Financial Value Added; NOPAT — Net Operating Profit after Tax; ED — Equivalent Depreciation; D — Depreciation.

In principle, the condition (FVA value > 0 or positive FVA) shows that the company's management has succeeded in providing financial value added to the company. In the meantime, the condition (FVA value < 0 or negative FVA) shows that there is no process of adding financial value to the company. Subsequently, the condition (FVA value = 0 or breakeven point) shows that the management is not successful in providing added value or financial reduction.

Refined Economic Value Added (REVA)

Considering stock market prices and abnormal returns formed by the difference between stock returns and market returns, while EVA is based on share value M. Pinochi et al. [13]. The formula used to calculate Refined Economic Value Added (REVA) is as follows:

$$REVAt = NOPATt - \left(MVt - 1 \times KW\right),$$

where REVA t — Refined Economic Value Added in the t-period; NOPAT t — Net Operating Profit After Tax in the t-period; MV $t - 1$ — Market Value of the business entity in period $t - 1$ (Market Value of Equity); KW — the cost of capital is the cost of borrowing interest and fees equity and calculated on a weighted average basis (WACC).

Using the Refined Economic Value Added (REVA) method can be interpreted as follows:

If $REVA > 0$, this indicates that there has been a process of economic added value for the company;

If $REVA < 0$, this indicates that the company does not process economic added value or is unable to pay its obligations to funders;

If $REVA = 0$, this indicates that there is no process of economic added value or economic reduction.

Several prior studies have investigated variables such as financial statements, economic value added, market value added, financial value added, and refined economic value added individually. In terms of the variable of financial statements, N. Ding et al. sought to see the extent to which the teams of top management are interconnected to the comparability of financial statements [14]. The study on experienced foreign CEOs (FCEOs) found that their financial and accounting expertise, coupled with international work experience, enhances financial statement comparability. This correlation weakens with rising economic policy uncertainty, emphasizing the critical role of financial reporting in understanding the FCEOs' impact on financial statement comparability. Subsequently, G. Salijeni et al. executed a study on the growth of Big Data and Analytics (BDA) tools. They revealed that BDA reshapes interactions among audit firm departments and with clients [15].

In terms of the variable of economic value added, A. Kordalska and M. Olczyk conducted a study to determine the factors that influence the development of global value chains (GVCs) in a few chosen Central and Eastern European (CEE) countries, with a focus on functional specialization (FS) [16]. This study, based on World Input-Output Database data, revealed a

distinct value-added pattern in Central and Eastern European countries (CEE). Poland and Slovakia's GVC positions are unfavorable due to their emphasis on low value-added manufacturing. The study highlighted wage convergence and strong GVC backward linkages as drivers of increased value-added in various business activities. Subsequently, L. Yang executed a study on testing the impacts of various trade standards on China's value-added and total exports in global value chains by using a gravity model [17]. The study highlights China's export advantages through international norm alignment and emphasizes strict regulation enforcement. Mandatory criteria have a greater impact than voluntary ones, particularly on overall exports. Value-added exports are negatively affected by voluntary country-specific requirements, while there is no statistically significant impact of voluntary global harmonized standards on either export category.

In terms of the variable of market value added, K. Blind et al. analyzed the influence of formal standards on commerce in global value chains (GVCs) in Europe [18]. Using a panel data gravity model, they examined the impact of national, European, and global standards on European trade. National standards impede European value chains, while European and international standards facilitate trade. European standards mainly affect intra-European value chains, and international standards enhance imports into Europe from third countries, ensuring information parity in the European Single Market. The interaction of national and European standards in European value chains positively influences trade, emphasizing the importance of national standardization. Subsequently, C. Lutz and G. Tadesse conducted a study exploring the difficulties encountered by smallholder producer cooperatives from developing nations in their pursuit of entry into agricultural global value chains [19]. They examined how incorrect selection and insufficient dedication affect competitiveness in farmers' market groups. The study challenged the prevailing assumption that open membership is universally beneficial, asserting that it can be problematic for innovative farmer's market organizations.

In terms of the variable of financial value added, A. Mirza et al. conducted a study to investigate, from the vantage point of a developing nation that has adopted the full complement of IFRS, how the value relevance of financial reporting has changed [20]. Their study, using the Ohlson pricing model, assessed financial statement relevance in the Malaysian capital market. It underlined the importance of operating cash flow alongside profits and the book value of equity for investment decisions. The study revealed a disparity between management bias in reported profits and book value of equity from 2012 to 2006 and the financial reporting framework, emphasizing earnings in investment decisions. These findings have regulatory implications for improving financial reporting reliability. Subsequently, H. Kaibuchi et al. worked on improving Value-at-Risk (VaR) estimation for extreme loss return distributions in financial risk management. They introduced GARCH-UGH, a two-step bias-reduced method for dynamic extreme VaR estimation. GARCH-UGH outperformed traditional methods in in-sample and out-of-sample backtesting across various financial time series [21].

In terms of the variable of refined economic value added, L. V. Dewri's research explored the interplay between corporate governance (CG), financial performance (FP), and refined economic value added (REVA) in predicting firm value (FV) and return on stock (RoS) using GMM estimation. The study identified strong correlations between FV and RoS and CG, FP, and REVA [22]. Effective CG practices can significantly enhance FP, sustain positive economic value, and ultimately improve FV and Ro S. Firms demonstrating consistent FV growth can provide a healthy return on investment (RoI) to shareholders, motivating managers to prioritize robust CG and providing investor confidence in stable FP and ongoing REVA growth [23].

Previous studies above examined individual variables and were conducted in different countries. In contrast, the current study, specific to Indonesia, integrates multiple variables (financial statements, economic value added, market value added, financial value added, and refined economic value added) simultaneously.

METHODOLOGY

This type of research is descriptive analysis with a quantitative approach. The data sources used are

Sample Criteria

No.	Sample Selection Criteria	According to Criteria	Does Not Meet Criteria
1	Telecommunications Sector Companies Listed on the IDX	5	–
2	Companies that publish audited financial statements	4	–
3	Telecommunications Sector Companies Listed on the IDX Become Cellular Operators	4	–
4	Incomplete Telecommunications Sector Companies for Research	–	1
Number of Companies Used		4	
Total Data for 5 Years		20	

Source: Indonesian Stock Exchange, 2022.

secondary data, namely the percentage level of financial inclusion in each province of Indonesia obtained from the Financial Services Authority through the website www.ojk.go.id, and the percentage of poverty, unemployment, and GDP to measure economic growth by presenting data covering each province in Indonesia published by the Central Statistics Agency through the website www.bps.go.id. Data analysis and hypothesis testing in this study used the Partial Least Squares (PLS).

Object of Research

The object of this research is a telecommunications sub-sector service company that is registered as a public company (issuer) on the Indonesia Stock Exchange (IDX). Telecommunications sub-sector companies are one of the most important industries for supporting the internet network in a country.

Population and Population Sampling Procedure

The populations of this study are telecommunications companies listed on the Indonesia Stock Exchange. The method of determining the sample in this study is purposive sampling (intentional sampling). The sample is presented in *Table 1*.

Based on the criteria that have been determined using the purposive sampling method, the number of sample companies in this research object is 4, according to predetermined criteria. Hence, the samples used in this study were 20 samples with annual reports, as displayed in *Table 2*.

The data used in this research is secondary data obtained through the websitehttps://www.idx.co.id/, in the form of a Statement of Financial Position (Balance Sheet) and a Profit and Loss Report, especially for telecommunications companies listed on the Indonesian Stock Exchange.

Analysis Techniques

The technique for analyzing financial performance in this study is to use the Economic Value Added (EVA), Market Value Added (MVA), Financial Value Added (FVA), and Refined Economic Value Added (REVA) methods, namely:

1. Economic Value Added (EVA)

According to M. Dewi [23], the steps used in calculating EVA are as follows:

a. Net Operating Profit After Tax (NOPAT)

Net Operating Profit After Tax + Interest Expense.

Research Sample

No	Code	Company name	Sector
1	EXCL	PT XL Axiata Tbk	Telecommunication
2	FREN	PT Smartfren Telecom Tbk	Telecommunication
3	ISAT	PT Indosat Tbk	Telecommunication
4	TLKM	PT Telekomunikasi Indonesia Tbk	Telecommunication

Source: Indonesian Stock Exchange, 2022.

b. Invested Capital (IC)

$$Invested\,Capital = Total\,Debt\,and\,Equity - short\,term\,Debt$$

c. Debt Capital Level (D)

$$Debt\,Capital\,Level\,(D) = \frac{Total\,Debt}{Total\,Debt\,and\,Equity} \times 100\%$$

d. Cost of Debt (rd)

$$Cost\,of\,Debt = \frac{Interest\,Expense}{Total\,Debt} \times 100\%$$

e. Tax Rate / Tax (t)

$$Tax\,Rate\,(t) = \frac{Tax\,Expense}{Profit\,Before\,Tax} \times 100\%$$

f. Capital Level of Equity (E)

$$Capital\,Level\,of\,Equity = \frac{Total\,Equity}{Total\,Debt\,and\,Equity} \times 100\%$$

g. Cost of Equity (re)

$$Cost\,of\,Equity\,(re) = \frac{Earnings\,Per\,Share\,(EPS)}{Stock\,Price} \times 100\%$$

h. Weighted Average Cost of Capital (WACC)

$$WACC = \{(D \times rd\,(1-tax) + (E \times re)\}$$

i. Capital Charges (CC)

$$Capital\,Charges = Invested\,Capital \times WACC$$

j. Economic Value Added (EVA)

$$EVA = NOPAT - Capital\,Charge$$

According to F. Gómez-Bezares et al. [24], to assess the financial performance of a company, the EVA method can be grouped into 3 categories as follows:
1. If EVA > 0 or EVA is positive.

The company's financial performance can be said to be good because it can add business value. In this case, employees are entitled to bonuses, creditors still receive interest and shareholders

can get returns equal to or more than what was invested.

2. If EVA = 0.

Economically "break even" because all profits are used to pay obligations to funders, both creditors and shareholders, so that employees do not get bonuses, only salaries.

3. If EVA < 0 or EVA is negative.

The company's financial performance is said to be unhealthy because it cannot provide added value. In this case, employees cannot get bonuses, it's just that creditors still get interest and shareholders don't get returns commensurate with what they invested.

Market Value Added (MVA)

The steps used to calculate MVA, according to E.K. Zavadskas et al. [25] are as follows:

a. Market Value

$$Market Value = Stock Market Price \times Number of Shares$$

b. Invested Capital

$$Invested Capital = Nominal Value \times Number of Shares$$

c. Market Value Added (MVA)

$$Market Value Added = Market Value - Invested Capital$$

In this case, the measurements are as follows:

1. MVA value > 0 or positive MVA

It shows management has succeeded in providing added value through the growth in market capitalization value of shares issued or that the company is able to sell shares in the market at a premium price.

2. MVA value < 0 or negative MVA

It shows management is unable to provide added value through the growth of the market capitalization value of the shares issued or the stock price in the market below the book value (equity per share).

3. MVA value = 0

It shows that management has failed to provide added or reduced value through the growth of the market capitalization value of shares because the stock price in the market is the same as the book value (equity per share).

Financial Value Added (FVA)

According to Rodryguez, in A. Octaviani, A. Husaini [26], the steps used in the FVA calculation are as follows:

a. Net Operating Profit After Tax (NOPAT)
$$NOPAT = Net Profit After Tax + Interest Cost$$

b. Total Resources (TR)
$$TR = Long Term Debt(D) + Total Equity(E)$$

c. Equivalent Depreciation (ED)
$$ED = Weighted Average Cost of Capital(k) \times TR$$

d. Financial Value Added (FVA)
$$FVA = NOPAT - (ED - D)$$

The measurement results using the Financial Value Added (FVA) method, as suggested by A. Octaviani and A. Husaini [26] can be interpreted as follows:

4. FVA value > 0 or positive FVA

It shows that the company's management has succeeded in providing financial added value to the company or that there is more finance when the company's net profit is able to cover the Equivalent Depreciation (ED).

5. FVA value < 0 or negative FVA

It shows that there is no process of financial added value for the company or that the company's net profit and depreciation are unable to cover Equivalent Depreciation (ED).

6. FVA value = 0 or breakeven point

It shows that management has failed to provide added value or financial reductions because the company's net profit and depreciation have been used up to pay Equivalent Depreciation (ED).

Refined Economic Value Added (REVA)

The formula used to calculate Refined Economic Value Added (REVA), as suggested by A. Octaviani and A. Husaini [26] is as follows:

$$REVAt = NOPATt - (MVt - 1 \times Kw).$$

The measurement results using the Refined Economic Value Added (REVA) method can be interpreted as follows:

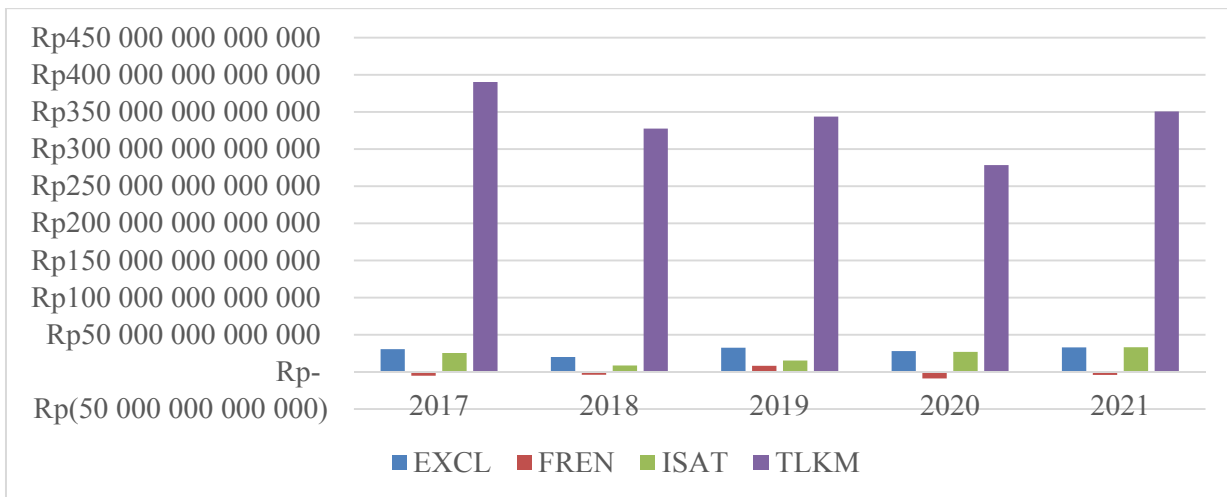1. If REVA > 0, this indicates that there has been a process of economic added value for the

Fig. 1. **Market Value Added (MVA) (in IDN)**
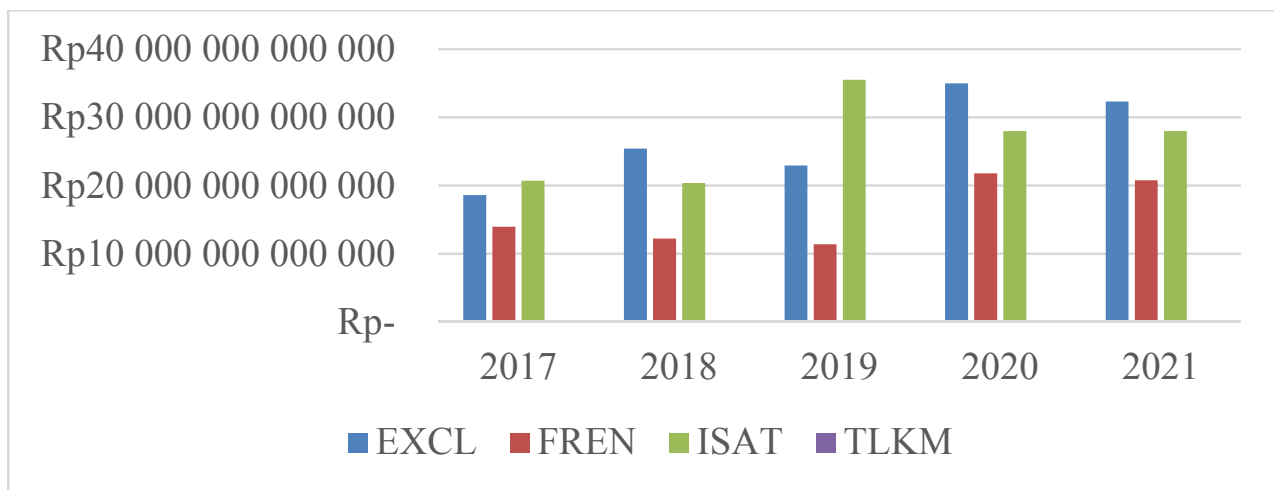*Source:* Indonesian Stock Exchange, 2022.

Fig. 2. **Financial Value Added (FVA) (In IDN)**
Source: Indonesian Stock Exchange, 2022.

company or that there is more economic value after the company has paid all obligations to the funders, both creditors and shareholders in the capital market.

2. If REVA < 0, this indicates that there is no economic added value process for the company or the company is unable to pay its obligations to the funders, both creditors and shareholders in the capital market.

3. If REVA = 0, this indicates that there is no process of economic added value or economic reduction because profits have been used up to pay obligations to funders, both creditors and shareholders in the capital market.

RESULT AND DISCUSSION

The telecommunications companies selected as samples in this study include:

1. **PT. XL Axiata Tbk (EXCL)**

PT. XL Axiata Tbk (formerly PT Excelcomindo Pratama Tbk) is a mobile telecommunications operator company in Indonesia.

2. **PT. Smartfren Telecom Tbk (FREN)**

PT Smartfren Telecom Tbk was established on 2 December 2002 under the name PT Mobile-8 Telecom based on Deed No. 11 dated 2 December 2002. PT Smartfren Telecom Tbk is one of the leading telecommunication service providers in Indonesia. Smartfren innovated by launching
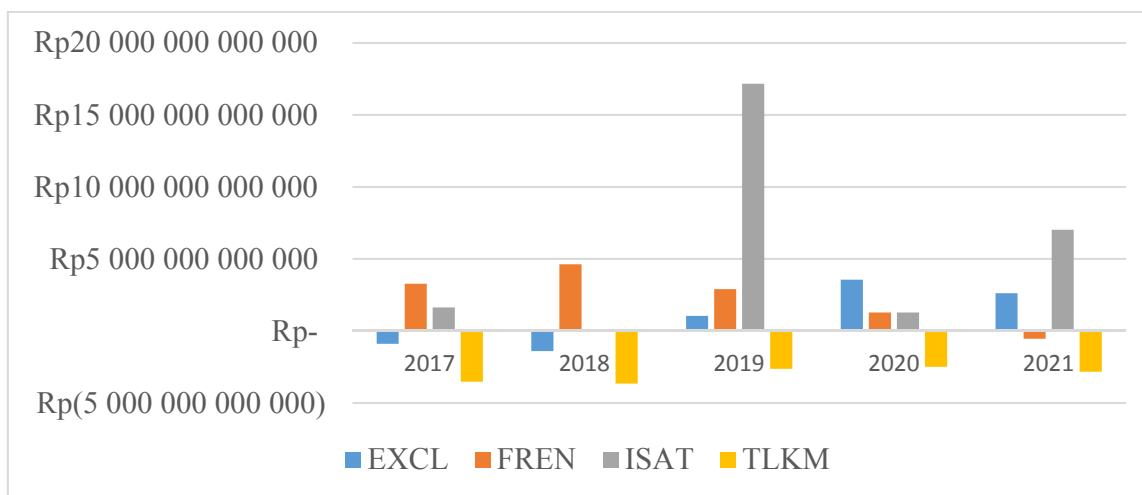
Fig. 3. **Refined Economic Value Added (REVA) (In IDN)**

Source: Indonesian Stock Exchange, 2022.

Table 3

Financial Value Added (FVA) (in IDN)

CODE	2017	2018	2019	2020	2021
EXCL	18,592,453,381,891	25,424,742,660,075	22,945,239,362,615	34,988,912,187,688	32,318,537,174,115
FREN	13,955,201,633,196	12,228,564,573,029	11,388,950,913,335	21,792,850,251,042	20,783,335,628,765
ISAT	20,708,077,341,973	20,357,786,244,802	35,503,950,196,509	27,980,072,436,540	31,369,050,027,658
TLKM	69,674,460,007	64,546,831,017	67,841,739,994	80,640,533,029	90,746,596,714

Source: Indonesian Stock Exchange, 2022.

Table 4

Refined Economic Value Added (REVA) (in Rupiah)

CODE	2017	2018	2019	2020	2021
EXCL	(898,193,420,745)	(1,403,485,350,769)	1,045,042,053,623	3,554,539,617,440	2,614,575,765,514
FREN	3,272,547,199,794	4,626,824,507,733	2,904,069,087,972	1,277,801,484,901	(540,220,425,394)
ISAT	1,627,683,127,606	121,188,267,780	17,164,876,477,116	1,282,952,284,288	7,020,433,499,586
TLKM	(3,519,427,059,425)	(3,656,834,714,811)	(2,631,501,427,737)	(2,488,592,893,509)	(2,837,361,088,982)

Source: Indonesian Stock Exchange, 2022.

the first commercial 4G LTE Advanced service in Indonesia in 2015.

3. **PT Indosat Tbk (ISAT)**

Established as a foreign capital company by the Indonesian government. Commenced commercial operations in September 1969 to build and operate the International Telecommunications Satellite Organization, or Intelsat, a ground station in Indonesia to access Intelsat's Indian Ocean Region satellites.

4. **PT Telekomunikasi Indonesia Tbk (TLKM)**

Telkom's majority shareholder is the Government of the Republic of Indonesia with 52.09%, while the remaining 47.91% is controlled by the public. Telkom shares are traded on the Indonesia Stock Exchange (IDX) with the code "TLKM" and the New York Stock Exchange (NYSE) with the code "TLK".

Economic Value Added (EVA) Calculation Results

The first step in determining EVA is finding net operating profit after tax (NOPAT). NOPAT is a measure of profit that does not include the tax costs and benefits of debt financing. It can be concluded that NOPAT is income before interest and tax (EBIT) adjusted for tax impact. The results of NOPAT can be seen in *Fig. 1* demonstrating the market value added (MVA).

The results of Market Value Added (MVA) research are in line with R.A. Masyiyan and D. Isynuwardhana's study, which determines that the MVA value in each company still has negative and positive values [6].

Financial Value Added (FVA) Calculation Results

The first step to determining FVA is finding net operating profit after tax. Net Operating Profit After Tax (NOPAT) is a measure of profit that does not include the tax costs and benefits of debt financing. It can be concluded that NOPAT is income before interest and tax (EBIT) adjusted for tax impact. The results of the FVA calculation are presented in *Table 3* and *Fig. 2*.

The results of Financial Value Added (FVA) research are in line with a study conducted by A.E. Bayraktaroglu et al. which found that the FVA value in each company still has negative and positive values [27]. In companies that produce a positive FVA value, it means that the company's management has been able to create added financial value for the company or the company's net profit and depreciation are able to cover Equivalent Depreciation.

Refined Calculation Results Economic Value Added (REVA)

The first step to determining REVA is finding net operating profit after tax (NOPAT). The results of REVA can be viewed in *Table 4* and *Fig. 3*.

The results of Refined Economic Value Added (REVA) research are in line with those of S. Geng et al., who determined that the REVA value in each company still has negative and positive values [28]. In companies that generate a positive REVA value, it means that there has been a process of economic added value for the company and more economic value after the company has paid all obligations to creditors, bank funders, and shareholders in the capital market.

CONCLUSION

The company's financial performance as measured by the Market Value Added (MVA) approach is profitable for PT XL Axiata Tbk, PT Indosat Tbk, and PT Telekomunikasi Indonesia Tbk. PT Smartfren Telecom Tbk has a negative market value added (MVA). A positive MVA indicates that business management has succeeded in generating added value. The company's financial performance uses the Financial Value Added (FVA) method for the 2017–2021 period, which has a positive value at PT XL Axiata Tbk, PT Smartfren Telecom Tbk, PT Indosat Tbk and PT Telekomunikasi Indonesia Tbk. A positive FVA means that the company's management has been able to create added financial value for the company or that the company's net profit and depreciation have been able to cover equivalent depreciation. The company's financial performance uses the Refined Economic Value Added (REVA) method, which has a positive value at PT Indosat Tbk. Refined Economic Value Added (REVA) has a negative value at PT XL Axiata Tbk, PT Smartfren Telecom Tbk and PT Telekomunikasi Indonesia Tbk. REVA, which has a positive value, has resulted in a process of economic added value for the company and more economic value after the company has paid all obligations to the funders, both creditors and shareholders.

REFERENCES

1. Horton A. Financialization and non-disposable women: Real estate, debt and labour in UK care homes. *Environment and Planning A: Economy and Space*. 2022;54(1):144–159. DOI: 10.1177/0308518X19862580

2. Kieso D. E., Weygandt J. J., Warfield T. D. Intermediate accounting. Vol. 2. Hoboken, NJ: John Wiley & Sons, Inc.; 2019. 800 p.

3. Rahadjeng E. R. Analisis Perbandingan Kinerja Perusahaan Otomotif dan Komponen Yang Tercatat Di Bursa Efek Indonesia Dengan Menggunakan EVA, REVA, FVA, Dan MVA. *Benefit: Jurnal Manajemen dan Bisnis*. 2019;4(1):102–110. DOI: 10.23917/benefit.v4i1.7789

4. Yoshino N., Taghizadeh-Hesary F. Optimal credit guarantee ratio for small and medium-sized enterprises' financing: Evidence from Asia. *Economic Analysis and Policy*. 2019;62:342–356. DOI: 10.1016/j.eap.2018.09.011

5. Choi J., Menon A., Tabakovic H. Using machine learning to revisit the diversification — performance relationship. *Strategic Management Journal*. 2021;42(9):1632–1661. DOI: 10.1002/smj.3317

6. Masyiyan R. A., Isynuwardhana D. Analysis of financial performance with economic value added (EVA) method, market value added (MVA), and financial value added (FVA). *JASa: Jurnal Akuntansi, Audit dan Sistem Informasi Akuntansi*. 2020;4(1):116–125. DOI: 10.36555/jasa.v4i1.882

7. Osadchy E. A., Akhmetshin E. M., Amirova E. F., Bochkareva T. N., Gazizyanova Y., Yumashev A. V. Financial statements of a company as an information base for decision-making in a transforming economy. *European Research Studies Journal*. 2018;21(2):339–350. DOI: 10.35808/ersj/1006

8. Bergitta Sonia R., Zahroh Z. A., Azizah D. F. Analisis Pengaruh Economic Value Added (Eva), Market Value Added (Mva), Dan Return on Investment (Roi) Terhadap Harga Saham (Studi Pada Perusahaan Property Dan Real Estate Yang Terdaftar Di Bursa Efek Indonesia Periode 2009–2012). *Jurnal Administrasi Bisnis (JAB)*. 2014;9(1):1–10. URL: https://media.neliti.com/media/publications/81106-ID-analisis-pengaruh-economic-value-added-e.pdf

9. Grigoraş-Ichim C. E., Cosmulese C. G., Savchuk D., Zhavoronok A. Shaping the perception and vision of economic operators from the Romania-Ukraine-Moldova border area on interim financial reporting. *Economic Annals-XXI*. 2018;173(9–10):60–67. DOI: 10.21003/ea.V173–10

10. Cantele S., Zardini A. Is sustainability a competitive advantage for small businesses? An empirical analysis of possible mediators in the sustainability — financial performance relationship. *Journal of Cleaner Production*. 2018;182:166–176. DOI: 10.1016/j.jclepro.2018.02.016

11. Moezaque D. L., Daito A. Enterprise risk management disclosure as an intervening variable in the effect of good corporate governance implementation and firm size on financial performance (study on banking companies listed on the Indonesia stock exchange for the period 2013–2018. *Dinasti International Journal of Economics, Finance & Accounting*. 2020;1(5):832–839. DOI: 10.38035/dijefa.v1i5.619

12. Olarewaju O. M., Msomi T. S. Intellectual capital and financial performance of South African development community's general insurance companies. *Heliyon*. 2021;7(4): e06712. DOI: 10.1016/j.heliyon.2021.e06712

13. Pinochi M., Fais F., Corsiglia M. Residual income model and abnormal returns: A comparison to factor styles and sell-side analysts. *Business Valuation OIV Journal*. 2019. DOI: 10.2139/ssrn.3478213

14. Ding N., Ullah I., Jebran K. Foreign experienced CEOs' and financial statement comparability. *Emerging Markets Finance and Trade*. 2022;58(13):3751–3769. DOI: 10.1080/1540496X.2022.2073814

15. Salijeni G., Samsonova-Taddei A., Turley S. Understanding how Big Data technologies reconfigure the nature and organization of financial statement audits: A sociomaterial analysis. *European Accounting Review*. 2021;30(3):531–555. DOI: 10.1080/09638180.2021.1882320

16. Kordalska A., Olczyk M. Upgrading low value-added activities in global value chains: A functional specialisation approach. *Economic Systems Research*. 2023;35(2):265–291. DOI: 10.1080/09535314.2022.2047011

17. Yang L. Fields of harmony: Trade standards and China's value-added exports in global value chains. *Economic Research — Ekonomska Istraživanja*. 2023;36(2):2140304. DOI: 10.1080/1331677X.2022.2140304

18. Blind K., Mangelsdorf A., Niebel C., Ramel F. Standards in the global value chains of the European Single Market. *Review of International Political Economy*. 2018;25(1):28–48. DOI: 10.1080/09692290.2017.1402804

19. Lutz C., Tadesse G. African farmers' market organizations and global value chains: Competitiveness versus inclusiveness. *Review of Social Economy*. 2017;75(3):318–338. DOI: 10.1080/00346764.2017.1300317

20. Mirza A., Malek M., Abdul-Hamid M.A. Value relevance of financial reporting: Evidence from Malaysia. *Cogent Economics & Finance*. 2019;7(1):1651623. DOI: 10.1080/23322039.2019.1651623

21. Kaibuchi H., Kawasaki Y., Stupfler G. GARCH-UGH: A bias-reduced approach for dynamic extreme Value-at-Risk estimation in financial time series. *Quantitative Finance*. 2022;22(7):1277–1294. DOI: 10.1080/14697688.2022.2048061

22. Dewri L.V. A critical assessment of interrelationship among corporate governance, financial performance, refined economic value added to measure firm value and return on stock. *Journal of the Knowledge Economy*. 2022;13(4):2718–2759. DOI: 10.1007/s13132–021–00808–8

23. Dewi M. Penilaian kinerja keuangan perusahaan dengan menggunakan metode EVA (economic value added) (studi kasus pada PT. Krakatau Steel Tbk Periode 2012–2016). *Jurnal Manajemen dan Keuangan*. 2017;6(1):648–659. URL: https://media.neliti.com/media/publications/196995-none-af210408.pdf

24. Gómez-Bezares F., Przychodzen W., Przychodzen J. Bridging the gap: How sustainable development can help companies create shareholder value and improve financial performance. *Business Ethics: A European Review*. 2017;26(1):1–17. DOI: 10.1111/beer.12135

25. Zavadskas E.K., Bausys R., Kaklauskas A., Ubarte I, Kuzminske A., Gudiene N. Sustainable market valuation of buildings by the single-valued neutrosophic MAMVA method. *Applied Soft Computing*. 2017;57:74–87. DOI: 10.1016/j.asoc.2017.03.040

26. Octaviani A., Husaini A. Penilaian Kinerja Keuangan Perusahaan dengan Menggunakan Metode Market Value Added (Mva) dan Financial Value Added (Fva) (Studi pada PT Sumber Alfaria Trijaya Tbk Periode Tahun 2014–2016). *Jurnal Administrasi Bisnis (JAB)*. 2017;52(1):198–205. URL: https://media.neliti.com/media/publications/202073-penilaian-kinerja-keuangan-perusahaan-de.pdf

27. Bayraktaroglu A.E., Calisir F., Baskak M. Intellectual capital and firm performance: An extended VAIC model. *Journal of Intellectual Capital*. 2019;20(3):406–425. DOI: 10.1108/JIC-12–2017–0184

28. Geng S., Liu S., Liao X. Operating performance of tourism listed companies in China: The perspective of economic value added. *SAGE Open*. 2021;11(1). DOI: 10.1177/2158244020981064

ABOUT THE AUTHOR

Muhammad Istan — PhD, Vice Rector 1, Lecturer of Economic Studies, Institut Agama Islam Negeri Curup, Curup, Bengkulu, Indonesia
https://orcid.org/0000-0003-2479-3802
muhammadistan@iaincurup.ac.id

Conflicts of Interest Statement: The author has no conflicts of interest to declare.

The article was submitted on 15.01.2023; revised on 28.03.2023 and accepted for publication on 26.04.2023.
The author read and approved the final version of the manuscript.