

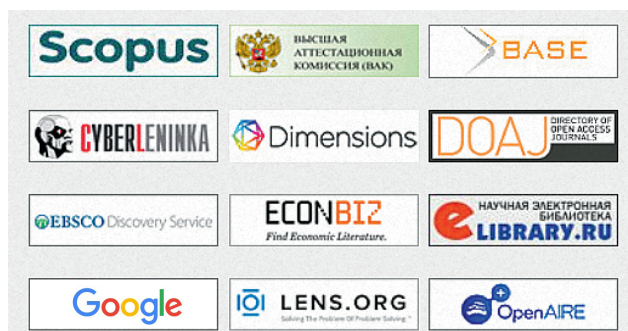
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Analysis of Innovation Activities of SMEs Participating in State Financial Support Programs

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ABSTRACT

The **purpose** of this study is to develop and test an Integrated Innovation Activity Indicator (IIAI) for small and medium-sized enterprises (SMEs), designed to assess their contribution to ensuring the technological sovereignty in the Russian Federation, taking into account participation in state innovation support programs. The paper justifies the need to move away from fragmented assessments of innovative development towards comprehensive models that take into account the combined influence of factors determining the ability of businesses to create and implement critical technologies. The **methodological framework** of the study is based on the approaches of the World Intellectual Property Organization (WIPO) and the Organization for Economic Co-operation and Development (OECD). The proposed IIAI is a composite index that integrates four key factors: the extent of SME participation in government support programs, the level of financial provision for projects, the focus on priority technological sectors, and human capital. The practical significance of the study lies in its potential to use the IIAI by government authorities, development institutions, and the expert community to improve innovation support instruments and enhance the contribution of SMEs to achieving technological sovereignty and sustainable economic growth. **Keywords:** analysis; small and medium-sized enterprises; innovation activity; technological sovereignty; government support; integrated indicator; multiplicative model

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INTRODUCTION

The development of small and medium-sized businesses (hereinafter referred to as SMEs) is a crucial prerequisite for creating a sustainable and competitive economy [1]. It is particularly important to provide financial support for innovative SMEs that have the ability to generate and implement high-tech solutions, which not only ensure commercial success but also contribute to the technological independence of the country [2]. The implementation of such financial support for SMEs is possible in various forms, including through partnership financing and tax incentives for its innovative activity [3–5].

In accordance with the Decree of the President of the Russian Federation dated July 21, 2020 No. 474, “On the National Development Goals of the Russian Federation for the period until 2030”, ensuring technological independence is identified as one of the priorities of government policy. To achieve this goal, direct government support for specific SMEs plays a significant role, including through the national project “Small and Medium-sized Enterprises and Support for Individual Entrepreneurial Initiative”.¹ It uses various mechanisms to encourage innovation activity: subsidies, grants, guarantees, and repayment instruments. One form of government support for innovation is the grant support provided by the Foundation for the Promotion of Innovation (FPI).² The participation of small and medium-sized enterprises (SMEs) in FPI programs can be seen as a key indicator of their innovation activities, reflecting their willingness to undergo technological transformation and their ability to integrate into the national innovation system.

The purpose of this research is to develop a method for analyzing the innovative activities of SMEs (small and medium-sized enterprises) within the context of government programs providing financial support for innovative projects

aimed at addressing the challenges of ensuring technological sovereignty in the country. In this study, innovation activity is understood as an integral indicator that reflects the involvement of small and medium businesses in grant schemes and considers factors contributing to the development of the country’s technological independence. To achieve this goal, it is proposed to address the following objectives:

1. To develop a methodological approach for assessing the innovation activities of SMEs as part of government financial support programs.
2. To calculate specific quantitative and qualitative indicators of SME innovation activities participating in grant programs using the example of regions within the Siberian Federal District.
3. To develop an integral coefficient of innovation activity for SMEs (ICIA) as a tool for assessing their contribution to the implementation of state innovation policies.
4. To identify areas for improvement in the mechanisms of government support for SME innovation activities in order to increase their role in ensuring the country’s technological sovereignty.

MATERIALS AND RESEARCH METHODS

The initial data for the analysis was obtained from official sources from the Unified Register of Small and Medium-Sized Enterprises,³ the Unified Register of Recipients of State Support for SMEs,⁴ data from the unified portal of the budget system of the Russian Federation. Additionally, information about support programs, participants, and projects was sourced from the FPI website.⁵ The calculations are based on data from regions that are part of the Siberian Federal District. These sources allow us to assess the participation of small and medium-sized

¹ Decree of the President of the Russian Federation dated 21.07.2020 No. 474 “On the National Development Goals of the Russian Federation for the period up to 2030”. Collection of Legislation of the Russian Federation. 2020. No. 30, Article 4884.

² Foundation for the Promotion of Innovation. The Contests section. URL: <https://fasie.ru/competitions> (accessed on 15.03.2025).

³ The Unified Register of small and medium-sized businesses. URL: <https://ofd.nalog.ru/index.html> (accessed on 22.05.2025).

⁴ The unified register of small and medium-sized businesses — recipients of support. URL: <https://rmsp-pp.nalog.ru/statistics.html#statdate=15.05.2025> (accessed on 22.05.2025).

⁵ The unified portal of the budget system of the Russian Federation. URL: <https://budget.gov.ru/Бюджет> (accessed on 23.06.2025). Foundation for the Promotion of Innovation. The section “Contest results”. URL: <https://fasie.ru/competitions/> (accessed on 15.03.2025).

enterprises (SMEs) in grant programs for innovation and correlate it with the goals of ensuring the country's technological sovereignty. The methodological basis of the study combines the tools of national financial monitoring and international approaches (WIPO,⁶ OECD⁷), which allows for a comprehensive assessment of the innovation activity of SMEs. Special attention is paid to the factors that determine the ability of small and medium-sized businesses to contribute to the achievement of the goals of technological independence outlined in the Concept of Technological Development of the Russian Federation (Decree of the Government of the Russian Federation dated May 20, 2023 No. 1315-p).⁸

Among the factors that need to be considered are the following:

- The scale of enterprises' participation in government support programs, which allows us to assess their readiness to integrate into technological development processes.
- Financial support for projects, measured by the amount of grants provided and their proportion to average values, reflects the level of financial support for innovative activity.
- The sectoral focus of support, which allows us to assess how government programs prioritize sectors of the economy important for technological sovereignty, such as IT, biotechnology, pharmaceuticals, new materials, and mechanical engineering.
- Human resources, or the level of involvement of labor in innovative activities by SMEs, including the availability of qualified specialists who can develop and implement advanced technologies.

⁶ Cornell University, INSEAD, World Intellectual Property Organization. Global Innovation Index 2023: Innovation in the Face of Uncertainty. Geneva: WIPO; 2023. 368 p. URL: <https://www.wipo.int/publications/en/series/index.jsp?id=129> (accessed on 15.05.2025).

⁷ OECD, Eurostat. Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data. URL: <https://ec.europa.eu/eurostat/documents/3859598/5889925/OSLO-EN.PDF> (accessed on 15.05.2025).

⁸ Decree of the Government of the Russian Federation dated May 20, 2023 No. 1315-r "Concept of technological development for the period up to 2030". URL: <https://rospatent.gov.ru/content/uploadfiles/technological-2023.pdf> (accessed on 15.05.2025).

The analysis of the needs of stakeholders in the development of state financial support programs for small and medium-sized enterprises (SMEs) highlights the importance of encouraging their innovation activities [6, 7]. At the same time, recent research supports the need for developing comprehensive tools to assess the activity of SMEs, using both quantitative and qualitative indicators [8, 9]. The scientific literature suggests that differences in the level of activity of small and medium-sized enterprises (SMEs) are related not only to the amount of financing provided, but also to the institutional conditions that allow them to participate in government support programs [10, 11]. Also, it is emphasized the importance of transition to combined financing models that include both grant and subsidy mechanisms as well as repayment instruments such as concessional loans and guarantees. This transition should take into account the role of business co-financing [12–17]. New organizational support formats, such as clusters, accelerators, and technology hubs, are becoming increasingly relevant [18, 19]. Special attention is given to the development of the scientific and educational environment and digital infrastructure, which directly affects the ability of SMEs to participate in innovative projects [20–23]. There is a direct correlation between the level of innovation activity and the development of the scientific environment and digital infrastructure [22, 23]. It has been proven that the successful realization of innovation activity is only possible on the basis of an organization's innovation potential. This potential refers to the ability of the organization to initiate, organize, and effectively implement innovative products using appropriate intellectual, human, infrastructural, technical, informational, and financial resources [24].

The analysis of research materials and methods reveals that, despite significant advancements in the field of evaluating the innovation potential and efficacy of government support measures, the issue of comprehensively analyzing the innovation activities of small and medium-sized enterprises (SMEs) through their participation in financial assistance programs aimed at achieving technological sovereignty re-

Table 1

Analysis of SME Innovation Activity in the SFD by the Scale of Participation in State Support Programs

Subjects of the SFD	Total quantity of SMEs, units	The share of SMEs in the region	Support Recipients, units	The share of SMEs – Support Recipients	CIA _{quantity}
The Tomsk region	16 861	7.04%	137	22.20%	3.15
The Novosibirsk region	65 247	27.26%	204	33.06%	1.21
The Kemerovo region	23 656	9.88%	61	9.89%	1.00
The Krasnoyarsk region	42 130	17.60%	90	14.59%	0.83
The Altai territory	28 014	11.70%	49	7.94%	0.68
The Irkutsk region	31 529	13.17%	49	7.94%	0.60
The Omsk region	23 016	9.61%	26	4.21%	0.44
The Republic of Khakassia	4 789	2.00%	1	0.16%	0.08
The Republic of Altai	2 557	1.07%	0	0.00%	0.00
The Republic of Tyva	1 589	0.66%	0	0.00%	0.00
The overall result	239 388	100,00%	617	100,00%	0,799

Source: Author's calculations.

mains understudied. Modern research typically focuses either on specific aspects, such as funding amounts, institutional barriers, or human resources, or on regional particularities. However, a holistic, methodological approach is needed to integrate quantitative and qualitative factors, considering the innovative activities of SMEs as a crucial element in achieving strategic objectives for the country.

THE RESULTS OF THE STUDY

Analysis of Innovation Activity

by the Number of SMEs Receiving Support

One of the key factors determining the contribution of SMEs to ensuring the technological sovereignty of a country is the scale of enterprises' participation in government financial support programs. This indicator allows us to assess the

degree of integration of SMEs into the processes of technological development and their willingness to be involved in the implementation of national priorities. To quantify this, we apply an approach based on the OECD methodology, where the indicator of innovation activity is the share of enterprises participating in support programs. Within the study, we calculated the coefficient of innovation activity based on the scale of participation, reflecting the ratio between the share of SMEs receiving state support and the share of SMEs in the region in the total number of enterprises in the federal district CIA_{quantity} [25]. This indicator demonstrates the relative level of SME involvement in government-led innovation promotion mechanisms, and provides valuable insights into the effectiveness of these initiatives in promoting SME growth and technologi-

cal advancement. The results of the analysis are presented in *Table 1*.

The results of the analysis in *Table 1* demonstrate significant inter-regional differences. The highest $CIA_{quantity}$ value was recorded in the Tomsk region (3.15), which indicates a high probability of receiving grants. More than 22% of the winners were registered here, while the share of SMEs in the region was only 7.04%. This reflects the active integration of the region's enterprises into innovative development and their potential as a support center for technological transformations. The Novosibirsk region ($CIA_{quantity}$ 1.21) also shows a positive deviation from the average, reflecting the maturity of the innovation infrastructure. The Kemerovo region (1.00) has a balanced participation, corresponding to the share of SMEs. The Krasnoyarsk territory (0.83) shows average results. The Irkutsk (0.60) and Omsk (0.44) regions have lower coefficient values, reflecting the limited participation of SMEs in government support programs. Of particular concern are the Republics of Khakassia, Altai and Tyva (0.08–0.00), where the participation of SMEs in support programs is practically non-existent.

Thus, the interpretation of the data indicates the need for additional analysis of the institutional conditions and innovation activity of enterprises in regions with low coefficient values to identify the causes of such differences.

$CIA_{quantity}$ records the relative representation of SMEs in government financial support programs and thus reflects the degree of their integration into technological development processes. Its values correspond to the risks of low adaptability of the economy and insufficient integration of businesses into technological transformations. High values indicate established access channels and the willingness of enterprises to technological changes. Low values indicate areas of potential risk and require additional analysis of the causes, without making direct conclusions about the nature of restrictions.

Analysis of Innovation Activity by Volume of Financing

Achieving Russia's technological sovereignty is impossible without a radical change in the business environment for technological inno-

vation. Small and medium-sized businesses are crucial, and their inclusion in government support programs is essential, along with the depth of financial support provided for their projects. A sufficient level of financial support allows companies to move from the stage of scientific and technical development to industrial implementation, forming the basis for profit growth and business capitalization.

In this regard, grant support can be a tool to motivate companies to participate in innovative projects and help compensate for the high level of risk associated with high-tech development. It is essential that financial mechanisms be accompanied by conditions that encourage businesses to actively engage in critical and end-to-end technologies, which determine the competitiveness and independence of the national economy.

To assess the scale of financial support for innovation activity, the study used the coefficient of innovation activity in terms of financing ($CIA_{finance}$). The proposed analytical indicator reflects the relative amount of funding received per winner compared to the average for the federal district [25]. The results of the analysis are presented in *Table 2*.

From *Table 2*, it can be seen that the average grant amount in the district was 8.95 million rubles. Only four regions had $CIA_{finance}$ values above 100%, with the maximum level recorded in the Republic of Khakassia at 212%. However, this is due to a single grant of 19 million rubles, which does not create a sustainable innovation effect.

The Altai territory (138%) and Tomsk region (122%) were allocated with significant amounts of funding, as well as a relatively large number of recipients. This indicates a more active use of grant support tools in these regions. The Kemerovo region (117%) also entered the group of subjects with an average grant amount exceeding the average value.

The Novosibirsk region and the Krasnoyarsk territory (89% each), are slightly below the average level. This may indicate the implementation of less capital-intensive projects with relatively wide coverage. The Omsk and Irkutsk regions showed the lowest values for this indicator,

Table 2

**Analysis of the Innovation Activity of Recipients of Grant Support from the FMS
in the SFD by Funding Criterion**

Subjects of the SFD	Total amount of financing, RUB	Grant Support Recipients, units	The average amount of the grant per 1 recipient, RUB	CIA _{fund} , %
The Republic of Khakassia	19 000 000	1	19 000 000	212
The Altai territory	604 100 000	49	12 328 571	138
The Tomsk region	1 492 165 171	137	10 891 717	122
The Kemerovo region	638 753 156	61	10 471 363	117
The Novosibirsk region	1 628 424 510	204	7 982 473	89
The Krasnoyarsk region	716 508 829	90	7 961 209	89
The Omsk region	158 300 000	26	6 088 462	68
The Irkutsk region	262 090 600	49	5 348 788	60
The overall result	5 519 342 266	617	8 945 449	X

Source: Author's calculations.

which, when combined with a low number of recipients, suggests limited resource provision for projects and presents a risk of reducing the innovation potential of SMEs in these regions.

Thus, CIA_{finance} reflects the depth of resource support for innovative SME projects and correlates with the threat of lagging behind in critical technologies due to insufficient funding and problems with their industrial implementation. High values demonstrate the willingness to implement capital-intensive projects, while low values indicate the risks of reducing innovation potential.

**Analysis of SME Innovation Activity
by Industry-Specific Support (OKVED)**

One of the most significant factors in achieving the country's technological sovereignty is the concentration of resources in priority areas of development, such as information technology, biotechnology, pharmaceuticals, new materials, and mechanical engineering, among others. Therefore, it is crucial to consider the sectoral focus of support when assessing the innovative

activity of small and medium-sized enterprises (SMEs) in the programs of the Foundation for the Promotion of Innovation (FPI).

To analyze this, we compared the shares of enterprises by type of economic activity (OKVED) with the shares of recipients of state support within the same industries. This allowed us to gain a better understanding of the distribution of support and identify areas where more attention is needed. This approach makes it possible to assess how the grant allocation correlates with the priorities of technological development. Unlike traditional industries (for example, trade and construction), which have a significant share in the structure of SMEs, but are practically not represented among the recipients of support, government programs demonstrate a pronounced selective nature, focusing mainly on enterprises operating in knowledge-intensive and critical sectors. In order to eliminate distortions associated with the high concentration of enterprises in "traditional" sectors, the subsequent analysis used the region's industry coefficient of innovation activity (CIA_{okved}), calculated

Table 3

Analysis of SME Innovation Activity by OKVED Criterion

Subjects of the SFD	Total quantity of SMEs under OKVED, units	The share of SMEs in the region under OKVED, %	Grant Support Recipients, units	The share of SMEs – Support Recipients, %	CIA _{okved} , %
The Tomsk region	10 398	7.45	137	22.20	298.24
The Novosibirsk region	40 007	28.65	204	33.06	115.42
The Kemerovo region	13 353	9.56	61	9.89	103.40
The Krasnoyarsk region	23 825	17.06	90	14.59	85.51
The Altai territory	16 808	12.03	49	7.94	65.99
The Irkutsk region	17 767	12.72	49	7.94	62.43
The Omsk region	13 339	9.55	26	4.21	44.12
The Republic of Khakassia	2 463	1.76	1	0.16	9.19
The Republic of Altai	1 091	0.78		0.00	0.00
The Republic of Tyva	610	0.44		0.00	0.00
The overall result	139 661	100.00	617	100.00	X

Source: Author's calculations.

by analogy with the CIA_{quantity} coefficient, but in relation to the totality of economic activities:

$$CIA_{okved} = \frac{\text{The share of OKVED SMEs in recipients of grant support}}{\text{The share of SMEs' OKVED in the region}}$$

For a correct assessment, the industry orientation coefficient (CIA_{okved}) is used, which reflects the ratio between the share of recipient enterprises in a particular industry and the share of SMEs in this industry in the region's economy. A value above 100% indicates the industry's priority in government support mechanisms, while a value below 100% indicates the underutilization of its innovation potential. The results of the analysis are presented in *Table 3*.

The results of the analysis of *Table 3* show that the absolute leader in terms of industry activity

is the Tomsk region (CIA_{okved} – 298.24%), where the high level of SME participation in grant programs reflects a developed scientific and educational base and the concentration of resources in knowledge-intensive industries. The Novosibirsk region (115.42%) also exceeds the average regional level, which confirms its status as a major innovation center. The Kemerovo region (103.40%) demonstrates a balance that corresponds to the structure of its economy. The Krasnoyarsk territory (85.51%), The Altai territory (65.99%), The Irkutsk (62.43%) and Omsk (44.12%) regions have lower values, which indicate an insufficient orientation of enterprises to priority sectors. The least active are the Republics of Khakassia (9.19%), Altai and Tyva (0%), where there is practically no participation of SMEs in areas critical to technological sovereignty. High values of the indicator are recorded where the innovative ac-

tivity of SMEs is based on a developed scientific, educational and industrial base, while low values indicate a weak focus on critically important areas. Thus, the sectoral structure of participation in support programs is an indicator of how the policy of stimulating innovation meets the objectives of a country's technological sovereignty.

ANALYSIS OF THE INNOVATION ACTIVITY OF SMES BY THE AVERAGE NUMBER OF EMPLOYEES

Achieving technological sovereignty is impossible without the effective use of human resources. Qualified specialists are essential for the development and implementation of advanced technologies. Therefore, it is important to consider the degree of involvement of labor resources in innovative projects when assessing the performance of small and medium-sized enterprises (SMEs).

The coefficient of innovation activity based on the average number of employees (ANE) can be

used to measure this involvement. This coefficient reflects the ratio of employees in recipient enterprises to the total number of employees in SMEs in a given region.

$$CIA_{ane} = \frac{\text{The share of ANE of SMEs regional grant support recipients}}{\text{The share of ANE of SMEs in a region}}$$

CIA_{ANE} allows us to determine how much human capital is involved in innovation processes through the mechanisms of grant support of the FPI. The high values of the indicator indicate that government support is concentrated in enterprises with developed human resources capable of generating technological developments and bringing them to the stage of industrial implementation. Low values reflect the weak use of labor resources in the innovation sector and create the risk of a shortage of competencies necessary to ensure technological sovereignty.

The results of the analysis are presented in Table 4.

Table 4

Analysis of SME Innovation Activity by Human Capital (ANE)

Subjects of the SFD	ANE of SMEs total	The share of ANE of SMEs in the region, %	ANE of SMEs – Support Recipients	The share of ANE of SMEs – Grant Support Recipients, %	CIA_{ane} , %
The Tomsk region	83822	6.78	2080	24.38	359.57
The Kemerovo region	144 877	11.72	1140	13.36	114.02
The Novosibirsk region	328 533	26.57	2560	30.00	112.91
The Altai territory	153 959	12.45	1027	12.04	96.66
The Krasnoyarsk region	204 249	16.52	1173	13.75	83.22
The Irkutsk region	159 216	12.88	350	4.10	31.85
The Omsk region	120 446	9.74	179	2.10	21.53
The Republic of Khakassia	22 670	1.83	23	0.27	14.70
The Republic of Altai	12 795	1.03		0.00	0.00
The Republic of Tyva	5 750	0.47		0.00	0.00
The overall result	1 236 317	100.00	8532	100.00	X

Source: Author's calculations.

The results of the analysis of *Table 4* demonstrate that the Tomsk region (359.57%) is significantly ahead of other regions: a significant number of SME personnel is combined with a high proportion of recipient enterprises, reflecting the presence of a stable innovation ecosystem and a developed knowledge base. The Novosibirsk (112.91%) and Kemerovo (114.02%) regions also show positive results confirming the maturity of their human resources infrastructure in the field of R&D. At the same time, the Omsk (21.53%), Irkutsk (31.85%) regions and the Republic of Khakassia (14.70%) have low values of the indicator, which indicates a weak integration of labor resources into innovative projects. In the Republics of Altai and Tyva, there is a lack of a dedicated SME workforce in government support programs. Thus, the human resource potential of small and medium-sized enterprises (SMEs) is a key indicator of their ability to engage in technological transformation and contribute to achieving the strategic goal of ensuring technological sovereignty in the country. Considering this factor in the system of innovation activity indicators allows us to identify not only the scale of enterprise participation, but also the quality of their resource base. This makes this factor crucial for the development of targeted government support measures.

Analysis of the Innovative Activity of SMEs by an Integral Indicator

In order to ensure technological sovereignty, it is crucial to consider the totality of factors that determine the ability of small and medium-sized enterprises (SMEs) to create and implement critical technologies, rather than evaluating individual aspects of their participation in innovation programs. The integral coefficient of innovation activity for SMEs (ICIA), proposed in this study, is a multiplicative indicator that takes into account a range of critically important factors contributing to technological sovereignty simultaneously. ICIA is an aggregated index calculated on the basis of normalized values of partial coefficients.

$$ICIA_i = \frac{w_1 * CIA_{quantity_i} + w_2 * CIA_{finance_i} + w_3 * CIA_{okved_i} + w_4 * CIA_{ane_i}}{w_1 + w_2 + w_3 + w_4},$$

where $ICIA_i$ — is an integral indicator of the innovation activity of the object of analysis i ; $w_1, w_2, w_3, w_4 \in [0,1]$ — the significance weights of the corresponding coefficients.

The article demonstrates the use of this indicator in analyzing the regional aspect of innovation activity among SMEs. However, the ICIA can also be used for other purposes:

- In a territorial context, for comparative analysis of innovation activity across different regions.
- For industry-specific analysis of enterprise activity in various sectors, such as IT, mechanical engineering, pharmaceuticals, biotechnology, and new materials.
- To analyze specific groups of SMEs based on their participation in government support programs, such as grant recipients, residents of technoparks, and cluster participants.

This indicator can be adapted to specific government support goals. If the focus of the support program is on creating high-tech jobs, then priority is given to the number ($w_4 > w_i$); if it is aimed at increasing the return on invested public funds, priority is given to the volume of financing ($w_2 > w_i$).

If the weights are not explicitly specified, an equilibrium model should be used:

$$ICIA_i = \frac{CIA_{quantity_i} + CIA_{finance_i} + CIA_{okved_i} + CIA_{ane_i}}{4},$$

where all coefficients are reduced to a single scale by normalizing their values using the formula:

$$Norm_{ji} = \frac{CIA_{ji}}{\max(CIA_j)}.$$

where CIA_{ji} — for j coefficient of innovation of the object of analysis i ; $Norm_{ji}$ — the normalized CIA value for the j coefficient of innovation for the object of analysis i .

The results of the analysis of the levels of the integral indicator of innovation activity of the region and its components are presented in *Table 5*.

The analysis has shown that the integral indicator of innovation activity allows for a comprehensive assessment of the impact of key factors

Table 5

Analysis of SME Innovation Activity by Integrated Indicator (IIIA)

Subjects of the SFD	CIA _{quantity}		CIA _{finance}		CIA _{okved}		CIA _{ane}		ICIA
	Fact	Norm	Fact	Norm	Fact	Norm	Fact	Norm	
The Tomsk region	3.15	1.00	1.22	0.57	2.98	1.00	3.56	1.00	0.8939
The Kemerovo region	1.00	0.32	1.17	0.55	1.03	0.35	1.14	0.32	0.3833
The Novosibirsk region	1.21	0.38	0.90	0.42	1.15	0.39	1.13	0.31	0.3762
The Altai Territory	0.68	0.22	1.38	0.65	0.66	0.22	0.97	0.27	0.3392
The Krasnoyarsk region	0.83	0.26	0.89	0.42	0.86	0.29	0.83	0.23	0.3004
The Irkutsk region	0.60	0.19	0.60	0.28	0.62	0.21	0.32	0.09	0.2742
The Omsk region	0.44	0.14	0.68	0.32	0.44	0.15	0.22	0.06	0.1929
The Republic of Khakassia	0.08	0.03	2.12	1.00	0.09	0.03	0.15	0.04	0.1671
The Republic of Altai	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
The Republic of Tyva	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Author's calculations under Tables 1–4.

on the development of the innovation environment and ensuring technological sovereignty. These factors include the scale of enterprise participation, the level of financial support, and industry orientation, as well as human resources.

In Table 5 it can be seen that the highest ICIA value was recorded in the Tomsk region (0.8939), which indicates a high concentration of knowledge-intensive entrepreneurship, a well-formed system of interaction between science, education and business, as well as effective integration of SMEs into priority technological areas. This region can be considered as the core of the innovation space, making the greatest contribution to ensuring the technological sovereignty of the country. The Novosibirsk and Kemerovo regions occupy positions of active regions with high involvement of SMEs in support programs, although they need further diversification of the industry structure and development of mechanisms for commercialization of innovations. The Krasnoyarsk and Altai Territories show moderate results, which demonstrates the need to strength-

en human resources and expand the participation of enterprises in high-tech sectors. The Irkutsk, Omsk regions and the Republic of Khakassia have low IQ values, reflecting structural and institutional limitations of innovation activity.

Thus, the ICIA acts as a universal analytical tool that can be used not only for inter-regional comparisons, but also to assess the innovation activity of SMEs by industry, type of economic activity or forms of participation in government support programs. It allows you to objectively determine the degree of business readiness to participate in technological transformations, identify factors limiting the development of innovations, and thus serves as a reliable basis for making managerial decisions aimed at strengthening Russia's technological sovereignty.

CONCLUSIONS

The results of the study confirm the importance of a comprehensive assessment of innovation activity among small and medium-sized businesses as a tool to ensure technological sovereignty and

promote economic development. The proposed integral indicator of innovation activity (ICIA), developed by the authors, is a multiplicative index that considers the combined impact of several key factors, including the scale of participation in support programs, financial support for projects, focus on priority sectors, and human resources.

The universal structure of this indicator allows its application at different levels of analysis, ranging from government strategic plans to corporate evaluations of innovation maturity. By using ICIA, it is possible to accurately measure the contribution of small and medium enterprises to the achievement of technological sovereignty.

ICIA can be used by:

- Government authorities to monitor the effectiveness of innovative entrepreneurship support programs, assess the contribution of SMEs

to the implementation of national technological priorities, and identify areas for stimulating innovation;

- Development institutions and innovation support funds to identify SMEs with high potential for implementing end-to-end technologies, evaluate the effectiveness of grant and venture capital instruments, and select projects for acceleration;

- Regional structures and innovation infrastructure to analyze the dynamics of innovative activity among enterprises, form acceleration programs, and integrate SMEs into technological clusters;

- The scientific and expert community to model the relationship between business innovation and the level of technological development in the economy.

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V.V. Plotnikova — description of the results and formulation of the research conclusions.

P.V. Strubalin — collection of statistical data, calculations, and tabular and graphical presentation of the results.

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Construction of High-order Dynamic Portfolio Models Based on VAR-ICA-MGARCH

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ABSTRACT

The aim of the study is to prove that dynamic portfolios can effectively reflect the temporal dynamics of current risks of a higher order, providing greater reliability and stability compared to traditional portfolios. The subject is the economic imbalance in portfolio models, which occurs when different participants have different level of knowledge about market conditions and the performance of assets. In an environment where traditional portfolios have shown low returns due to the pronounced peaks and sharp declines in financial asset returns, as well as their inability to account for dynamic changes in financial risks. This study incorporates higher-order short-term risks into traditional portfolios in order to mitigate the effects of deviations from the normal distribution. The methodology is based on the concept of multiple financial time series and the VAR-ICA-MGARCH model. This model effectively captures the conditional mean, the covariance matrix, the mutual asymmetry matrix, and the mutual kurtosis matrix, thereby characterizing temporal changes at higher-order moments. Due to the inherent nonlinearities of dynamic portfolio optimization tasks, we use a genetic algorithm to solve the dynamic portfolio model. The results of the study show that dynamic portfolios can effectively reflect the changing dynamics of current higher-order risks, while providing greater reliability and stability than traditional portfolios. Even when exposed to such complex risks, dynamic portfolios perform better. The practical significance of this research lies in determining the time-varying weighting coefficients for the portfolio and conducting both simulation experiments and empirical analysis.

Keywords: AI; high-order dynamic investment portfolio; genetic algorithm; VAR-ICA-MGARCHSK model; CARA utility function

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INTRODUCTION

One of the most important reasons is that financial market variables often violate the normality assumption, failing the traditional Markowitz mean-variance model. Many relevant studies have shown that the yield of financial assets is non-normal, usually showing the characteristics of peaks and thick tails. The investment results obtained by calculating such data using the traditional Markowitz mean-variance model may significantly deviate from the actual situation. In response to this phenomenon, to weaken the impact of non-normality on the outcome of investment decisions, scholars have done many fruitful studies in this regard [1, 2]: consider the skewness of the traditional portfolio and find that the investment portfolio that introduces the skewness considerably deviates from the conventional portfolio results.

It considered financial income data's peak and thick tail phenomenon [3]. It is difficult for the traditional portfolio model to achieve the desired effect and constructs a high-order moment portfolio model considering skewness and kurtosis and then solve this high-order moment portfolio model using the genetic algorithm. Empirical results suggest that the presence of high-order moments has a more significant impact on investment decisions. Based on investor utility, we have constructed a two-tier parameter estimation model of a portfolio with base constraints with the idea of two-tier planning [4]. Then, the algorithm framework for derivative-free optimization was designed, and the algorithm subproblems were solved using ADMM (Alternating Direction Method of Multipliers). This approach better serves the portfolio model with base constraints for investment decisions. The wavelet-high-order moment portfolio model was proposed [5], taking into account that investors have different preferences, combining the considerable overlap of the discrete wavelet transformation method with a high-order portfolio moment. Based on different perspectives, two integration schemes were proposed: high-frequency and full-scale. The model is improved by screening appropriate risk preference characteristics.

Economic asymmetry arises when different market participants possess varying levels or types of knowledge about market conditions, asset performance, or other relevant factors affecting invest-

ments. Traditional models often assume that information is evenly distributed among investors, but in reality, this is not always the case. This can lead to inaccuracies in investment decisions, as investors with more information may have an advantage over those with less information.

By using genetic algorithms in a dynamic portfolio context, several advantages emerge regarding handling these asymmetries. Higher-order moment risks captured by frameworks like VAR-ICA-MGARCH provide a richer understanding of volatility clustering, skewness, kurtosis, and the interdependencies between assets. Incorporating these features ensures that the optimization process explicitly takes into account structural shifts caused by changing economic environments or shocks. Unlike traditional methods that require strict assumptions about probability distributions (such as normality), genetic algorithms work directly with raw datasets, allowing for more flexibility in dealing with irregular patterns resulting from heterogeneous investor behaviors [5–7].

It introduced a central regularization algorithm to compensate for the original method's shortcomings and significantly improved its application value by applying L1 norm penalties to the non-diagonal elements of the estimated matrix during the solution process. Using the sensitivity VaR model (SDSVaR), which takes into account state dependence to measure the direction and magnitude of risk spillover effects between industries, This model considered the plate rotation effect and constructed a cross-industry portfolio model. They have analyzed the impact of inter-industry risk spillover and portfolio rotation on asset allocation. The traditional portfolio method is easily affected by outliers, leading to the calculation results that are inconsistent with the actual situation. They improved the traditional portfolio model by combining the robust method and obtained a better portfolio model [8–10].

The authors used a particle swarm optimization algorithm to solve the portfolio model reducing the possibility of falling into local optimization [11–13]. They built a portfolio model based on symmetric triangular fuzzy numbers and compared it with the combination of set empirical mode decomposition and ordinary least squares and the single fuzzy linear regression method. The results indicate that the

portfolio model based on set empirical mode decomposition and fuzzy linear regression is superior, which has reference significance for building the optimal portfolios [14–18].

Most existing portfolio models assume that the investment period is fixed [19, 20]. However, with the ongoing in-depth study of the financial market, we have found that there are not only high-order moment risks in the financial market but also time-varying risks. However, the traditional Markowitz mean-variance model does not consider the dynamic relationship between financial asset returns and risks, which is one of the main drawbacks of the conventional Markowitz mean-variance model. Thus, how to effectively construct a dynamic portfolio effectively has become a topic of interest for many researchers. For example, it studied the portfolio problem using the mean end wealth risk-return (EaR) in continuous time and compared it with the traditional mean-variance model. The researchers [21–24] proposed the MGARCHSK model in order to capture the dynamic changes of high-order moments and to conduct empirical research, given the non-normality of the distribution of return on financial assets and the fact that traditional portfolios do not take into account the high-order moment risk or the time variability of financial risk. The empirical results demonstrate time-varying high-order moment risk in the financial market as well as volatility aggregation in these high-order moment risks.

At the same time, the investment effect of a portfolio based on high-order moment risk is also better than that of a traditional portfolio. This was achieved by using interval numbers to measure returns and semi-absolute deviations to measure risks, in order to construct an interval-valued portfolio model. Research shows that investors can choose the investment proportion based on their personal preferences and adjust it depending on the investment environment [25–27]. Finally, the effectiveness and reliability of the dynamic portfolio was demonstrated through empirical analysis. The researchers [28–30] improved the relative robust portfolio optimization (RRPO) model by introducing a dynamic reference point. Their empirical findings suggest that the benefits of aggressive behavior are good, and conservative behavior has reasonable control over the standard deviation and maximum loss value. The goal was

to minimize risk taking into account the background risks of investment decisions and the turnover rate of securities as constraints. A fuzzy portfolio model was then constructed. The empirical results support the general principle of “high yield, high risk”. It proposes an investment decision-making model with a flexible time horizon that considers consumption and bankruptcy management. The researchers built an optimal portfolio model considering inflation and an uncertain time horizon. They evaluated the portfolio problems of varied projects, stocks, and risk-free assets; and constructed a mixed portfolio optimization model with a flexible time horizon aimed at the maximizing net present value of final wealth. Empirical research shows that the hybrid portfolio strategy, which allows for a flexible time horizon is more effective than the existing project portfolio strategy with a flexible time frame [31–34].

This paper introduces skewness and kurtosis risks into the traditional portfolio, combining them with previous literature research and considering the non-normal distribution of financial asset returns and the characteristics of peaks and thick tails. It constructs a high-order moment portfolio to weaken the impact of deviations from the basic assumptions. At the same time, given the time-varying nature of the return rates of financial assets and their risks, this paper utilizes the VAR-ICA-MGARCHSK model to capture the time-varying of conditional mean, covariance matrix, CO-skewness matrix, and CO-kurtosis matrix. Finally, a genetic algorithm is used to solve high-order portfolio solutions’ nonconvex and nonlinear problems to obtain the optimal investment weight and construct a dynamic portfolio model. To demonstrate that the dynamic portfolio is more advantageous than the traditional portfolio, this paper provides further explanation based on simulation and empirical analysis. Simulation and empirical analysis results indicate that the VAR-ICA-MGARCHSK model can effectively capture the financial high-order moment risk and find that the financial high-order moment has significant time variability. Compared with the traditional portfolio, the dynamic portfolio model’s investment selection results based on the VAR-ICA-MGARCHSK model more closely align with the actual market conditions, and the investment effects are better than a traditional portfolio.

1. PRINCIPLES OF HIGH-LEVEL DYNAMIC PORTFOLIOS

1.1. Principles and Pitfalls of Traditional Portfolios

Traditional mean-variance models (i.e., traditional portfolio models) include the First Type Mean-Variance Model and the Second Type Mean-Variance Model. Taking the First Type of Mean-Variance Model as an example, (assuming that there are n securities in the portfolio), a specific principle is shown in Equation (1).

$$\min \sigma_p^2 = W^T \Sigma W$$

$$s.t. \begin{cases} \mu_p = W^T \mu \geq r \\ \sum_{i=1}^n w_i = 1 \\ w_i \geq 0 \quad i = 1, 2, \dots, n, \end{cases} \quad (1)$$

where W represents the weight vector, Σ represents a covariance matrix, μ represents the mean vector, and r represents a given expected rate of return.

Traditional portfolio models often achieve superior results by satisfying basic assumptions, but as financial markets continue to evolve, the model's flaws are becoming apparent. First, in practice, the volatility of financial markets and the impact of external events, etc., will make it difficult to meet the basic assumptions of the traditional Markowitz mean-variance model. The most important of which is that normality is difficult to satisfy. Secondly, the Traditional portfolio model assumes that the mean and variance are time-varying, that is, only statically consider the relationship between investment returns and risks, and does not consider the fact that investment returns and risks are dynamically changing in actual situations. This makes it challenging to make effective dynamic investment decisions in practice. Therefore, given the problem that normality is challenging to satisfy, this paper introduces high-order moment risk. The VAR-ICA-M GARCHSK model captures the dynamic changes in investment returns, covariance matrix, covariance matrix, and co-kurtosis matrix. Therefore, by considering non-normality and time-varying, this paper improves upon the traditional portfolio model.

1.2. VAR-ICA-MGARCHSK the Principle of the Model

This paper introduces the VAR-MGARCHSK model, which illustrates the existence of high-order financial moment risk and captures the time variability of investment returns and risks. The main expressions of the VAR-MGARCHSK model are shown in Equation (2).

$$\begin{cases} Y_t = \sum_{i=1}^{q_0} \Phi_i Y_{t-i} + \varepsilon_t \\ \eta_t = H_t^{-1/2} \varepsilon_t \\ \text{vech}(H_t) = B_0 + \sum_{i=1}^{q_1} B_{1,i} \text{vech}(\eta_{t-i} \eta_{t-i}^T) + \sum_{j=1}^{p_1} B_{2,j} \text{vech}(H_{t-j}) \\ \text{vech}(S_t) = \Gamma_0 + \sum_{i=1}^{q_2} \Gamma_{1,i} \text{vech}((\eta_{t-i} \eta_{t-i}^T) \otimes \eta_{t-i}^T) + \sum_{j=1}^{p_2} \Gamma_{2,j} \text{vech}(S_{t-j}) \\ \text{vech}(K_t) = \delta_0 + \sum_{i=1}^{q_3} \delta_{1,i} \text{vech}((\eta_{t-i} \eta_{t-i}^T) \otimes \eta_{t-i}^T \otimes \eta_{t-i}^T) + \sum_{j=1}^{p_3} \delta_{2,j} \text{vech}(K_{t-j}) \end{cases} \quad (2)$$

Among them, Y_t represents the yield series, Φ_i represents the autoregressive vector coefficient represents the VAR model used to capture the dynamic investment return, η_t refers to the vector after the standardization of the ε_t random error vector. H_t , S_t and K_t represents conditional covariance matrix, conditional co skewness matrix and conditional co kurtosis matrix, respectively. $\otimes$ represents Kronecker product. However, the MGARCHSK model is not widely used in practice because as the number of variables and the order of lag increase, the parameters estimated by the MGARCHSK model also increase significantly. The main principles of the ICA-MGARCHSK model are:

$IC_t = (IC_{1t}, IC_{2t}, \dots, IC_{nt})^T$ n independent components Y_t called yield sequences, such as IC_{it} and IC_{jt} ($i \neq j$) are independent, and there is a reversible matrix U (or transformation matrix) such as:

$$IC_t = UY_t. \quad (3)$$

The conditional variance of formula (3), the conditional skewness, and the conditional kurtosis can be obtained, respectively:

$$\begin{cases} \text{var}(IC_t | I_{t-1}) = UH_t U^T \\ \text{skew}(IC_t | I_{t-1}) = US_t (U^T \otimes U^T) \\ \text{kurt}(IC_t | I_{t-1}) = UK_t (U^T \otimes U^T \otimes U^T) \end{cases}, \quad (4)$$

where $\text{var}()$ $\text{skew}()$ $\text{kurt}()$ represent the variance, skewness, and kurtosis, respectively. After obtaining Y_t the independent components of the yield series IC_t , you can use the unary GARCHSK model to model them separately IC_t , then the unary GARCHSK model is as follows (5):

$$\begin{cases} \xi_{lt}^H = w^H + \sum_{i=1}^{q_1} \alpha_{li}^H (\eta_{l,t-i}^H)^2 + \sum_{j=1}^{p_1} \beta_{lj}^H \xi_{l,t-j}^H \\ \xi_{lt}^S = w^S + \sum_{i=1}^{q_2} \alpha_{li}^S (\eta_{l,t-i}^S)^3 + \sum_{j=1}^{p_2} \beta_{lj}^S \xi_{l,t-j}^S \\ \xi_{lt}^K = w^K + \sum_{i=1}^{q_3} \alpha_{li}^K (\eta_{l,t-i}^K)^4 + \sum_{j=1}^{p_3} \beta_{lj}^K \xi_{l,t-j}^K \end{cases}, \quad (5)$$

where l ($l=1, 2, \dots, n$) represents the l th independent component. ξ_{lt}^H , ξ_{lt}^S and ξ_{lt}^K represents the conditional variance, conditional skewness, and conditional kurtosis of the l independent component, respectively (6).

$$\begin{cases} H_t = U^{-1} \Xi^H (U^T)^{-1} \\ S_t = U^{-1} \Xi^S (U^T \otimes U^T)^{-1} \\ K_t = U^{-1} \Xi^K (U^T \otimes U^T \otimes U^T)^{-1} \end{cases}. \quad (6)$$

Among them $\Xi_t^H = \text{diag}(\xi_{1t}^H, \xi_{2t}^H, \dots, \xi_{nt}^H)$ $\Xi_t^S = \text{diag}(\xi_{1t}^S, \xi_{2t}^S, \dots, \xi_{nt}^S)$ and $\Xi_t^K = \text{diag}(\xi_{1t}^K, \xi_{2t}^K, \dots, \xi_{nt}^K)$ the conditional covariance matrix, the conditional co-skewness matrix and the conditional co-kurtosis matrix represent the independent components, respectively (6).

Therefore, the VAR-MGARCHSK and the ICA-MGARCHSK models can be constructed based on the principle of the VAR-ICA-MGARCHSK model. That is, the investment income of the yield series Y_t time-varying is captured through the VAR model and then extracted. The residuals of the VAR model are used to construct the ICA-MGARCHSK model to estimate the yield sequence's dynamic high-order moment risk.

1.3. Portfolios Based on Utility Functions

Assuming that the investor's initial wealth at the beginning of the period is 1, and the wealth in the t -period is W_t , the investor gets the maximum effect in the t -period, that is, maximizes $U(W_t)$. Considering the impact of financial high-order moment risk on the portfolio, the Taylor formula unfolds (Fang et al., 2019) the utility function as shown in Equation (7).

$$U(W_t) = \sum_{i=0}^{\infty} \frac{U^{(i)}(\bar{W}_t)(W_t - \bar{W}_t)^i}{i!}, \quad (7)$$

where $\bar{W}_t = E(W_t) = 1 + w_t^T \mu_t$ represents the expected wealth at the end of the t -period, represents the conditional expected return vector, takes the expectation of equation μ_t (7), and performs a fourth-order truncation to obtain:

$$\begin{aligned} E(U(W_t)) &= U(\bar{W}_t) + U^{(1)}(\bar{W}_t)E(W_t - \bar{W}_t) + \frac{1}{2!}U^{(2)}(\bar{W}_t)E(W_t - \bar{W}_t)^2 + \\ &+ \frac{1}{3!}U^{(3)}(\bar{W}_t)E(W_t - \bar{W}_t)^3 + \frac{1}{4!}U^{(4)}(\bar{W}_t)E(W_t - \bar{W}_t)^4 + o(W_t^4). \end{aligned} \quad (8)$$

From Equation (8), the conditional utility expects the conditional high-order moment risk of the available portfolio to be approximated, i.e.:

$$E(U(W_t)) \approx U(\bar{W}_t) + \frac{1}{2} U^{(2)}(\bar{W}_t) \sigma_{p,t}^2 + \frac{1}{3!} U^{(3)}(\bar{W}_t) s_{p,t}^3 + \frac{1}{4!} U^{(4)}(\bar{W}_t) k_{p,t}^4, \quad (9)$$

where $\mu_{p,t}$, $\sigma_{p,t}^2$, $s_{p,t}^3$ and $k_{p,t}^4$ represent the total return, total variance, total skewness, and total kurtosis of the t-day of the dynamic portfolio, respectively. The calculation is shown in Equation (10).

$$\begin{cases} \mu_{p,t} = W_t^T R_t \\ \sigma_{p,t}^2 = W_t^T H_t W_t \\ s_{p,t}^3 = W_t^T S_t (W_t \otimes W_t) \\ k_{p,t}^4 = W_t^T K_t (W_t \otimes W_t \otimes W_t), \end{cases} \quad (10)$$

where R_t , H_t , S_t and K_t represent income vector, covariance matrix, CO skewness matrix, and CO kurtosis matrix, respectively.

This article uses the constant absolute risk aversion effect function (CARA), which is $U(W_t) = -e^{\rho W_t}$. The ρ parameter represents the investor's constant absolute risk aversion parameter, which is taken as 1. Thus, the optimization problem of a dynamic portfolio model based on utility functions can be expressed in Equation (11).

$$\begin{cases} \max E_{t-1}(U(W_t)) = -e^{-\rho(1+\mu_{p,t})} \left(1 + \frac{\rho^2}{2} \sigma_{p,t}^2 - \frac{\rho^3}{6} s_{p,t}^3 + \frac{\rho^4}{24} k_{p,t}^4 \right) \\ s.t. \quad W_{t-1}^T I = 1 \\ \quad \quad w_{i,t} \geq 0 \end{cases} \quad (11)$$

Next, using the Lagrange multiplier method, we can find the optimal weight of Equation (11), and obtain Equation (12):

$$(\mu_t - R_{0,t}) - \psi_1(w_t) H_t w_t + \psi_2(w_t) S_t (w_t \otimes w_t) - \psi_3(w_t) K_t (w_t \otimes w_t \otimes w_t) = 0, \quad (12)$$

where $\psi_i(w_t) = \frac{\rho^i}{i!} (1 + \frac{\rho^2}{2!} \sigma_{p,t}^2 - \frac{\rho^3}{3!} s_{p,t}^3 + \frac{\rho^4}{4!} k_{p,t}^4)^{-1}$ Equation (12) is a nonlinear function of the weight

vector W_t . Therefore, considering the nonlinear nature of Equation (12), this paper employs the genetic algorithm with the non-dominated sorting and the elite strategy to obtain the optimal weight to obtain the time-varying dynamic investment weight W_t , and then create the dynamic portfolio.

1.4. Construction of High-order Dynamic Portfolio Models

In summary, according to the principles of the VAR-ICA-M GARCHSK model and the utility function-based portfolio model, as well as the genetic algorithm, this paper develops a high-order dynamic portfolio model. The specific algorithm is illustrated in the flowchart in Fig. 1.

- (1) Capture of the yield series using the VAR-ICA-M GARCHSK model;
- (2) Construction of a high-order dynamic portfolio model using a portfolio model based on utility function;
- (3) Adoption of a genetic algorithm with an elite strategy of a non-dominant ranking to obtain high-order dynamic investment weights;
- (4) The effectiveness and feasibility of the high-order dynamic portfolio models are explained according to simulation experiments and empirical analysis.

2. SIMULATION EXPERIMENTS

This paper first verifies that high-order dynamic portfolios are more effective than traditional portfolios based on simulation experiments to prove the effectiveness of high-order dynamic portfolios. Firstly, a 4-dimensional MGARCHSK model with 1000 samples was simulated using R software. An independent principal component

analysis was then used to obtain each independent component (6). Finally, the high-order dynamic investment weights were obtained using a genetic algorithm. The investment utility and high-order dynamic

investment weights for the first 100 days obtained from the VAR-ICA-MGARCHSK model are shown in Fig. 2.

Where CL represents the average dynamic portfolio utility value, UCL represents the upper three-sigma limit of the dynamic portfolio's utility value, and LCL represents the lower three-sigma limit of the dynamic portfolio utility value. As can be seen in Fig. 2, the investment utility obtained by the traditional portfolio is -0.4783 , the average investment utility of dynamic portfolios is -0.4197 . The daily investment return of dynamic portfolios is therefore higher than that of the traditional ones. In contrast, the investment value of dynamic portfolios is basically stable within the Six Sigma range. Therefore, the investment benefit obtained from using dynamic portfolios is relatively stable, and the investment effectiveness of dynamic portfolios is consistently greater than that of traditional portfolios (see Table 1).

3. EMPIRICAL ANALYSIS

In order to verify the practical application effect of high-order dynamic portfolios, this study selects data from January 03, 2014, to April 19, 2019. The logarithmic yield data for 6 stocks of China Mobile, China Construction Bank, China Telecom, Industrial and Commercial Bank of China, Chinese Life Insurance, and Agricultural Bank of China were used. A total of 1304 samples were recorded as x_1 , and x_2, x_3, x_4, x_5, x_6 , respectively. The data was obtained from Yingwei Financial, and their yield images are shown in Fig. 3.

According to Fig. 3, there is a significant volatility aggregation in each stock, but it needs to be further

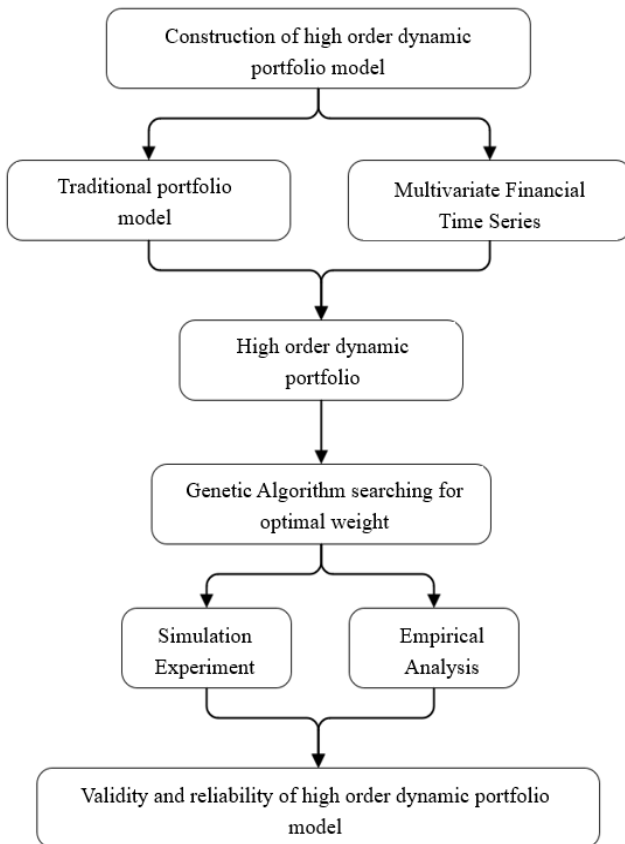


Fig. 1. Flowchart of the Construction of a Dynamic Portfolio Model

Source: Compiled by the authors.

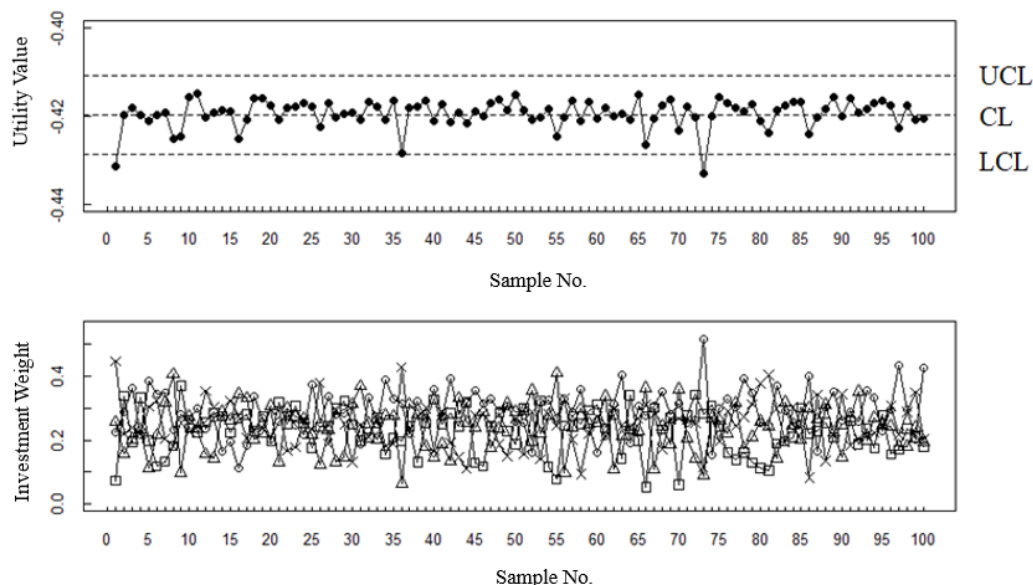


Fig. 2. Dynamic Portfolio Utility Values for the First 100 Days (Above) and Dynamic Investment Weights (Bottom)

Source: Compiled by the authors.

Table 1

Comparison of the Effects of High-end Dynamic Portfolios and Traditional Portfolios

Parameter	Utility value	Mean	Variance	Kurtosis	Skewness
Dynamic portfolios	-0.4197	0.0089	0.2618	-0.0018	0.5027
Traditional portfolios	-0.4783	0.0105	0.7922	0.0782	3.1604

Source: Compiled by the authors.

determined whether there is a significant volatility agglomeration at the high-order moment. First, the basic statistical analysis of each stock is carried out to obtain the basic statistical information representing the return series for each stock, as shown in Table 2. From Table 2, we see that except for the Industrial and Commercial Bank of China and the Agricultural Bank of China, the skewness of the other stock yields is positive, indicating that there is a greater possibility of a decline in ICBC and the Agricultural Bank of China. Except for China Telecom, the peak statistical value is greater than 3. This indicates that China Telecom's yield distribution has a thicker tail than the normal distribution, and other yield distributions have a lighter tail than the normal distribution. At the same time, it can be seen from the JB statistics that each yield series rejects the assumption of following a normal distribution. Therefore, the basic assumptions of the traditional portfolio cannot be satisfied. If at this time only according to the first two-order moment to select the portfolio may have certain limitations, resulting in the investor's choice of a portfolio is not

the optimal portfolio. Considering the impact of the high-order moment on the portfolio can help avoid the impact of financial risks better, and choose a more suitable investment weight.

To determine whether the yield series can be used to establish a VAR model, the unit root test is performed on each stock yield series. The specific results are shown in Table 3.

According to Table 3, each yield sequence is a stationary series. That is, each yield sequence is a 0-order single whole sequence. Based on the AIC criterion, the VAR(1) model is finally selected to fit the yield series, and then the residuals of the VAR(1) model are extracted to establish the ICA-M GARCHSK. The results of the GARCHSK model fitted to each individual component are presented in Table 4.

According to Table 4, most of the coefficients in the variance equation are very significant, indicating a high level of volatility aggregation in these 6 stocks. At the same time, according to the fitting results of the skewness equation and the kurtosis equation, we can see that these 6 stocks have obvious conditional skew-

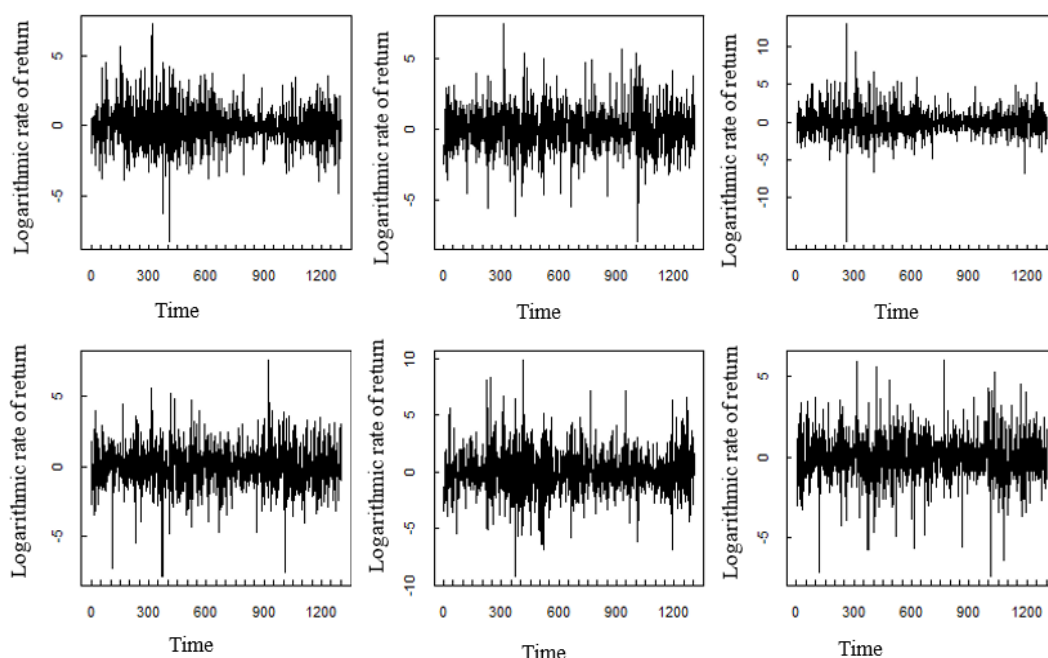


Fig. 3. 6 Stock Closing Price Logarithmic Yield Image

Source: Compiled by the authors.

Table 2

Basic Descriptive Statistics

Variable	Number of samples	Mean	Variance	Skewness	Kurtosis	JB Statistics
x_1	1303	-0.004	1.374	0.099	2.701	400.963***
x_2	1303	0.015	1.474	0.090	2.304	292.357***
x_3	1303	0.005	1.573	0.080	8.864	4287.536***
x_4	1303	0.011	1.487	-0.204	2.845	451.638***
x_5	1303	-0.007	1.900	0.307	2.453	349.704***
x_6	1303	-0.003	1.415	-0.177	2.835	451.765***

Source: Compiled by the authors.

Note: *** represents passing 1% respectively a Significance test.

ness and conditional kurtosis, and there are significant time-varying features. Therefore, to better avoid risks, investors should take into account the existence of high-order financial risk moments when making investment decisions. Based on this, the construction of a portfolio can better obtain stability and get closer to the desired investment outcome.

The conditional variance, conditional skewness, and conditional kurtosis of each stock are calculated according to the GARCHSK model fitted with each independent component, as shown in Fig. 4–6. Based on these Fig., the conditional variance, conditional skewness, and conditional kurtosis have the phenomenon of large fluctuations followed by large fluctuations, and small fluctuations followed by small fluctuations. This also shows that there is also a significant fluctuation aggregation phenomenon of the conditional high-order moment, which further proves that when the portfolio is carried out. The impact of the conditional high-order moment risk on the portfolio cannot be ignored. It should be considered to facilitate investors to make better investment choices.

According to Equation (6), the optimal investment weight for the first 20 days of April 2019 (including April 19, 2019) was obtained using the genetic algorithm, as shown in Fig. 7. In the year leading up to April 19, 2019 (including April 2019), each stock's weight change on the 19th is shown in Fig. 8.

According to Fig. 7, the investment weight of each stock changes with time, and the change of different stock weights over time are also more significant. This also reflects that in the process of building a portfolio, the dynamic changes of risk cannot be ignored to achieve the desired outcome. Figure 8 demonstrates the change in the weight of each stock at different investment stages. The results show that the dynamic investment weight of each stock varies over time. This

Unit Root Test Results

Variable	Statistics	p-value
x_1	-26.556***	<0.01
x_2	-25.589***	<0.01
x_3	-26.429***	<0.01
x_4	-25.977***	<0.01
x_5	-25.473***	<0.01
x_6	-24.2156***	<0.01

Source: Compiled by the authors

Note: *** represents passing 1% respectively a Significance test.

means that the investment situation of investors in each stock daily is inconsistent. In theory, it is necessary to continuously adjust the investment weight according to the different risks faced by different stocks to maintain the expected utility maximization, so the high-order dynamic portfolio is both theoretically and practically more reliable and feasible.

Next, we calculated the investment utility value from April 19, 2024 (including April 19, 2024) to further compare the Dynamic portfolio and the Traditional portfolio. The results are shown in Table 5. The change in total utility in the year before April 19, 2024 (including April 19, 2024) is shown in Fig. 9, where the red dotted line represents the utility value of the Traditional portfolio.

According to Table 5, the average investment utility obtained by the high-order dynamic portfolio is -0.414, while the investment utility of the traditional portfolio is -0.620. At the same time, we can see that the investment return obtained by the high-order dynamic portfolio fluctuates less. In other words, its investment results are relatively stable, and its investment utility is better than the traditional portfolio. This also shows

Table 3

Table 4

Fitting Results of the CHARTSK Model for Each Independent Component

	Parameter	IC ₁	IC ₂	IC ₃	IC ₄	IC ₅	IC ₆
Equation of variance	w^H	0.0126***	0.2738***	0.1097***	0.1665***	0.0295***	0.0397***
	α_1^H	0.9281***	0.5940***	0.6167***	0.7554***	0.7251***	0.7075***
	β_1^H	0.0447***	0.1242***	0.3833***	0.0595***	0.0429***	0.0522***
Equation of skewness	w^S	0.2145***	0.0278	-0.0468	0.0250	0.2241***	4.0300***
	α_1^S	0.1125	0.2661***	-0.5174	-0.6066***	0.9985***	0.4577***
	β_1^S	0.0161***	-0.0374***	0.0000	0.0016	0.0256***	0.9509***
Kurtosis equation	w^K	0.9165	3.3807***	3.6772***	3.5706***	0.6717***	1.2399***
	α_1^K	0.6659**	0.0356***	0.0000	0.000	0.7336***	0.8743***
	β_1^K	0.0003	0.1838***	0.0003	0.0002	0.1658***	0.0710***

Source: Compiled by the authors.

Note: ***, ** represents passing 1%, 5% respectively a Significance test.

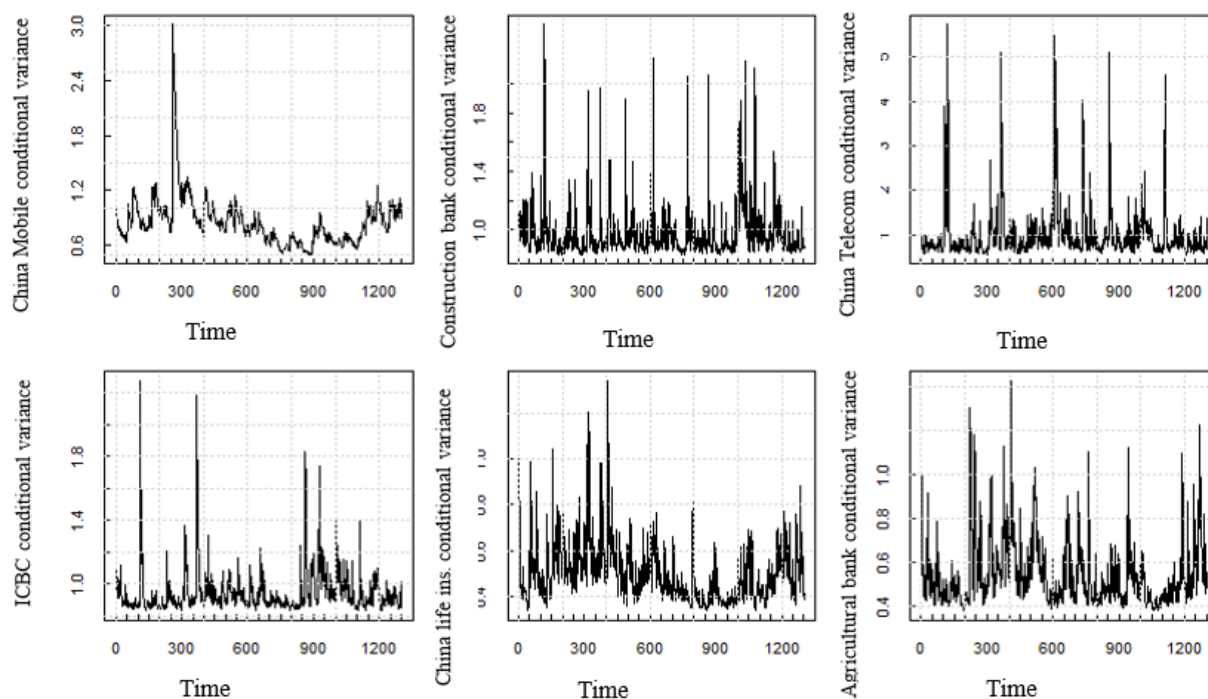


Fig. 4. Image of the Conditional Variance of Each Stock

Source: Compiled by the authors.

that if the basic assumptions of the traditional portfolio are not met, only second-order moment risk is considered. It often fails to bring better investment decisions for investors but will misestimate or underestimate the possible risks, resulting in wrong investment decisions. Further, it can be found that the investment weight

between different stocks changes with time. That is, the investment weight of different stocks sometimes changes, while the investment weight of each stock in the traditional portfolio remains unchanged. Therefore, ignoring the time-varying risk of different stocks can lead to poor investment results.

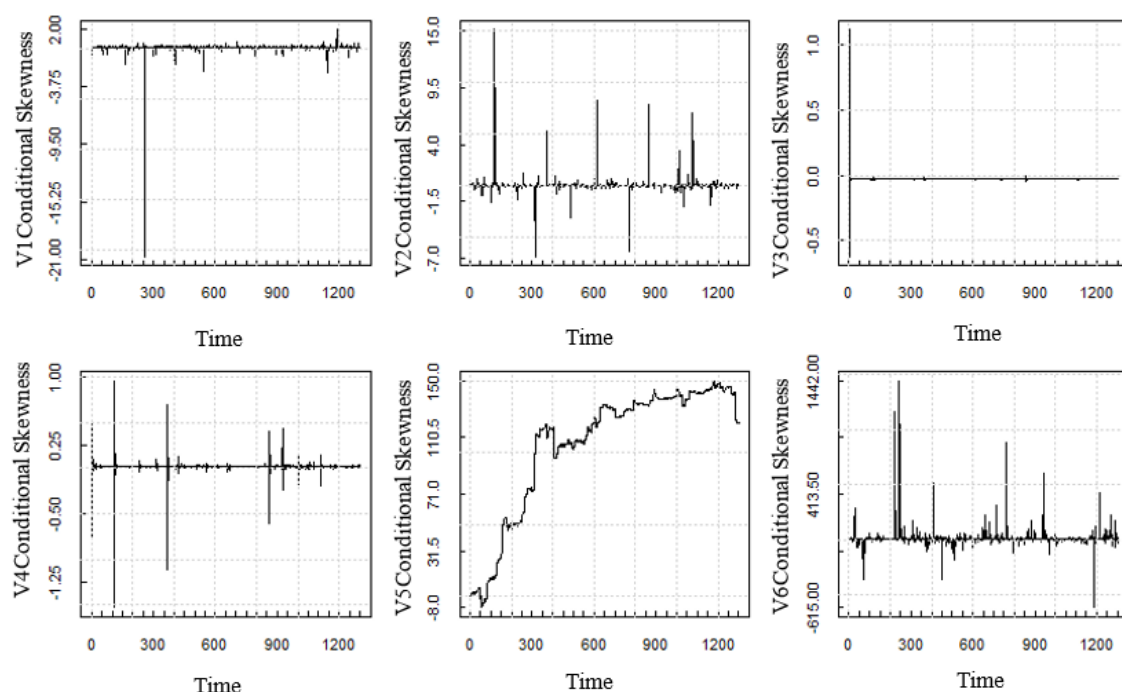


Fig. 5. Skewness Image of Each Stock Condition

Source: Compiled by the authors.

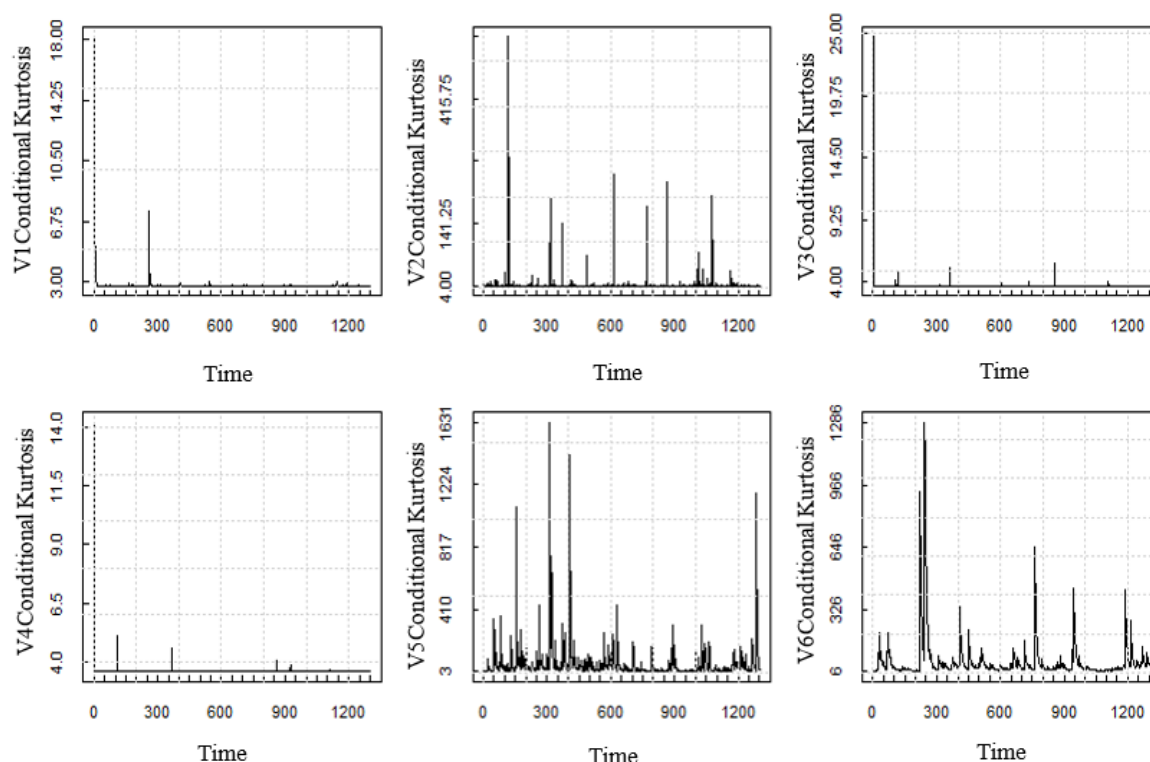


Fig. 6. Image of the Kurtosis of Each Stock Condition

Source: Compiled by the authors.

Figure 9 reflects the utility comparison between a high-order dynamic portfolio and a traditional portfolio (where the solid black line represents the utility of a traditional portfolio). The results show that the investment utility of a high-order dynam-

ic portfolio is always higher than that of the utility of traditional portfolio. The investment utility of a high-order dynamic portfolio is relatively stable, which shows the adaptability and reliability of a high-order dynamic portfolio. Therefore, in the ac-

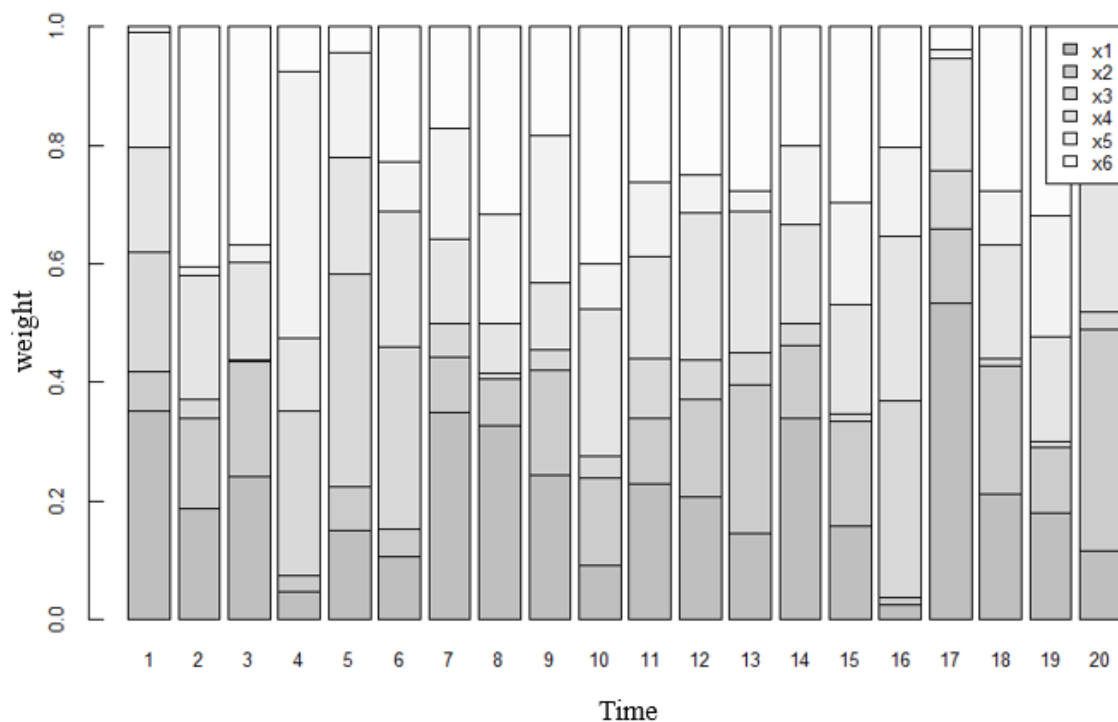


Fig. 7. Dynamic Weights of a Portfolio

Source: Compiled by the authors.

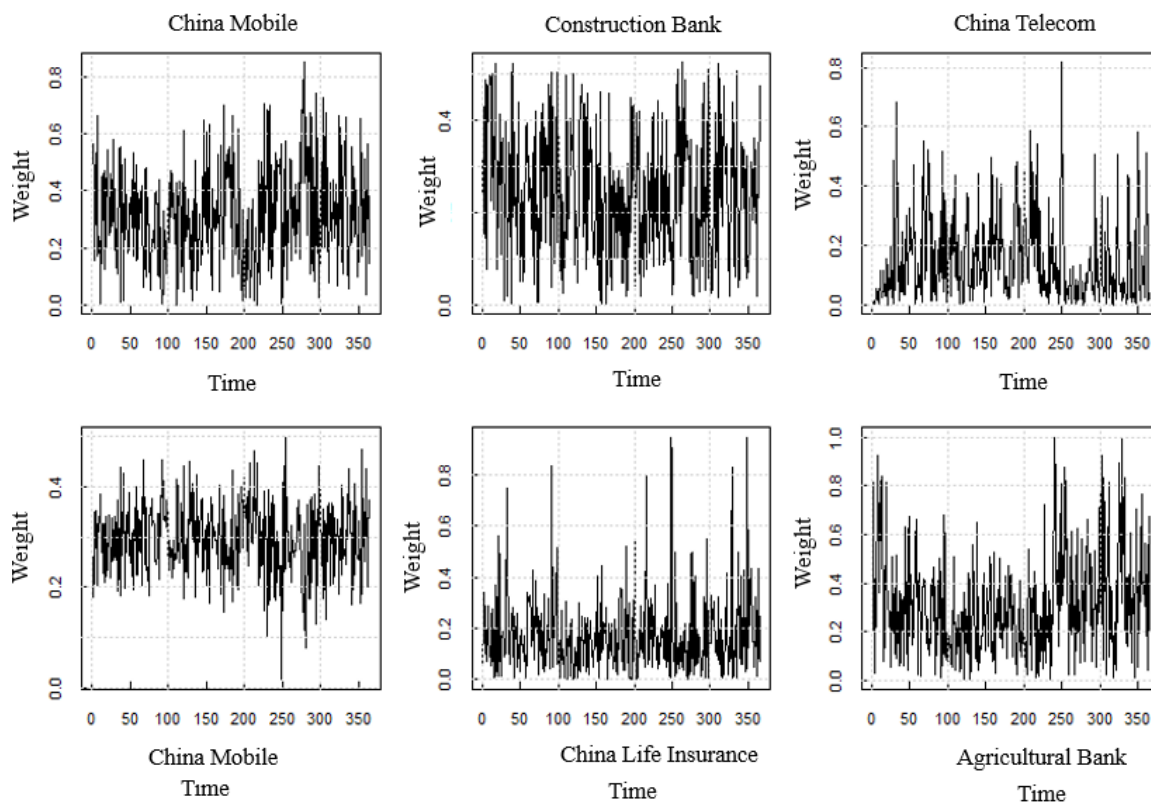


Fig. 8. Changes in the Investment Weights of Individual Stocks

Source: Compiled by the authors.

tual investment decision-making process, we should consider the impact of both high-order moment risk and the time-varying risk to make the best possible investment decisions.

Finally, this paper uses the deterministic equivalent losses (CEL%) to compare the specific differences between dynamic and traditional portfolios. This is calculated as:

Table 5

Comparison of Dynamic and Traditional Portfolios

Parameter	Time	x_1	x_2	x_3	x_4	x_5	x_6	Total utility
High-end dynamic portfolios	1	0.35	0.07	0.20	0.18	0.19	0.01	-0.46
	2	0.19	0.15	0.03	0.21	0.02	0.40	-0.37
	3	0.24	0.19	0.00	0.17	0.03	0.37	-0.41
	4	0.05	0.03	0.28	0.12	0.45	0.08	-0.33
	5	0.15	0.07	0.36	0.20	0.18	0.04	-0.35
	6	0.11	0.05	0.31	0.23	0.09	0.23	-0.41
	7	0.35	0.09	0.06	0.14	0.19	0.17	-0.41
	8	0.33	0.08	0.01	0.08	0.18	0.32	-0.36
	9	0.24	0.18	0.03	0.11	0.25	0.18	-0.42
	10	0.09	0.15	0.04	0.25	0.08	0.40	-0.46
	11	0.23	0.11	0.10	0.17	0.13	0.26	-0.40
	12	0.21	0.16	0.07	0.25	0.06	0.25	-0.43
	13	0.15	0.25	0.06	0.24	0.03	0.28	-0.40
	14	0.34	0.12	0.04	0.17	0.13	0.20	-0.44
	15	0.16	0.18	0.01	0.18	0.17	0.30	-0.42
	16	0.02	0.01	0.33	0.28	0.15	0.20	-0.33
	17	0.53	0.13	0.10	0.19	0.01	0.04	-0.45
	18	0.21	0.22	0.01	0.19	0.09	0.28	-0.40
	19	0.18	0.11	0.01	0.18	0.20	0.32	-0.38
	20	0.11	0.37	0.03	0.27	0.06	0.16	-0.42
Traditional portfolios	—	0.44	0.33	0.15	0.07	0.00	0.00	-0.62

Source: Compiled by the authors.

$$\frac{U(V^*) - U(V')}{U(V')} * 100\%,$$

where $U(V^*)$ and $U(V')$ sum represent the utility values of a dynamic portfolio and a traditional portfolio, respectively. The greater the deterministic equivalent loss, the better the dynamic portfolio compared to the traditional portfolio, as shown in Table 6. The changes in deterministic equivalent CEL% throughout the investment phase are shown in Fig. 8.

According to Table 6, the CEL value is greater than 0, indicating that the effect of the Dynamic portfolio is better than that of the traditional portfolio. This is due to the fact that the Dynamic portfolio can bet-

ter capture the presence of high-order matrix risk than the Traditional portfolio and effectively avoid the high-order matrix risk, thereby making a more sensible investment decisions. Figure 10 reflects the change of deterministic equivalents throughout the investment period. The results demonstrate that the investment effect of high-order dynamic portfolios is basically better than that of traditional portfolios [35–37]. High-order dynamic portfolios introduce high-order moment risk into traditional portfolios [38–44]. This not only weakens the impact of not meeting the normality assumption [45–50] but also takes into account the time-varying nature of risk and achieves better investment results, thus demonstrating the

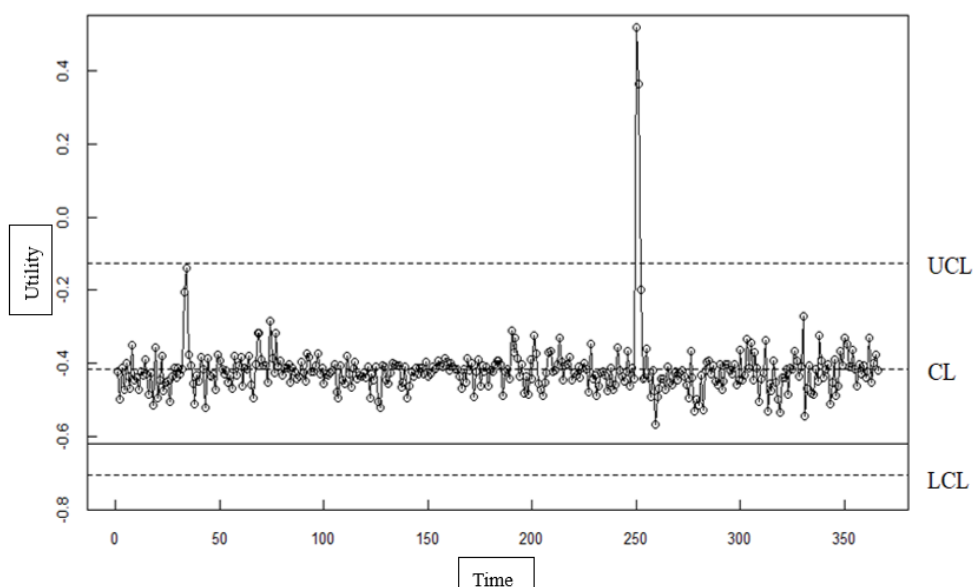


Fig. 9. Utility Comparison between High-order Dynamic Portfolios and Traditional Portfolios

Source: Compiled by the authors.

Table 6

Comparison of the Utility Effects of High-Order Dynamic Portfolios and Traditional Portfolios

Days	CEL, %	Days	CEL, %	Days	CEL, %	Days	CEL, %
1	25.66	6	34.13	11	35.11	16	46.58
2	40.75	7	34.15	12	30.86	17	27.28
3	34.64	8	41.23	13	34.70	18	35.91
4	46.83	9	32.76	14	29.52	19	39.38
5	44.13	10	25.85	15	32.02	20	32.71

Source: Compiled by the authors.

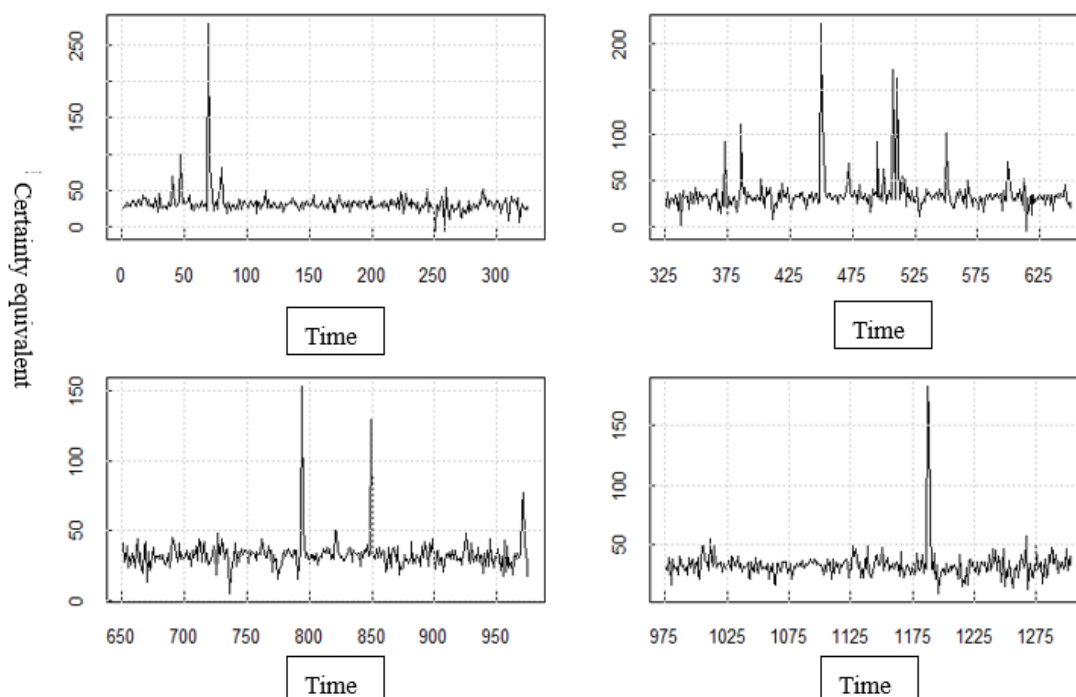


Fig. 10. Variation in the Loss of Certainty Equivalents (CEL%)

Source: Compiled by the authors.

robustness and operability of high-order dynamic portfolios [51–55].

CONCLUSION

The Traditional portfolio model requires that the variables obey the assumption of normality. Because of the instability of the financial market, the assumption of normality is often challenging to meet. Therefore, to reduce the impact of violating the normality assumption on the portfolio, skewness, and kurtosis (i.e., high-order moment risk) are also considered in the investment decision-making in order to enhance the reliability of the investment decision-making decisions. At the same time, because the return, covariance matrix, co-skewness matrix, and co-kurtosis matrix of the financial market vary over time, this paper uses the VAR-ICA-MGARCHSK model to capture the temporal variability of returns and risk. Finally, considering the nonlinearity of portfolio solutions based on the utility function, this paper uses the genetic algorithm with an elite strategy to obtain the optimal investment weight to build a dynamic portfolio.

To demonstrate that the effectiveness of the constructed dynamic portfolio is closer to the actual situation, this paper conducts simulation experiments and empirical analysis between the Dynamic portfolio and the Traditional one. The simulation experiment results show that the dynamic portfolio can better consider the

existence of high-order moments in the financial market and capture the time variability of high-order moments. At the same time, because the dynamic portfolio takes into account the existence of high-order risks, the dynamic portfolio can obtain better investment results than the traditional portfolio. In the financial market, there is not only a high-order moment risk but also a high-order moment risk that is time-varying, and the high-order moment risk has a significant impact on the portfolio selection. If the high-order moment risk is not considered, it can lead to wrong investment decisions. Therefore, to effectively diversify the risk of financial high-order moments, it is necessary to consider the dynamic investment decisions with high-order moments.

In this paper we consider the possible high-order moment risk in the financial market and pay attention to the dynamic changes in financial risk. However, due to the rapid changes in data in the era of big data, this paper selects the log return data of stocks from January 03, 2014 to April 19, 2024 as a research sample. The data used has a certain lag, which also makes the empirical research of this paper limited to the past development of six stocks of China Mobile, China Construction Bank, China Telecom, Industrial and Commercial Bank of China, China Life Insurance, and Agricultural Bank of China. Therefore, to make the research results more reliable, scholars should try to update the stock return data to the latest date in future research work to make them more timely.

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Moderated Mediation in Earnings Management and Firm Value: Examining the Roles of CSR Disclosure and Accounting Conservatism

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ABSTRACT

This study examines the relationship between earnings management and firm value, emphasizing the mediating role of corporate social responsibility (CSR) disclosure and the moderating effect of accounting conservatism. Using a sample of 731 non-financial companies listed on the Indonesia Stock Exchange from 2016 to 2023, with 5,848 firm-year observations, the research employs panel regression and conditional process modelling to test moderated mediation effects. The findings reveal that earnings management negatively impacts firm value, as profit manipulation erodes investor confidence and diminishes the reliability of financial statements. CSR disclosure fully mediates this relationship by mitigating the adverse effects of earnings management, signalling the firm's commitment to social responsibility, and enhancing stakeholder trust. Furthermore, accounting conservatism moderates these relationships by weakening the negative association between earnings management and firm value while strengthening the positive effect of CSR disclosure on firm value. These results highlight the strategic importance of combining CSR disclosure and conservative accounting practices as governance mechanisms to bolster investor confidence and stabilize firm value.

Keyword: firm value; earnings management; CSRD and accounting conservatism

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INTRODUCTION

Investors and managers often have divergent interests in decision-making, which can lead to conflicts of interest. While investors aim to enhance the value of their investments and achieve maximum profits, managers frequently prioritize personal welfare through the policies and authorities they control. This divergence can motivate managers to exercise discretion in financial reporting, sometimes employing methods that do not accurately reflect the firm financial condition [1]. This practice, known as earnings management, involves manipulating financial information for specific purposes, either legally or illegally [2, 3]. Mnif and Slimi [4] define earnings management as the deliberate alteration of financial information to mislead investors or achieve contractual benefits tied to the reported accounting figures.

From the agency theory perspective, earnings management arises due to information asymmetry between principals and agents. Under such conditions, managers may exploit their discretion opportunistically to maximize personal utility [5]. These opportunistic behaviours often adversely affect the quality of financial statements, rendering them less transparent and unreliable. Consequently, this can undermine the firm credibility and reduce its long-term value [1]. Furthermore, earnings management practices may induce stock price volatility, elevate long-term risks, and erode investor and creditor confidence [6, 7].

Conversely, Corporate Social Responsibility Disclosures (CSRD) can serve as an effective mechanism to mitigate the adverse effects of earnings management. By providing a positive signal to investors, CSRD can help counterbalance the perceived risks associated with earnings management practices [8]. Thus, CSRD function not only as a corporate attribute but also as a mediator that can alleviate the adverse impacts of earnings management on firm value. However, the effectiveness of CSRD in enhancing firm value depends on the quality of the firm financial reporting.

Accounting conservatism represents a critical governance mechanism that curtails the extent of earnings management. Accounting conservatism promotes greater transparency in financial statements by ensuring the early recognition of losses

and deferring the recognition of income until it is fully realized. This approach strengthens the link between earnings management and CSRD while enhancing CSRD role in improving firm value [9, 10]. A combination of robust CSRD and conservative accounting practices can bolster investor confidence in the company's sustainability. CSRD become more effective in enhancing firm value when underpinned by conservative accounting practices, as more prudent financial statements reinforce the perception that CSRD represents a genuine commitment rather than a mere image-building strategy [11, 12].

This study aims to investigate the effect of earnings management on firm value, incorporating CSRD as a mediating variable and accounting conservatism as a moderating variable. Using a conditional mediation model, this study provides new insights into the mechanisms underlying the relationship between earnings management, CSRD, and firm value. The sample comprises 731 non-financial companies in Indonesia from 2016 to 2023, yielding a total of 5,848 observations. The findings reveal that earnings management negatively impacts firm value. Moreover, CSRD fully mediates the relationship between earnings management and firm value, emphasizing CSR's role in mitigating the effects of earnings management. Accounting conservatism weakens the relationship between earnings management and CSRD but strengthens the relationship between CSRD and firm value.

This research makes several contributions to the literature. First, it adopts a novel approach by positioning earnings management as an independent variable, highlighting its direct influence on firm value. Second, the study introduces methodological novelty by applying a moderated mediation model, offering more profound insights into CSRD role as a mitigating mechanism. Third, it extends the literature on firm value by exploring the interplay between earnings management, CSRD, and accounting conservatism, particularly in emerging markets such as Indonesia.

LITERATURE REVIEW

Earnings Management and Firm Value

Managers' decisions are often deemed opportunistic when they exploit accounting policies to prioritize their interests at the expense of shareholders [2, 4, 13]. Managers may manipulate profits to their

advantage through various accounting methods, rules, and guidelines, such as reducing depreciation, altering allowances, adjusting stock values, engaging in tax manipulation, and other tactics while disregarding shareholder interests [6, 14]. As a result, the financial information reported fails to present an accurate and fair representation of the firm value, leading to errors in decision-making [15, 16].

Earnings management can damage a firm image, undermining investor confidence in the reliability of financial statements and creating a perception that the quality of reported earnings is poor [17]. According to agency theory, earnings management arises from information asymmetry and weak corporate governance systems, which create opportunities for management to engage in opportunistic behaviour. Consequently, earnings management has a detrimental impact on firm value. A notable example of this phenomenon is the case of PT Garuda Indonesia in 2019, where the revelation of earnings management practices resulted in a 40% decline in the firm stock price.

The discretionary accrual accounting approach has been shown to negatively affect a firm operational performance and overall value due to the misleading nature of the information it produces [18]. Several studies have also identified a negative relationship between earnings management, financial performance, and firm value [19]. For instance, a study by Ibrani et al. [20] earnings management in non-financial firms in Malaysia found a negative correlation between earnings management and firm value following acquisition dates [21].

H1: Managers opportunistic behaviour in the form of earnings management will reduce the firm value.

The Moderation Role of Accounting Conservatism

Accounting conservatism, rooted in agency theory, helps reduce information asymmetry between management and stakeholders while minimizing agency costs. As a set of regulatory practices, accounting conservatism also plays a pivotal role in corporate governance by enhancing the transparency and accountability of financial statements. By adhering to conservative principles, companies can increase investor confidence in the reliability of their financial statements, ensuring they are

free from manipulative practices. A study by Francis et al [22] demonstrated that accounting conservatism effectively reduces information asymmetry and mitigates adverse market reactions to events that harm the company.

Accounting conservatism has been shown to lower capital costs [23], reduce the risk of stock price crashes [24], and provide shareholders with high-quality, decision-useful information [25]. Additionally, it fosters improved CSRD by enhancing the quality of company information and reducing information asymmetry. Accounting conservatism encourages managers to align their activities with CSR initiatives, ensuring they address the interests of all corporate stakeholders. This alignment underscores the benefits of managerial commitment to conservative reporting practices [25]. In this context, conservatism enhances the transparency of CSR implementation, demonstrating respect for stakeholder interests [23, 26]. Companies adopting conservative practices are better positioned to fulfil their CSRD obligations effectively, meeting stakeholder expectations.

As a moderating variable, accounting conservatism is anticipated to weaken the negative impact of earnings management on CSRD. Companies that embrace accounting conservatism tend to produce more credible CSRD that are less susceptible to the effects of profit manipulation. Furthermore, accounting conservatism can amplify the positive impact of CSRD by delivering additional signals to investors about sound governance practices. According to signal theory, integrating transparent CSRD with conservative accounting practices strengthens the company's commitment to sustainability and financial accountability. Empirical evidence supports this perspective, with several studies reporting that accounting conservatism enhances investor confidence in CSR disclosures, strengthening their influence on firm value [9, 27].

H2: Accounting conservatism weakens the negative impact of earnings management on CSRD.

H3: Accounting conservatism reinforces the positive effects of CSRD on firm value.

The Role of CSRD Mediation

Earnings management is often perceived as opportunistic behaviour that negatively impacts a company's reputation due to the lack of cred-

ibility in reported financial statements. Investors view earnings management as undermining transparency and accountability, influencing their perception of the firm value [11]. When conducted effectively, CSRD can serve as a mitigation mechanism to improve stakeholders' negative perceptions. From signal theory, CSRD provides a positive signal to investors, demonstrating the company's commitment to sustainability and social responsibility [28]. Moreover, CSRD serves as a tool to enhance environmental accountability and secure legitimacy from stakeholders by showcasing the company's responsibility for the impacts arising from its business activities [29].

CSRD also reflects company's ethical values and strategic intent to maintain legitimacy, thereby mitigating the adverse effects of earnings management on firm value [30]. Empirical evidence supports the idea that CSRD can enhance the corporate image, even in cases where the company has been engaged in earnings management [8, 12]. CSR is not merely an organizational attribute but also signifies the company's dedication to sound governance practices, effectively addressing the detrimental consequences of opportunistic behaviour.

H4: CSRD reduces the negative impact of earnings management on firm value.

RESEARCH METHODS

The population of this study consists of 839 non-financial companies listed on the Indonesia Stock Exchange (IDX) during the period 2016–2023. As presented in *Table 1*, the final sample comprises 731 companies, resulting in 5,848 observations. A total of 108 companies were excluded from the sample due to incomplete data. Financial data was sourced from the Bloomberg database. At the same time, CSR disclosures were calculated based on information provided in the companies' sustainability reports and annual reports obtained from the official websites of each listed company. Financial and insurance companies were excluded from the sample because the measurement of variables for these sectors has significantly different characteristics.

The dependent variable in this study is measured using Tobin's Q as a proxy for firm value, as it reflects market expectations of future performance [31]. Tobin's Q is calculated by summing the equity

Table 1

Research Sample

Sectoral Indices	Σ Company	Σ Observation
Energy	89	712
Basic Materials	110	880
Industrial	67	536
Consumer Non-Cyclical	129	1032
Consumer Cyclical	165	1320
Healthcare	34	272
Property and Real Estate	92	736
Technology	47	376
Infrastructure	69	552
Logistic and Transportation	37	296
Sample	839	6712
Firms with missing data	108	864
Final Sample	731	5848

Source: Compiled by the authors.

market value (stock price multiplied by the number of outstanding shares) and the book value of debt, then dividing the total by the book value of total assets [32]. We employ the accrual earnings management proxy for the independent variable, earnings management. Discretionary accruals are calculated using the modified Jones model [33, 34]. Following prior research [4, 35], the total accrual level for a given company ($TAC_{i,t}$) is defined as the difference between net income before extraordinary items from the income statement ($NI_{i,t}$) and cash flows from operations obtained from the cash flow statement ($OCF_{i,t}$):

$$TAC_{i,t} = NI_{i,t} - OCF_{i,t}.$$

Second, in line with the modified Jones model, non-discretionary accruals ($NDAC_{i,t}$) for each observation in the sample are assessed based on total assets ($TA_{i,t}$), property, plant, and equipment ($PPE_{i,t}$), and changes in revenue ($\Delta REV_{i,t}$). The variables are divided by the total assets from the previous period to allow us to account for differences in the size of the firm:

$$\frac{TAC_{i,t}}{TA_{i,t-1}} = a_0 + a_1 + \frac{1}{TA_{i,t-1}} + \frac{\Delta REV_{i,t}}{TA_{i,t-1}} + \frac{PPE_{i,t}}{TA_{i,t-1}} + \tau_{i,t}.$$

Third, nondiscretionary accrual is calculated using, total assets ($TA_{i,t}$), changes in revenue ($\Delta REV_{i,t}$), changes in receivables ($\Delta REC_{i,t}$) and property, plants, and equipment ($PPE_{i,t}$).

$$NDAC_{i,t} = a_0 + a_1 + \frac{1}{TA_{i,t-1}} + \frac{\Delta REV_{i,t} - REC_{i,t}}{TA_{i,t-1}} + \frac{PPE_{i,t}}{TA_{i,t-1}} + \tau_{i,t}.$$

Finally, discretionary accrual ($NDAC_{i,t}$) is a proxy of earnings management ($AEM_{i,t}$) calculated as the difference between the overall accrual ($TAC_{i,t}$) and the non-discretionary accrual value obtained using the modified Jones model ($NDAC_{i,t}$). In line with previous research [3, 13, 19]. Since discretionary accrual can be used to exaggerate a firm's actual profit and underestimate unprofitable profits, we use the absolute value of discretionary accrual (DA) as a proxy for earnings management, the total accrual is calculated:

$$DA_{i,t} = TA_{i,t} - NDA_{i,t}.$$

The mediation variable, CSRD, is calculated based on the Global Reporting Initiative (GRI) standards [11, 36]. The checklist method is used to assess the extent of CSRD made by companies. For each social responsibility item disclosed, the company is assigned a score of 1, and a score of 0 is assigned for items not disclosed. The total CSRD score is calculated using the following equation:

$$\text{CSR Score} = \frac{\text{Items Disclosed}}{\text{Total Items in GRI checklist}}.$$

The moderation variable, accounting conservatism, is measured using the model developed by Basu (1997), which serves as the foundation for numerous studies assessing the level of accounting conservatism. This model is widely recognized and considered one of the most popular measures in the accounting literature. The degree of accounting conservatism is calculated using the following equation:

$$\frac{X_{i,t}}{P_{i,t-1}} = \beta_0 + \beta_1 [D_{i,t}] + \beta_2 [R_{i,t}] + \beta_3 [R_{i,t} \times D_{i,t}] + \varepsilon_{i,t}.$$

The model variables are defined as follows:

- $X_{i,t}$: earnings per share of firm i for fiscal year t ;
- $P_{i,t}$: the price per share i at the start of fiscal year t ;
- $X_{i,t} / P_{i,t-1}$: earnings per share ratio;
- $R_{i,t}$: firm's unforecast stock market performance per share over twelve months beginning nine months before the end of fiscal year t ;
- $D_{i,t}$: a dichotomous variable equal to 1 if $R_{i,t} < 0$ and 0 otherwise;
- $E_{i,t}$: the error term.

The control variables were measured based on established methodologies in prior studies. Firm size (FZ) is measured as the natural logarithm of total assets. The current ratio (CR) is calculated by dividing current assets by current liabilities. Return on assets (ROA) is measured as net profit divided by total assets, while return on equity (ROE) is measured as net profit divided by total equity. Leverage (LEV) is calculated as total debt divided by total assets. For data analysis, panel data regression and the PROCESS tool were employed, using equations 7 and 14 of the Hayes (2022) model regression to test the mediation and moderation models. The regression equation is expressed as follows:

Model 1: Direct effect

$$\text{Tobin's } Q = \beta_0 + \beta_1 EM + \beta_2 FZ + \beta_3 CR + \beta_4 ROA + \beta_5 ROE + \beta_6 LEV + \varepsilon.$$

Model 2: Moderation

$$CSR D = \beta_0 + \beta_1 EM + \beta_2 EM * CA + \beta_3 FZ + \beta_4 CR + \beta_5 ROA + \beta_6 ROE + \beta_7 LEV + \varepsilon.$$

$$\text{Tobin's } Q = \beta_0 + \beta_1 CSR D + \beta_2 CSR D * CA + \beta_3 FZ + \beta_4 CR + \beta_5 ROA + \beta_6 ROE + \beta_7 LEV + \varepsilon.$$

Model 3: Mediation (indirect effect)

$$\text{Tobin's } Q = \beta_0 + \beta_1 EM + \beta_2 CSR D + \beta_3 FZ + \beta_4 CR + \beta_5 ROA + \beta_6 ROE + \beta_7 LEV + \varepsilon.$$

RESULTS AND DISCUSSION

Descriptive Statistics and Correlation Analysis

Table 2 presents the descriptive statistics of the variables in the research model. The average firm value (FV) value is 0.142, with a standard deviation of 2.113. This indicates high variability among the sample companies, as the minimum value is 0.076 and the maximum value is 2.929. This heterogeneity suggests that the sample includes a mix of firms with differing valuations, with most companies exhibiting lower firm values, as the average is closer to the minimum.

The average earnings management (EM) score is -0.525 , suggesting that most companies adopt conservative earnings management practices. However, the data has significant variability, with a minimum value of -3.564 and a maximum of 1.406 . Accounting conservatism (AC) also demonstrates high variability, ranging from -1.435 to 4.000 . This variability indicates substantial differences in the application of accounting conservatism across companies. The mean value of 1.303 reflects that companies, on average, have implemented accounting conservatism reasonably well.

The average CSR score is 0.766 , with a minimum of 0.450 and a maximum of 0.923 . This finding suggests that most sample companies have adhered to reasonable standards for CSR. The average firm size (FZ) for the control variables is 11.599 , indicating significant variability in the scale of assets among the companies. The average current ratio (CR) is 49% , with a standard deviation 4.821 . The return on assets (ROA) averages 11% , with a standard deviation of 0.355 , while the return on equity (ROE) averages 32% , with a standard deviation of 0.780 . Leverage (Lev) averages 44% , with a standard deviation of 0.764 , and ranges from a minimum of 0.380 to a maximum of 0.536 , indicating a generally conservative approach to debt usage in corporate operations.

Table 3 summarizes the correlation analysis for the independent variables in the research model. The correlation coefficients for all variables are below 0.7 , indicating no symptoms of multicollinearity in the model (Alsayegh et al., 2020). Multicollinearity was further assessed using variance inflation factors (VIF), with a threshold of 10 as the standard limit for multicollinearity concerns (Myers, 1990). The results show that all VIF values are below 10 , indicat-

ing weak VIF values and confirming the absence of multicollinearity among the independent variables in the research model.

The regression results indicate that earnings management (EM) has a significant negative impact on firm value (FV), consistent with prior literature suggesting that earnings management practices erode investor confidence and reduce the Firm's value. CSR mediates this relationship, as the inclusion of CSR in the model renders the relationship between EM and FV insignificant, indicating complete mediation. This finding implies that CSR effectively alters investors' negative perceptions of earnings management, mitigating its adverse effects on firm value.

Furthermore, accounting conservatism (AC) acts as a moderator that weakens the negative relationship between EM and FV. This suggests that companies adopting conservative accounting practices can alleviate the detrimental effects of earnings management on firm value. Conversely, AC strengthens the positive relationship between CSR and FV, indicating that combining high CSR and conservative accounting practices enhances investor confidence, ultimately boosting firm value. Among the control variables, return on assets (ROA) exhibits a significant positive effect on FV, underscoring the critical role of profitability in driving firm value. This highlights the importance of financial performance as a key determinant of investor perceptions and market valuation.

DISCUSSION

Earnings Management and Firm Value

Based on *Table 4*, Model 1, the results indicate that earnings management (EM) negatively impacts firm value (FV), with a significance value of 0.097 (-0.001). Earnings management practices significantly diminish firm value as profit manipulation by managers generates negative sentiment among stakeholders. This occurs because the published financial statements fail to accurately reflect the company's business conditions [21, 38]. Earnings management deteriorates the quality of financial statements, making it difficult for investors to evaluate the firm's performance effectively and often leading to misguided decision-making [39].

From the agency theory perspective, management leverages the flexibility of accounting standards to engage in opportunistic earnings management, often

Table 2

Descriptive Statistics

Variable	Obs	Minimum	Maximum	Mean	Std. Deviation
FV	5848	0.076	2.929	0.142	2.113
IN	5848	-3.564	1.406	-0.525	8.682
AC	5848	-1.435	4.000	1.303	5.488
CSR	5848	0.450	0.923	0.766	0.208
FZ	5848	9.170	15.414	11.599	5.908
CR	5848	0.320	0.651	0.496	4.821
ROA	5848	0.420	0.300	0.117	0.355
ROE	5848	0.660	0.460	0.327	0.780
LEV	5848	0.380	0.536	0.344	0.765

Source: Compiled by the authors.

Table 3

Correlation Matrix and VIF

	FV	IN	AC	CSR	FZ	CR	ROA	ROE	LEV	VIF
FV	1									1.59
IN	0.308	1								3.98
AC	-0.108	0.334	1							3.54
CSR	0.503	0.402	-0.005	1						1.99
FZ	-0.065**	0.608	0.077**	-0.028*	1					1.41
CR	-0.004	0.440	-0.015	0.009	-0.002	1				1.94
ROA	0.659**	0.013	-0.203	0.005	-0.019	-0.001	1			1.92
ROE	-0.001	-0.002	0.057**	-0.003	0.031*	-0.007	0.008	1		2.57
LEV	0.101	-0.201	0.223	0.352	0.111	0.025	0.043	-0.088**	1	5.21

Source: Compiled by the authors.

Note: * 0.1%, ** 0.05.

selecting specific accounting methods to enhance their wealth. Prior research has shown that earnings management enables firms to meet or exceed analysts' estimates, thereby increasing managerial compensation [19]. This practice can also influence stock prices and outcomes of initial public offerings (IPOs) [15, 40]. Mnif et al. [4] revealed that managers often use income smoothing to inflate profits during challenging periods and reduce them during favourable times to secure their positions.

Earnings management can lead to a decline in firm value when shareholders suspect profit manipulation [34]. This value erosion is linked to heightened information asymmetry, a tarnished corporate reputation, and reduced stakeholder support [39, 41]. Furthermore, earnings management exacerbates

market inefficiencies and decreases firm value [7]. The observed negative relationship between earnings management and company valuation underscores the critical importance of transparency and accountability in financial statements for maintaining investor confidence and preserving firm value.

The Moderation Role of Accounting Conservatism

Based on Table 4, Model 2, accounting conservatism (AC) weakens the negative relationship between earnings management (EM) and firm value (FV) (significance: 0.061; coefficient: -0.009). This indicates that conservatism acts as a control mechanism that limits the extent of profit manipulation. Accounting conservatism enhances financial reporting quality by increasing transparency

Table 4

Regression Results

Variable	Model 1		Model 2		Model 3	
	Beta	P-value	Beta	P-value	Beta	P-value
IN	-0.001	0.097*	-0.003	0.054*	-0.001	0.707
		(-0.200)		-0.184		-0.117
EM*AC			-0.009	0.061*		
				(0.516)		
CSR*AC			0.002	0.045**		
				(-0.195)		
EM→CSR→FV					0.851	0.050**
						(5.937)
CR	-0.003	0.752	0.009	0.047**	-0.003	0.052*
		(-0.316)		(0.721)		(-0.316)
ROA	0.758	0.000***	0.004	0.074*	0.758	0.000***
		(8.197)		(0.338)		(8.185)
ROE	0.001	0.094*	0.002	0.089*	0.001	0.095*
		(0.133)		(0.143)		(0.132)
LEV	0.001	0.027**	0.002	0.090*	0.001	0.027**
		(0.092)		(0.122)		(0.092)

Source: Compiled by the authors.

Note: * 0.1%, ** 0.05, *** 0.01.

and minimizing risks associated with information asymmetry. These findings align with Li et al. (2020), who reported that accounting conservatism boosts investor confidence by providing a more realistic depiction of a firm's performance. Wati et al. [42] observed that companies with higher conservatism are more valued by investors due to the perceived reliability of their financial statements. Similarly, Pathak et al. [8] demonstrated that accounting conservatism effectively mitigates the adverse effects of earnings management on firm value. Further studies by F. Shahzad et al. [43], Gavana and Gottardo [9] reinforce the argument that accounting conservatism enhances profit quality and reduces the negative consequences of financial misreporting on a firm's reputation.

Conversely, accounting conservatism strengthens the positive relationship between CSR and firm value (FV) (significance: 0.045; coefficient: 0.002). This suggests that robust CSR and conservative

accounting practices send a powerful positive signal to the market. Such signals reflect the company's commitment to transparency, accountability, and sustainability, which enhances investor confidence. CSR and accounting conservatism work synergistically to create a stable and trustworthy corporate image. These findings are consistent with those of Sofian et al. [11], who found that integrating CSR and accounting conservatism increases a firm's appeal to stakeholders. Gavana and Gottardo [9] further reported that CSR disclosures supported by conservative accounting practices bolster firm value by strengthening relationships between the company and its stakeholders. Additional studies by Li et al. [10], Wati et al. [42] highlight that companies combining CSR with accounting conservatism are better equipped to manage market uncertainties. Furthermore, Anagnostopoulou et al. [23] concluded that this approach enhances market stability by signalling adherence to sound governance practices.

The Role of CSRD Mediation

The results indicate that CSRD mediates the relationship between earnings management (EM) and firm value (FV), underscoring the crucial role of CSR in enhancing investors' perceptions of a company. CSR serves as a signal to the market, demonstrating the company's commitment to sustainability and social responsibility, thereby mitigating the negative impact of earnings management. By fostering trust and improving the company's image among stakeholders, CSRD enables investors to focus more on the long-term benefits rather than the short-term risks associated with profit manipulation. Shira [44] asserts that effective CSR practices can reduce market risks linked to earnings management. Pathak et al. [8] highlight that robust CSR disclosures contribute to higher corporate value by fostering stronger relationships between companies and society. Similarly Alqatan and Hichri [28] emphasize that CSR can function as a mitigation tool, offsetting the adverse effects of profit manipulation on a company's reputation. Naqy and Valaskova [45] found that CSR creates a framework for companies to adhere to higher corporate governance standards, enhancing their appeal to investors. These findings align with Shahzad et al. [45], who observed that CSRD helps stabilize markets and reduce the volatility of firm values.

CONCLUSION

This study concludes that earnings management negatively impacts firm value, indicating that profit manipulation undermines investor confidence and diminishes the quality of financial statements. CSRD fully mediates the relationship between earnings management and firm value, demonstrating that CSR can alleviate investors' negative per-

ceptions by signalling a company's commitment to social responsibility. Additionally, accounting conservatism weakens the adverse effects of earnings management on firm value while strengthening the positive relationship between CSRD and firm value. These findings highlight the strategic importance of combining CSRD and accounting conservatism to enhance investor confidence and stabilize firm value.

Theoretically, this research contributes to the literature by supporting Agency, Legitimacy, and Signals theories, which explain how CSR and accounting conservatism mitigate the detrimental effects of earnings management and improve firm value. Practically, companies are encouraged to enhance CSR disclosures as part of their strategic initiatives to strengthen stakeholder trust and improve reputational standing. Regulators are also advised to promote policies reinforcing accounting conservatism to ensure transparency and reliability in financial reporting. The combined implementation of these approaches can deliver long-term benefits for market stability and corporate sustainability.

However, this study has certain limitations. The sample is restricted to non-financial companies in Indonesia, potentially limiting the generalizability of the findings. The measurement of CSR is index-based, which may not capture all dimensions of CSR disclosure. Furthermore, external factors such as macroeconomic conditions and regulatory changes were not considered. Future research should broaden its scope to include financial companies and other regions, adopt more comprehensive CSR measurement methodologies, and incorporate relevant external variables to provide broader and more actionable insights into corporate value management.

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The Russian Insurance Market: Current State and Development Prospects

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ABSTRACT

The article presents the results of the research presented in the reports of the participants at the XXV scientific and practical conference "Insurance, Education and Science" on the topic "The Formation of Insurance Culture: Financial Education and Responsible Business", organized by the All-Russian Union of Insurers and the Financial University under the Government of the Russian Federation. The article reflects the main findings of this event. The presentations of the participants covered the current state of the global and Russian insurance markets, as well as forecasts and possible models for its development. They also addressed a wide range of problems of certain types of insurance and reinsurance. Special attention was paid to the need to improve the level of insurance literacy and insurance culture among Russian citizens as a factor in the development of the insurance market. The results of research into the development of digitalization with a focus on increasing the efficiency of insurance companies and improving the quality of services offered to customers as well as the development of new software.

Keywords: insurance; insurance science; insurance market; reinsurance; insurance company (IC); digitalization of the economy; sustainable development; training of insurers; insurance literacy; insurance culture

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INTRODUCTION

The Russian insurance market has been facing severe sanctions in recent years [1], which, on the one hand, present a serious challenge to its growth, but on the other, they have led to an increased focus on finding ways to stimulate domestic insurance development. This includes exploring cooperation between Russian and foreign insurance companies, considering their financial potential and conducting thorough market research.

Significant factors in the development of the market include the level of financial literacy among citizens, the growth of financial education in Russia, an increased sense of social responsibility, ethical business practices in the insurance industry, and an awareness among insurers of the importance of insurance in the national economic and social spheres.. These factors contribute to the creation of comprehensive insurance coverage, which should be incorporated into the risk management systems of organizations, personal financial planning, and the creation of pension plans and strategies.

The XXV anniversary International Conference “Insurance, Education, and Science” was held to discuss the importance of insurance culture, financial education, and social responsibility of business. The goal of the event was to present the key findings of the conference attendees, exploring the current state and future prospects of the Russian insurance market, as well as strategies and practices for improving financial literacy, training personnel for the ICs, and developing the Russian pension system.

During the conference, participants used various research methods, including empirical, theoretical, qualitative, and quantitative approaches, to collect, analyze, and interpret data. These methods helped the attendees find answers to their questions and test the hypotheses they had formulated.

INTERNATIONAL CONFERENCE “INSURANCE, EDUCATION AND SCIENCE”: HISTORICAL RETROSPECTIVE

The tradition of holding annual scientific and practical conferences on insurance was estab-

lished by Prof. E. V. Kolomin, Deputy Director of the Financial Research Institute at the Ministry of Finance of the USSR/Russian Federation and the first president of the All-Russian Scientific Insurance Society (VSS), which was revived. These conferences aim to activate scientific research in the field of insurance, promote the improvement of teaching quality in insurance disciplines and training personnel for the insurance market, as well as strengthen the interaction between insurance science and business.

The first VSS conference took place in 1999 in Samara. Later, the conference was hosted by Russian regional centers, such as Petrozavodsk, Ufa, and Kursk, but with fewer participants and irregular publication of research results. However, after insurance businesses became involved in the organization and work of the conferences, their importance has increased. In 2007, IC Rosgostekh became a partner of the conference, and the number of participants significantly increased. They included not only academic and teaching staff from universities, but also teachers from colleges, representatives from the Investigative Committee, the Ministry of Finance, the Central Bank of Russia, and the State Duma. During the breakout sessions, discussions focused on specific types of insurance, business processes in the IC, and training for insurers. Conference materials were collected and sent to major Russian libraries, as well as the Insurance Literature Library at St. John's University in the USA.¹

Since 2020, the conferences have been fully supported by the Association of Professional Participants in the Russian Insurance Market, VSS. Due to the COVID-19 pandemic, the conferences were held both in full-time and remote format of participation at universities in Moscow and St. Petersburg. By 2024, annual international insurance conferences had become a unique product of the self-organization of the educational and scientific infrastructure of the insurance market. These

¹ The Kathryn and Shelby Cullom Davis Library at St. John's University's School of Risk Management. URL: <https://www.stjohns.edu/academics/schools/peter-j-tobin-college-business/maurice-r-greenberg-school-risk-management-insurance-and-actuarial-science/kathryn-and-shelby-cullom-davis-library/> (accessed on 09.07.2024). Unfortunately, the resources of this library are currently unavailable in Russia.

conferences discuss issues related to the development of insurance theory, teaching methods for insurance subjects, the conditions and limitations of their practical orientation, and cooperation with employers. The results and final materials of the 2015–2023 conferences were discussed in leading Russian scientific journals [2–21]. The topics of conferences are always related to the most urgent and pressing problems of socialization and development of insurance relations in Russia [2–6], which are developing and changing following Russian society, and the practice of insurance education [7, 8]. The ideas first presented at conferences were later reflected in publications in leading highly rated journals and served as the basis for fruitful scientific discussion on a very wide range of issues related to agricultural insurance [9–12], the effectiveness of digitalization of the insurance business and the protection of policyholders' rights [13–15], sustainable development and environmental insurance [16–20], pension reform [21–23] and other relevant topics.

More than two thousand people participated in the last eighteen conferences. Over one thousand reports were presented and sixteen collections of works were published, containing about one and a half thousand articles. As a result of the collaboration between the real business community and academics, a scientific information resource on insurance has become available to the public. However, insurance science still needs support. Despite the continued growth of the insurance market, specialized insurance departments are gradually disappearing. The peak of this trend was reached in 2017–2018 [8], and the number of trained insurance specialists, insurance disciplines taught, and scientific research on insurance topics has been decreasing.

THE STATE AND PROSPECTS OF THE RUSSIAN INSURANCE MARKET

The participants of the XXV scientific and practical conference discussed the current state and prospective prospects for the development of the Russian insurance market, as well as problems of its digitalization. Professor S.P. Solyannikova emphasized the importance of insurance business, continuity of generations of researchers of

the insurance market at the Financial University and the role of E.V. Kolomina in the development of insurance science. The President of VSS E.V. Ufimtsev noted that the insurance market has shown a twenty-five percent increase in 2023, with two trillion 320 billion in insurance premiums collected, with high business profitability, almost all types of insurance showing positive dynamics, with life insurance being the driving force with a 50 percent increase. The quality of work of ICs with private clients increased and the number of public complaints decreased (averaging from 18,000 to 11,000).

From the point of view of E.S. Nabiullina, the Chairman of the Central Bank of the Russian Federation, a constructive dialogue on insurance is now possible in the State Duma of Russia, which has replaced criticism from deputies in this sector of the financial market.

VSS plans to actively participate in the development of Russian insurance science, including by supporting the holding of this and similar conferences and competitions among undergraduates and postgraduates.

A.V. Yakovlev, Director of the Financial Policy Department at the Ministry of Finance of the Russian Federation, discussed the main directions for the development of the insurance market at the current stage. First and foremost, he spoke about stimulating long-term savings among citizens, which involves not only including insurance companies in long-term saving programs, but also providing tax incentives for them. In the near future, another financial instrument for long-term investment and savings will be introduced on the market: equity life insurance. This is reflected in current legislation. To protect the rights and interests of policyholders, a system of guarantees for voluntary life insurance is being developed, similar to the current systems in place for guaranteeing bank deposits and pension savings. These measures aim to increase the attractiveness of such savings combined with insurance coverage.

The expansion of cooperation within the framework of BRICS is expected:

- Exploring the possibility of creating a specialized reinsurance company (BRICS Re) to form a new international reinsurance hub.

- Protecting national insurance markets.
- Developing independent logistics solutions.

Eurasian reinsurance company has been established and is soon to begin operations. Its primary goals are:

- Assisting in increasing mutual trade and investment within the Eurasian Economic Union (EAEU).
- Promoting economic integration among member states.
- Expanding trade and economic relations among member states and third countries.

The priority for the improvement and development of CTP is the creation of a unified CTP system in the territory of the Union State of Russia and Belarus and the connection of CTP insurers' information systems to the ESIA.

The Ministry of Finance of the Russian Federation will continue to implement the Strategy for Improving Financial Literacy and shaping the financial culture of the population until 2030.

Materials on insurance for various categories of citizens and entrepreneurs, prepared by representatives of the Financial University and Plekhanov Russian University of Economics, contain information presented in an accessible form. These materials provide information about:

- Accidental events that may cause unforeseen expenses for citizens and entrepreneurs.
- Types of insurance that can cover such expenses, both compulsory and voluntary.
- Unforeseen expenses that can arise as a result of these accidental events.

The Ministry of Finance of the Russian Federation has set clear goals for the development of insurance in the territories of the new subjects of the Russian Federation, including the development of a mechanism for insurance against military risks with state support, the development of three types of compulsory insurance (CTP, OSGOO, OSGOP).

A. N. Shcheglov, Deputy Chairman of the Board of JSC Russian National Reinsurance Company (RNRC), presented the main results of the development of the domestic reinsurance market. When analyzing reinsurance data in Russia, it is important to take into account changes in accounting methodology and statistical report-

ing, which reduces the possibility of comparing data from 2023 with previous periods. In 2022, with the introduction of sanctions, the Russian reinsurance market changed significantly, and indicators related to reinsurance premiums due to the transfer of risks to RNRC were distorted. Reinsurance within the framework of the CTP reinsurance pool is carried out without involving RNRC, and this is a fairly significant segment of the Russian reinsurance market.

According to RNRC data, excluding CTP operations, in 2022 the volume of the reinsurance market in Russia decreased by 33% compared to 2021, but increased by 13% in 2023. The share of RNRC in the reinsurance market in 2023 was 72%, and other Russian reinsurers — 24%, which shows that alternative capacities they are present on the Russian market. At the same time, the share of foreign reinsurance — 4% — has decreased many times since 2021 from 72%. First Deputy General Director of GSK Yugoria, A. D. Yazykov presented his findings on real and possible insurance, ways to identify and prevent unfair practices by policyholders and insurers, and to prevent the emergence of insurance products with reduced customer value. During the presentation, the speakers summarized Russian and international experience, and formulated principles for consumer protection in financial services that should be implemented in Russia. These principles include:

- Disclosure of information and transparency.
- Financial education and awareness.
- Responsibility and business conduct of financial service providers and intermediaries.
- Protection against fraud and misuse.
- Data protection and confidentiality of consumers.
- Handling of complaints and compensation for harm caused by actions or omissions.

These principles aim to protect the safety and welfare of consumers in financial transactions and services. N. V. Galushin, the General Director of JSC National Insurance Information System (NSIS), presented the results of their work on creating and launching information support for the Russian insurance market in a speech. The participants were especially interested in analyz-

ing the possibilities for addressing flood losses in the Orenburg region and adjacent areas in spring 2024.

Vice-President of the VSS G.B. Yakovlev spoke about the prospects and problems of the development of the life insurance market in Russia: The life insurance market currently accounts for 35% of the insurance market. The volume of the insurance premium by the end of 2023 amounted to 813 billion rubles. This is an increase of 52% compared to 2022. There are 20 million insurance contracts in force, and insurance reserves amount to 1.6 trillion rubles. It is planned to create two more life insurance companies. The market segment growth trend continues: 226 billion rubles were collected in Q1 2024. The share of life insurance payments in the monetary income of the population has increased 8 times in 7 years.

Compulsory insurance was the focus of attention of the editor-in-chief of the Insurance Business magazine, Professor R. T. Yuldashev.

The ongoing preparations of Russian insurers for the transition to IFRS 17 were the topic of a recent report by D.A. Gorulev, director of the Institute for Digital Economics at St. Petersburg State University. In his report, Gorulev argued that, under the general model of IFRS 17, insurance contract liabilities should be calculated based on the expected present value of future cash flows, considering non-financial risks. He also argued that the current regulatory framework for IFRS in Russia is insufficient.

The plenary session ended with a presentation by Professor A.A. Tsyganov from the Financial University on the consumer behavior of potential home insurance buyers in Russia. In 2022, NAFI and VSK Insurance House conducted a survey to identify the main concerns of Russian society. Concerns about the safety of one's own property were not among the top priorities, which did not motivate consumers to sign classic home insurance policies. The fears of Russian citizens regarding the loss of property are mostly associated with the risks of fire (67.1%), flood (31.5%) and natural disasters (15.1%). However, 18.5% of citizens do not worry about their apartment or house at all, which may indicate a limited understanding of property rights and obligations.

To analyze consumer behavior in the insurance market, it is necessary to consider archetypal cultural patterns and the economic code, as well as the experience of implementing the "Compulsory Insurance of Wages" Law in the USSR. Overcoming the challenges of developing the mass housing insurance market in Russia requires various insurance options with state support at the regional level. These options should eventually become mandatory for each region.

It is important to provide insurance coverage against emergency risks, as well as against fire and floods, which are significant concerns for citizens. The involvement of the state can ensure a positive outcome, such as through the dissemination of information via utility payments, subsidies, and the inclusion of compulsory insurance coverage against emergency situations in fire insurance policies.

According to the speaker, a unified structure is needed to oversee the development of housing insurance in Russia.

FINANCIAL EDUCATION AND INSURANCE CULTURE

The main topic of the conference is reflected in the speech of L.A. Presnyakova, Adviser to the Head of the Consumer Protection Service of the Central Bank of the Russian Federation, who focused on the results of the implementation of the Strategy for Improving Financial Literacy in the Russian Federation for 2017–2023. She laid the foundations of the financial education infrastructure within the education system (98% of schools and 96% of vocational schools were covered; 135 thousand teachers were trained). Financial literacy classes have been introduced from the first to the eleventh grade, with each region developing its own program. As a result, 58 regional centers have been established, reaching a total audience of 60 million listeners. Additionally, a volunteer movement has begun, with 18 thousand people trained as volunteers.

The specifics of the new strategy are that it will focus on long-term planning and building trust in financial institutions. Research on the practical use of consumer profiles will be expanded, and teaching and research in behavioral economics will be intensified.

The methodology for calculating the financial culture index will be based on factors such as the number of voluntary insurance contracts concluded by the population. Measures implemented during the strategy's implementation will be adapted to different stages of the human life cycle, with more attention paid to financial cybersecurity and the formation of sound financial behaviors.

Partnerships with companies from various business sectors will be expanded. The strategy shifts the focus from financial literacy to the formation of a financial culture, with main efforts directed towards educating economically active citizens. The logic of the process is to move from financial literacy to financial culture and, then, as financial culture increases, towards financial well-being. In order to achieve this, the financial market needs to function as a unified system, as it is easy for customers to lose trust if there are any issues.

If a sufficiently high level of trust has been established in banks in the country, the situation with insurance is more complex, and trust in this area is still being built. The Central Bank of the Russian Federation provides a range of tools to implement the Strategy, including the Financial Culture portal and Financial Navigator, as well as textbooks. At the same time, financial education tools are aimed at different audiences, including people who find themselves in difficult financial situations. The level of financial literacy and culture achieved is the result of actions by financial organizations. It is important for them to be aware of their responsibilities and understand that consumers should have basic financial knowledge. Therefore, the Strategy emphasizes the need to broaden the range of partners in improving financial literacy. As part of implementing the adopted Strategy, the Central Bank of the Russian Federation conducts applied scientific research. The very concept of "financial culture" requires clarification and a more comprehensive description of this phenomenon from a social and economic perspective.

One of the departments of the Central Bank, for example, has conducted a study on the impact of financial literacy on consumer behavior.

Specifically, the study attempts to address "naïve" financial behavior, where the client acts rationally on a personal level (microloans, etc.) but not generally rationally.

The Central Bank would like to address these and other issues together with the academic community in order to achieve its goals.

Professor K.E. Turbina of MGIMO University of the Ministry of Foreign Affairs of Russia focused on the use of scientific research and forecasts of the insurance market development in the educational process. For example, the discipline "Economics of the insurance market" is taught in the first year and includes three parts: the institutional theory of the insurance market; factors of supply and demand by type of insurance; forecasting the insurance market. The latter involves calculations and comparisons that the student makes. The students were invited to participate in the project "Assessment of the effectiveness of state regulation of the insurance market." According to several dozen experts who took the survey, this effectiveness can be estimated at 55 points out of 100.

S.V. Beri, Director of the Rosgosstrakh Department, presented a report on the formation of an insurance culture through customer service, focusing on the competencies of the employees of the IC contact centers.

Representatives of the section "Strategy and practice of improving financial/insurance literacy" examined these concepts from different angles. The report by Professor S.A. Belozyorov of St. Petersburg State University (SPbU) was devoted to the interpretation of the terms "Insurance literacy" and "Insurance culture".

A report by Professor I.B. Kotlobovsky from Moscow State University and Senior Lecturer V.G. Varshamova from the same university was dedicated to the culture of risk and the human factor in the face of natural disasters. The report focused on floods, including the Orsk natural disaster that occurred in spring 2024. This event showed a number of errors and omissions made by decision makers, leading to significant material damage.

As of the morning of April 10th, 12,817 residential buildings and 14,969 household plots

were flooded in Orsk and its surrounding area. If decision makers had a better understanding of risk identification and management techniques, such damage could have been prevented.

A speech by Professor I. P. Khominich of the Russian University of Economics was devoted to the influence of demographic factors on insurance culture and literacy.

A report on the role of the family in financial literacy in the insurance sector was presented by Associate Professor A. Y. Alyoshina of Moscow State University. Due to the fact that the subject of social studies, which discusses the role of insurance in people's lives, is being removed from school curricula, the responsibility of families in this area is increasing. To improve insurance literacy, it is suggested to use the experience of "Open Days" organized by insurance companies for employees and their families, as well as holding events such as quizzes, games, and exhibitions as part of city activities. Initiatives in this regard can be taken by the IC, BCC, Association for the Development of Financial Literacy (ARFG), National Center for Financial Literacy, and other organizations promoting financial literacy, with support from city administrations and relevant departments, as well as higher and secondary professional educational institutions.

MGIMO Associate Professor V. V. Barabanova continued her analysis of the problems of implementing housing insurance in Russia, gave in her speech an overview of natural disaster risk management systems with government support, as well as data from the online survey "Why don't people insure their homes?", according to which almost 40% of respondents with uninsured housing had never thought about insurance.

In her speech, E. Y. Galkina, a teacher at the POU "CAPT", presented data characterizing the insurance culture in Kashira. She noted that among residents, people who had not signed insurance contracts predominated (61%), and among those who were insured, the majority (46%) said they were forced to contact an insurance company.

Among the reasons for distrust in the IC, there were doubts about the fulfilment of obligations by insurers (16.6%), financial losses related to

contracts with the former USSR State Insurance Company (30.2%), general distrust of financial institutions (25.8%), a low level of service at insurance companies (19.4%) and a lack of information about insurance companies (8%). Associate Professor of St. Petersburg State University A. A. Koltsova studied the perception of the insurance services market among young people. The speaker cited data from a survey of young people, among whom only 18% used insurance services. She explained that the reasons for this low interest included lack of knowledge about insurance (53.3%), lack of funds (26.7%), lack of popularity of insurance (13.3%) and lack of personal interest in the topic (6.7%). She suggested that it is important to pay special attention to different types of insurance for young people in educational programs, such as insurance for young car owners, families with children, international students, and those involved in extreme sports. Methodological support requires more practice-oriented tasks aimed at finding and processing information about the insurance market; working with cases based on specific life situations. When conducting pedagogical monitoring, a double (entrance/exit) questionnaire is required.

PERSONNEL TRAINING FOR INSURANCE COMPANIES

The targeted training of specialists for the IC was a focus of attention for the representative of VSS, Associate Professor E. V. Zlobin. He identified the main challenges of targeted training through the example of the Continuity program, which was developed with his involvement. Some of these challenges include the need to coordinate curriculum and program changes, as well as students who "graduate" without feeling gratitude towards the company that funded their training and often do not wish to return to their home regions. Additionally, there are issues related to the insurance company's structural policies, such as employee dismissals due to restructuring and the lack of appealing vacancies in regional areas, as well as an unclear personnel strategy.

Increasing motivation to study insurance-related subjects among undergraduate economics students was the main focus of attention for

S.A. Kalaida, an associate professor at St. Petersburg State University, and Yu.A. Tarasova, an associate professor at the Higher School of Economics in St. Petersburg.

Associate professors of Kemerovo State University, O.N. Kozlova and A.N. Chelombitko, conducted an analysis of the development of insurance education and the formation of a model for interaction between universities and insurance companies based on materials from scientific and practical insurance conferences held between 2007 and 2023. More than a thousand presentations presented in collections of scientific papers allowed them to identify areas for the development of insurance research, including in the field of personnel training for insurance companies. During the analyzed period, there has been a gradual shift from general theoretical issues to the analysis of insurance as part of the financial system. A topic dedicated to the Russian insurance market has been developed. There has been a transition from focusing on national markets to regional and international markets. More and more attention has been paid to the development of new types of insurance, such as environmental insurance, insurance for new risks associated with digitalization, and investment life insurance. The expansion of social insurance coverage and its special role has been noted. A significant number of studies have been dedicated to pension insurance. Integration processes have led to an examination of the interaction between Russian and foreign insurance markets, including educational programs. These studies have continued in the face of external challenges such as sanctions and the pandemic.

The topic of business processes in insurance organizations has evolved from general issues of solvency and financial stability regulation to include marketing, underwriting, and actuarial calculations. During the conference, a range of topics of interest to researchers in the field of education has emerged, including methodological support for insurance courses, applied learning technologies, experiences and new developments, and the interaction between universities and employers. Based on these findings, speakers recommend establishing a comprehensive training

program for insurance professionals that takes into account the needs of schools, universities, vocational schools, and employers.

The interaction between the institutions of the SPO and the IC for the training of insurance industry personnel was discussed in a report by M.V. Rodionova, a lecturer at Petrovsky College. SPO graduates work as operational accounting specialists, office sales managers, insurance agents, insurance specialists, and loss settlement administrators.

L.A. Shutova, Head of the department for work with young specialists at Ingosstrakh SPAO, spoke about the Youth Ambassadors program, which made it possible to increase the results of the HR department's activities through advertising from 10% to 30% in 2023 during the classroom selection process. An ambassador can be a teaching employee of the company or an external university teacher loyal to the company. At the same time, it is advisable to involve a specialized educational institution, faculty, discipline and career guidance activities with undergraduates.

THE DEVELOPMENT OF THE INSURANCE MARKET IN THE CONTEXT OF DIGITALIZATION

Two sections of the conference — “Insurance Modernity” and “Insurance Markets and Products” — were devoted to the problems of developing insurance relations, forming new insurance products, and adjusting business processes in insurance organizations.

The participants of the Insurance Modern section listened to a report by Professor Y.T. Akhmediani of the Russian University of Economics on the topic “Prospects for the development of the insurance market in the context of digitalization of insurance services”. The Russian insurance market demonstrates digital maturity, efficiency, and financial stability. Ensuring the quality of insurance services in the context of digitalization requires a customer-centric approach and the provision of customized digital insurance products that meet the real needs of policyholders.

At the same time, it is essential to develop standards for digital insurance services, train skilled personnel who are aware of insurance

needs in the digitalization of the market, and enhance digital insurance literacy.

Global post-pandemic risks for the insurance market became the topic of a report by MGIMO Professor of the Ministry of Foreign Affairs of Russia N.G. Adamchuk.

O.V. Zakirova, Associate Professor at the Volga State University of Technology, identified the key role of smart contracts for the development of InsurTech in Russia.

The topic of the speech given by Associate Professor E.V. Altukhova from the Financial University was identifying the risks associated with the use of artificial intelligence (AI) in financial technology (FinTech). She stated that Russia is among the top five countries in terms of the number of documents accepted in the field of AI. This will inevitably lead to an increase in awareness of insurance needs.

V.A. Voevodin, an associate professor at MIET, revealed the main stages in the development of information risk insurance regulations in Russia from 2000 to 2024. He emphasized that the problem of information security is either recognized as a priority and requiring immediate attention, or it is absent from strategic planning, even though it has not been fully addressed. The limitations of current methods, models, and tools for assessing the stability of critical information infrastructure under threats to information security hinder the development of information relationships.

Associate Professor of MGIMO, E.V. Nebolsina, gave a speech on the current trends in the transformation of the insurance industry. The prospects for the development of insurance regulation in Uzbekistan were discussed by Professor H.M. Shennaev of Tashkent State University of Economics and Director B.R. Shamsutdinov of the Innovative Insurance Center at the National University of Uzbekistan. R.S. Azimov, General Director of Uzbekinvest Insurance Company, discussed the role and place of compulsory and voluntary insurance in the development of the national insurance model in Uzbekistan.

MSU employee E.Y. Arkhipova discussed the features of the Chinese insurance market's development after the pandemic. She noted that the

People's Republic of China has begun to actively restructure its business processes, particularly online sales channels. She pointed out that demand for certain personal insurance products had increased sharply, especially for long-term care insurance, from 25.8% to 37.6%. The speaker also mentioned government initiatives to create joint insurance products, such as the joint initiative between the government and commercial insurers, "Huimin Insurance", to provide insurance coverage against critical illnesses for low-income individuals. She emphasized that the perception of insurance among the Chinese population has improved due to these joint efforts between the state and private insurers during the pandemic.

In his speech, MGIMO Professor A.P. Arkhipov stated the inflationary nature of the growth of the Russian insurance market in 2023.

The specific features of the life insurance industry in the new circumstances, financial support in the event of an oil spill, and insurance for tourist risks in the Republic of Belarus were presented in the reports by Associate Professor E.V. Zhegalov, Associate Professor O.L. Domnina and Professor T.A. Verezubov.

The main trends in the insurance market development in Siberia were described in the report by E.L. Prokopyeva, an economist from the Siberian State Institution of the Central Bank of Russia.

The conceptual aspects of social risk research were discussed by Associate Professor S.E. Shipitsyna from Perm State National Research University. She noted that the manipulation of social risks can lead to an unjustified increase in dependence, a violation of social justice principles, and the formation of a consumerist society.

THE PROSPECTS FOR THE DEVELOPMENT OF THE RUSSIAN PENSION SYSTEM

The topics of the presentations at the meeting of the section on the future of the pension system are relevant from both a scientific and practical perspective, affecting the financial interests of Russian citizens. A.K. Solovyov, the director of the Research Center for the Development of the State Pension System at the Financial University, will discuss the challenges of developing the Rus-

sian state pension system in light of digitalization and global issues.

The future of pension savings in compulsory pension insurance was presented by Associate Professor of Baikal State University E. V. Ageeva. The problems of state and non-state pension provision through the eyes of youth were highlighted by O. A. Alexandrova, Deputy Director of the ISEPN FNSC RAS. The report of A. V. Ragozin, Director of the Center for Organization, Financing and Inter-Territorial Relations in Healthcare at the Financial University, was devoted to the issues of determining the income base of the pension system.

The stability of the mechanism for redistributing pension obligations was discussed by D. V. Pomazkin, a chief expert at the HSE Center for Comprehensive Social Policy Research. He noted that if there are internal changes caused by a system reform, such as adjustments to the retirement age, contribution rate, and other main parameters, an external impact will form over time, bringing the system back to its original state.

Estimates show that, over time, the increasing number of pensioners due to longer life expectancy will gradually return the number to pre-reform levels.

ESG-TRANSFORMATION IN FINANCIAL MARKETS

The Deputy Director of the Corporate Relations Department of the Central Bank of the Russian Federation, V. Y. Stepanenko, spoke at the plenary session and focused on topical issues related to implementing the principles of sustainable development in the Russian financial market. The participants of the session, which was dedicated to the problems of ESG transformation in financial markets, discussed these issues.

The problems of insuring crowded facilities against terrorist attacks were the focus of the attention of Associate Professor V. P. Avdotyin from RUDN University and L. V. Palinkash from MSU. During the presentation, the performance indicators of the Russian Anti-Terrorism Insurance Pool, which includes 24 insurance and reinsurance companies in Russia, were shared. Since 1 Janu-

ary 2024, the capacity for reinsurance against terrorism and sabotage has increased from 18.6 billion rubles to 25 billion rubles.

The Ministry of Finance of the Russian Federation has reported that, in order to encourage legal entities, a state-supported insurance scheme has been introduced to protect the property of individuals and companies against damage caused by events resulting from sabotage or terrorist acts in the territories of new Russian regions.

At the end of the presentation, the speakers agreed that it was essential to adopt a law on liability insurance for the owners of crowded facilities. Professor T. E. Gvarliani from Sochi State University focused on climate change and its impact on the increasing role of government regulation in insurance. He noted that the total damage caused by climate change exceeded \$250 billion and that direct losses from natural disasters averaged 1–2% of national income over a ten-year period. Climate change leads to forest fires and floods.

The vice-rector of the Ural State University of Economics, E. G. Knyazeva, analyzed the current state and priorities of regulating compulsory medical insurance in Russia. She emphasized the importance of building a stable and balanced system for providing medical care based on the principles of unity, accessibility, and quality in Russian healthcare.

Yu. A. Solovyova, an employee of Rosgosstrakh, presented her perspective on ESG (Environmental, Social, and Governance) principles through the lens of digital car insurance. She highlighted how car insurance can have a positive impact on the environment by encouraging careful driving and timely maintenance, which can reduce pollution and promote sustainable practices.

CONCLUSIONS

The XXV Anniversary International Conference “Insurance, Education, and Science” was a significant event for representatives of Russia’s scientific and educational institutions in the insurance sector. During the plenary session and seven thematic sessions, more than 70 presentations were delivered. Around 150 participants, including over 100 in-person attendees, attended the confer-

ence both in person and virtually. Representatives from Belarus, Kazakhstan, and Uzbekistan were among those who attended. Teachers from over 40 higher and vocational educational institutions located throughout Russia's regions also participated in the event. Among the conference attendees were more than 25 professors and doctoral holders, over ten department heads, several dozen associate professors and candidates of science.

The development of the Russian insurance market continues relatively smoothly, despite some sanctions restrictions that have had a limited impact on the insurance and reinsurance sectors. However, these sanctions have emphasized the importance of domestic insurance companies and the need for them to develop their own capabilities in order to set and solve complex insurance-related tasks.

This includes the creation of an insurance culture that takes into account the interests of all stakeholders, including through financial education and increased responsibility on the part of insurance businesses. To this end, it would be beneficial to develop and implement targeted programs aimed at improving financial literacy in

the sector, for example in collaboration with the National Union of Agricultural Insurers and other relevant organizations.. It is also important to introduce risk management and insurance courses in secondary and specialized educational institutions. Additionally, it would be beneficial to support the creation of branded insurance classrooms and collaborative spaces with appropriate logistics support in universities.

In today's world, with an increasing need for highly skilled professionals, the formation of a digital culture in society, and concerns about improving educational quality, it is essential to motivate students to study insurance-related subjects in economics. This is a trend in the development of higher education in Russia, as it involves updating the model of interaction between insurance companies and educational institutions.

It is crucial to involve the insurance industry in the reform of Russian education and the implementation of the "Professionalism" federal project. The conference concluded with a scientific reading in memory of Professor Y. S. Bugaev, where representatives of Russian insurance scholars were awarded.

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S.A. Belozyorov — formulated the research goals and objectives, developed the article's hypothesis, and validated it based on the data obtained.

Yu. V. Gryzenkova — reviewed the literature on the topic under study, analyzed and described the results.

E. V. Zlobin — analyzed and described the results.

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The Optimal Way to Sell a Debtor's Property During Bankruptcy

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ABSTRACT

This article is devoted to the issue of choosing the most effective way to sell the property of a bankrupt entity. It discusses the sale of each asset individually or selling of the entire property complex as an operating business. At the same time, there is no unified practice on this issue in the judicial practice in bankruptcy cases. The purpose of the study is to determine the optimal way to sell a debtor's property during bankruptcy by establishing the main criteria for analysis during the selection of either an object-based sale of assets or a sale of a property complex as a whole as a single production and technological unit of business. In the course of the research, methods such as content analysis of sources, regulatory regulation, and market analysis were used. These studies were carried out by taking into account the analysis of the current legislation norms, general economic market trends and the study of judicial practice in bankruptcy cases of business entities. This study is based on a forensic examination conducted by the author as a judicial expert in a bankruptcy case of a legal entity. In the course of the study, the author analyzed the main reasons for the location of non-current assets in business entities, examined the basic conditions and market trends in the sale of property of bankrupt entities, and identified the main criteria and factors that influence the decision on choosing the optimal method for selling the debtor's property during bankruptcy. The study shows that there is no consensus on this issue among the scientific community and judicial practice. The author has developed and proposed recommendations that are most likely to lead to cost-effective decisions when choosing a mechanism for selling the property of a bankrupt entity. The sale of industrial and real estate on site would be more appropriate if the production process was destroyed, and part of the equipment was dismantled. Conversely, the sale of the debtor's property as a single lot (excluding non-core assets) would be most effective if the debtor's assets could be sold as a going concern.

Keywords: bankruptcy; business sale; market value; valuation activity; court proceedings; method of implementation; debtor

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INTRODUCTION

Based on the analysis of the life cycle of a business, it can be argued that eventually, most organizations may face liquidation. If it is not possible to identify [1] and prevent bankruptcy during the early stages of a financial crisis, the organization may end up being liquidated through court proceedings. At the same time, for many companies, the process of liquidation begins during a financial crisis when it becomes impossible to repay all debts owed to creditors from the company's assets. In these situations, the company goes through bankruptcy proceedings in a court of law. During the bankruptcy process, a common question arises: should the company's assets be sold as a single entity, or should they be divided into individual assets such as equipment, real estate, and vehicles? There is no uniform practice on this matter in bankruptcy court decisions. The lack of uniformity is due to the fact that in each case of bankruptcy of an economic entity (commercial organization or individual entrepreneur), there are individual operating conditions, disparate levels of initial financial condition of bankruptcy proceedings, varying degrees of depreciation of fixed assets, different levels of property security and a number of other significant factors.

It should be noted that even in the absence of a single mechanism for the sale of the debtor's property (on an object-by-object basis or by a single property complex), nevertheless, the analysis of judicial practice and the study of market trends allowed us to develop well-reasoned recommendations for determining the optimal way to sell the debtor's property during bankruptcy, taking into account public interests.

The purpose of the study is to determine the optimal way to sell a debtor's property during bankruptcy, by establishing the main criteria for analysis during the selection process of individual assets or the sale of a property complex as a whole, as a single business unit.

To achieve this goal, the author solves the following tasks:

- analyze the main reasons for the sale of the main production assets of economic entities;
- investigate the main conditions and market trends in the sale of property of bankrupt entities;
- identify the main criteria and factors influencing the decision on choosing the optimal way to sell the debtor's property during bankruptcy: object-by-object sale of assets or sale of the entire property complex as one production and technological line;
- develop recommendations on the best way to dispose of debtor property during bankruptcy.

The development of appropriate recommendations for choosing the best way to dispose of a debtor's assets during bankruptcy can help streamline the process and respect the interests of all parties involved. The algorithm proposed in this article for selecting the appropriate method of asset sale can help make a well-informed decision on this matter more quickly. These scientific studies were carried out by the author, taking into account the conclusions obtained during the judicial examination in the debtor's bankruptcy case [see Ruling of the Arbitration Court of the Tula Region dated 02.05.2023 in case no. A68–13003–34/2020 (bankruptcy of Tula Pioneer LLC)].

The results of these studies will be relevant for arbitration managers when preparing proposals for the sale of a debtor's assets, as well as for bankruptcy creditors when deciding on approval of a property sale plan. These conclusions may also be helpful to judicial authorities in resolving disputes regarding the choice of a suitable method of selling assets during bankruptcy proceedings. Additionally, individual thoughts and findings from the research may be useful for business owners in making managerial decisions regarding the implementation and/or diversification of their companies.

THE RESEARCH PART

Within the scope of this study, it would be beneficial to consider all the primary reasons why

a current and profitable business could be sold, either in its entirety or in parts. It should be noted that for the purposes of this study, the assets and properties of an economic entity are considered to be non-current assets such as fixed assets, ongoing construction projects, intangible assets such as licenses and production technologies, and other long-term investments. The findings of this research are less relevant to the current assets of an organization. It is significant to note that in the event of a municipal unitary enterprise's bankruptcy, it becomes necessary to apply specific legislative regulations for such entities [2]

Let's identify the reasons why a commercial enterprise may need to sell its property.

1. Temporary financial problems. If an organization is experiencing financial difficulties, such as a shortage of funds, inability to repay debts or pay dividends to shareholders, then asset sales may be one of the ways to solve these problems. At the same time, they will probably sell non-core products (not involved in the main production process). assets.

2. Updating and upgrading. The sale of some assets may allow an organization to free up space and invest in new technologies, equipment, or improved production processes, which will increase efficiency and competitiveness.

3. Restructuring and optimization. In some cases, the sale of property can help optimize your assets by eliminating duplication or excess capacity. This can lead to increased profits and an improved overall production structure.

4. Diversification. The sale of assets may allow you to change activities or adjust the specialization of production, and will help you find new markets or business lines.

5. Acquisition and merger. Asset sales can also be part of a strategy to attract new investors or to merge with other companies.

6. Personal motives of the owner [3]. In some cases, the owner of an enterprise may decide to sell assets for personal purposes, for example, to generate income or invest in other projects or at the end of his professional career.

7. Payment of debts that cannot be covered by the organization's current operations. The

sale of assets can provide a source of funding to pay off the organization's debt. However, the payment of all major debts may be at a stage of bankruptcy for the organization.

In most cases, in addition to getting the maximum amount for property being sold, other aspects of economic activity can be important. For example, if it is necessary to maintain the current production process, an organization may sell only non-essential, outdated, or significantly worn out items of fixed assets. This is because preserving the production line is more important than selling the property.

Alternatively, an organization might want to vacate production facilities in order to expand its production or change its business model. However, there is no need to worry about maintaining the existing production at that location. Instead, the goal may be to use those facilities for other purposes. When making management decisions during which the sale of property is envisaged, the management of the selling organization proceeds from market conditions, taking into account all relevant factors.

The sale of the property of a debtor organization during bankruptcy is not aimed at respecting the interests of its owners, but rather at serving the public interest. The bankruptcy process is characterized by a constant search for a balance between the interests of the insolvent debtor, its creditors, the state, and society, while taking into account the fulfillment of the obligations of the business entity to its creditors [4]. Therefore, during bankruptcy, there is a reasonable need to form the maximum bankruptcy estate from the debtor's assets. However, time also plays an important role in this process. Nevertheless, the goal of preserving the production chain during bankruptcy is worth it. The preservation of current production by the debtor is acceptable, and it is possible to sell a single property complex as a whole. At the same time, it is necessary to find a way to sell it so that it generates as much money as possible in the shortest possible time at the lowest possible cost.

There are two main approaches here:

1. Selling the property as a part of one lot, as a property complex, as a single production and technological line.
2. Selling the specified property in several lots, by disassembling it into parts and selling them individually.

So, when selling the property, you have a choice between selling it as a whole complex or in separate parts.

Considering options for the sale of assets, as mentioned previously, the issue of selling non-current assets that are involved in the production process is currently being addressed. With regard to materials, stocks, finished products, securities, and other non-core assets, this issue is not as significant.

The rate of sale of single items of property (or several items of property related to each other by similar qualitative characteristics) is higher than the rate of sale of a (significantly larger) batch of property. Moreover, the following principle of pricing in economics can be cited as a general economic trend: "Wholesale is always cheaper than retail". The principle described generally suggests that wholesale prices are usually lower than retail prices. This is because when buyers purchase goods in larger quantities, they are able to receive discounts from manufacturers and save on costs associated with logistics, packaging, and order processing. Hence, variable costs are significantly reduced, that is, those that directly depend on the number of services provided or goods sold. At the same time, wholesale sales can be beneficial for both sellers and buyers at the same time. Retail trade provides for a margin [5].

Note that the above principle is suitable not only for consumer goods, but also for industrial raw materials, production equipment, etc.

However, considering the issue of implementing the production line as a property complex (industrial equipment combined into a single production process, including real estate where this line is located), that is, the sale of assets as a bulk, in a single lot, which includes the main production assets including the production line, real estate and all necessary infrastructure for

production (power supply networks, water supply, sanitation systems, transportation infrastructure, and other essential elements of the production process at this particular facility), it is necessary to take into account other factors affecting pricing.

For example, when selling production equipment and real estate in parts, revenue may theoretically be higher, but unnecessary unjustifiably high costs may appear (for example, for disassembly and transportation).

In such a situation, it is necessary to analyze all the pricing factors for the sale of the bankrupt entity's property.

It should be noted that each case of bankruptcy has its own unique circumstances and financial details. It can be difficult for a court to fully understand all the economic and technical aspects of a situation on its own, so the judicial system often seeks the help of specialists and appoints expert reports to assist in resolving these issues [6].

Let's consider the issue of determining price-forming factors in more detail.

Analyzing the market opportunities for selling a property complex, we started from the existing standards and regulations for valuation activities provided by Federal Law No. 135-FZ dated July 29, 1998 "On Valuation Activities in the Russian Federation". The principles of selling debtors' assets during bankruptcy proceedings were taken into account and the general economic principles of pricing in market relations between businesses were analyzed. Based on this analysis, the following conclusion was reached:

When deciding on the most effective method for selling the assets of a bankrupt company (object-by-object sale of assets or sale of a single property complex), it is necessary to analyze the following price-forming factors:

1. The opportunity to avoid the irretrievable loss of previously capitalized costs incurred for the installation and commissioning of the production line.
2. The ability to avoid the costs of dismantling, loading, transportation, unloading, installation and commissioning of production equipment.

3. The opportunity to preserve the production permits, the existing product certification and/or trademark, i.e. to avoid additional costs for the above set of documentation.

4. The ability to maintain business reputation and established business contacts with suppliers of resources and buyers of finished products.

5. The presence of non-core assets, which can negatively affect the formation of the value of a single property complex.

Let's analyze each factor in more detail.

The opportunity to avoid the irretrievable loss of previously capitalized costs incurred for the installation and commissioning of the production line.

The organization, which is currently in bankruptcy proceedings, initially produced products on a production line that will be sold to replenish the funds in its bankruptcy estate. At the same time, the current owner has incurred corresponding costs for the design, delivery, installation, and commissioning of this specific production line.

Initially, creating a production line involves the following steps:

- preparation of project documentation, which includes design estimates, a feasibility study, a business plan, and so on;
- search and preparation of appropriate premises sufficient for carrying out all stages of production, as well as supply and sales processes of commercial activities;
- purchase of all necessary production equipment and its delivery to the installation site;
- installation of equipment in a single production line;
- carrying out the start-up and commissioning of the line.

This is not an exhaustive list of events.

Consequently, the actual operating production line has a value significantly higher than the value of the property itself (equipment and real estate in which this production is located).

In the event of the sale of a production line as a whole, all previous capital expenditures related to its formation would be considered

irrecoverable from an economic perspective. These capitalized costs would have value and a positive impact on the property's value only if the production line remained in its current location, without any need for relocation.

However, in the event of the acquisition of the entire property complex by a new owner, the capital expenditures incurred for designing, delivering, installing, and commissioning production equipment during the construction of the production line would continue to be economically viable and would positively influence the value of the property.

In order to determine the cost indicators for capital expenditures related to the design, installation, and adjustment of equipment for an operating production line, we refer to relevant literature on evaluation activities. If there is no exact documentation on the costs of forming the production line (excluding the cost of equipment), appropriate calculations can be made to determine cost indicators. In scientific and reference literature, the costs associated with activities such as design, transportation, installation, and commissioning equipment for a production line are typically expressed as a percentage of the cost of industrial equipment. At the same time, there is a certain range indicated, as the amount of corresponding expenses may vary depending on the location, business profile, equipment originality, and other factors. Considering all these relevant features, it is necessary to determine cost parameters.

To analyze the data, we recommend using the "Handbook of the Appraiser of Machinery and Equipment, Correction Coefficients and Characteristics of the Machinery and Equipment Market" by L. A. Leifer [7].

Installation of equipment usually costs 15% of its cost [7]. In the scientific and reference literature, the percentage of commissioning costs is indicated from the value of the new equipment. Considering that the equipment is in operation, but partially worn out (and in some cases partially obsolete) It can be one and a half to two times cheaper than a new one (excluding transportation and installa-

tion costs), then the percentage value for these costs will be higher in relation to partially worn equipment. However, this calculation does not yet take into account the cost of transporting equipment. It depends on the distance and the delivery method.

Note that all of the above conclusions apply not only to a single production line, but also to real estate, including production and storage facilities, as well as the rights to the land (ownership, lease, or other use) on which these properties are located. When determining the cost indicators for real estate, it is important to take into account both the rights to the building and the land plot separately [8]. The economic rationale for acquiring all the property suggests that there is no need to relocate the current production line to a different location. Alternatively, a long-term lease could be arranged for the real estate, under agreed terms. The termination of this lease by the landlord would cover the costs of relocating production and compensate for any losses incurred during the process of moving production to a new site.

The ability to dispense with the need to carry out the costs of dismantling, loading, transportation, unloading, installation and commissioning of production equipment.

If the existing production line is sold during bankruptcy, with the condition that the equipment is transferred to another location, in addition to the irrecoverable loss of previous installation and commissioning costs for the line, additional costs will need to be incurred for moving the equipment to a new location. It is not fundamentally important whether the production equipment from this line is transferred entirely to one location or in parts (equipment units) to two or more locations, forming or replacing elements of other production processes. The costs associated with dismantling, transportation, and installation at the new location must be fully covered.

According to the data from this directory, the average discount for dismantling equipment will be at least 10% of the total value of movable property [7]. At the same time, it is also necessary to take into account the costs of

transporting equipment (possibly parts of the production line to various locations) to a new place of use. Further, it is also necessary to take into account the costs of installing equipment in a new location.

The opportunity to preserve the production permits, the existing product certification and/or trademark, i.e. to avoid additional costs for the above set of documentation.

Speaking about the current production line of the debtor organization, it is also necessary to keep in mind the permits for production, licenses (if any are provided for by the Federal Law "On Licensing of Certain Types of Activities" dated 04.05.2011 No. 99-FZ or other regulatory legal acts regulating licensing), the right to extract minerals [9], product certification, trademark and other intangible assets directly related to the manufactured products. It is necessary to understand that intangible assets, according to current legislation, have a relationship not so much with the production line as with the business entity. Individual objects of intangible assets (trademark, technological map of production, recipe) can be sold within the framework of a single production complex (or separately from it) [10]. However, some objects (membership in a self-regulating organization [11], license [12], permits [13]) are directly linked to a legal entity, and the alienation of such specialized (inseparable) assets is not provided for by current legislation. At the same time, there are legal mechanisms when a bankrupt entity is not liquidated, but completely (as a single complex of property and a legal entity) passes into ownership to a new owner who has bought out all the property and repaid the debts of bankruptcy creditors. In this way, it is possible to preserve licenses and other permits.

A trademark, despite the legally existing possibility of alienation separately from other property [14], may also be part of a single property complex implemented during bankruptcy.

According to the "Methodological recommendations for assessing the value of intellectual property rights" MP-3/22 dated 09.08.2022, developed by the Association of the SROO "Ex-

pert Council' and the Union of Forensic Experts "Expert Council", when evaluating a trademark as part of a business-forming technology, its value is defined as a share in the total cost of the technology. If the trademark cannot be sold separately, its value is taken into account as part of the value of the entire property complex.

The need for the debtor's trademark, and therefore the likelihood of its acquisition by the buyer (sale by the seller) at a fair value, will exist to a greater extent than the likelihood of maintaining the production of the manufactured products at the existing place of production.

Modern trends in the analysis of a business as a single property complex are leading to the need to define not only physical property, but also intangible assets. In this context, the term "intellectual property" is increasingly used and should be harmoniously integrated with all fixed assets and material resources [15].

If property (real estate, equipment, intangible assets) is sold separately (in parts), i.e. in different lots, rather than in a single lot (property complex [16]), then the probability of buyers acquiring intangible assets, including trademarks and permits, at a fair price is lower than within a single lot.. This is due to the fact that the equipment can also be purchased by existing manufacturers of related products who already have their own registered trademark. At the same time, real estate (when selling premises separately from equipment) can also be acquired for production purposes in another area of economic activity.

The ability to maintain goodwill and well-established business contacts with suppliers of resources and buyers of finished products.

The business reputation of an organization can significantly enhance the economic effect of owning an existing business [17]. At the same time, according to accounting rules, intangible asset "goodwill" can appear in an economic entity only after the sale of this legal entity (shares, shares in the company, etc.). However, from a financial point of view, business reputation as an opportunity to bring eco-

nomical benefits can be in an organization at any stage of the legal entity's activity. Accordingly, property sold in one lot as a single functioning production complex has, from an economic point of view, such a hidden (informal) asset as the "economic analogue of goodwill" [18]. The term "goodwill" is sometimes used as a synonym for the term "business reputation".

For valuation purposes, when determining the value of a positive business reputation (goodwill), any future economic benefit generated by a business or assets that are inseparable from a given business or asset groups that make up it is determined. Examples of such benefits may be increased efficiency resulting from business combinations (reduced operating costs and economies of scale not reflected in the value of other assets), organizational capital (for example, benefits arising from an established network or the opportunity to enter new markets, etc.) [see Order of the Ministry of Economic Development of the Russian Federation dated 22.06.2015 No. 385 "On Approval of the Federal Valuation Standard "Valuation of Intangible Assets and Intellectual Property (FSO No. 11)"]].

According to the rules of accounting procedures, "goodwill" appears in a legal entity only after the business is realized, however, from a financial point of view, this economic phenomenon, according to the author, can occur in an existing business entity, and before the implementation of the existing business. A property complex that is released from existing obligations in the future by writing off debts in bankruptcy proceedings may have some characteristics of having a positive business reputation value (goodwill). For a more precise definition of the described phenomenon, it is advisable to use such a scientifically proven concept as the "economic analogue of goodwill". "The economic equivalent of goodwill is defined as the difference between the value of the market value of an economic entity (company) and the amount of separately identified and valued assets less the amount of liabilities of this economic entity (outside the fact of the purchase and sale

of the company). The economic analogue of goodwill does not meet all the criteria of an asset for accounting purposes and is not subject to accounting, but within the framework of the relevant economics, discipline or field has sufficient features to be recognized as an asset and can be used for valuation procedures, management accounting, financial analysis, business planning and other analytical procedures not regulated by accounting rules [18].

Under certain circumstances, if a business is implemented as a single property complex, there is a reasonable chance of preserving the business's reputation, including established relationships with suppliers and customers.

Preserving the labor collective as a formed human capital for the operating business.

If an organization enters the bankruptcy process in the course of its production activities, then when choosing the option of selling property as an operating business or on an on-site basis, it is important to take into account such asset as human capital [19].

A well-selected and well-trained workforce that produces high-quality products is a valuable asset for any organization. However, if the production process is disrupted and employees are let go, the recruitment and training of new personnel for other projects may require significant investment. At the same time, funds spent on recruiting and developing employee relationships during production will not be recouped during the winding down of operations. These costs can be avoided if the business continues under new ownership.

The presence of non-essential assets can negatively impact the overall value of a property complex.

Speaking about the sale of the debtor's property in a single lot, it is necessary to understand that there is a possibility of non-core assets in this property complex, i.e. property that is not used directly in the production process.

The concept of "non-core assets" is disclosed in the scientific literature [20, 21] and in various regulatory legal acts, for example, in the Decree of the Government of the Russian Federation dated 10.05.2017 No. 894-p "On approval of

Methodological recommendations for the identification and sale of non-core assets" (applied to state corporations, state-owned companies, joint-stock companies, the share of the participation of the Russian Federation in the authorized capitals of which exceeds 50 percent, as well as in respect of subsidiaries of the above entities that are not used in their main (statutory) activities).

From an economic point of view, "non-core assets" are assets owned by an organization or company that do not correspond to the concept of 'core assets'.

From an economic perspective, core assets are those owned by organizations or companies and used in their core activities, or necessary for implementing long-term business plans, development strategies, or meeting profile criteria.

Accordingly, the acquisition of non-core assets can be a financial burden for potential buyers. The more economically feasible it is to acquire property in a single transaction, the fewer non-core assets are included in a complex.

Economically, in addition to the production line and real estate required for the operation of the line and performance of production functions, profile assets may include all resources directly related to production and sale of finished goods, including trademarks for products.

CONCLUSIONS

Summarizing the research, it is worth noting that it is not possible to determine a single, most effective way to sell the assets of a bankrupt company. This is because each case has its own unique characteristics. However, within the scope of this study, we were able to identify some fundamental principles that can guide financial analysis procedures and help make informed decisions.

In case of selling the property during bankruptcy proceedings, in accordance with Clause 3 of Article 110 of Federal Law No. 127-FZ "On Insolvency (Bankruptcy)" dated October 26, 2002, the initial sale price of the assets of the organization is determined by a decision of the creditors' meeting or the creditors' committee, taking into account the market value of

the debtor's property, determined in accordance with the appraiser's report, if such an assessment was carried out at the request of the bankruptcy creditor or an authorized body in accordance with the specified law. At the same time, when determining the market value of a property, it is advisable to take into account many price-forming factors, including the safety and completeness of equipment, the ability to start production without significant investments, the degree of equipment wear, etc. [22].

Considering the issue of selling a property on behalf of a debtor during bankruptcy, we would like to note that all the costs associated with dismantling, transporting the equipment included in the production line, and installing it in a new location (including installation and commissioning) are not considered by either the debtor (the bankrupt entity) or the creditors involved in the bankruptcy process. However, a potential buyer would need to take these costs into account when deciding whether or not to purchase the property, as they would become additional expenses for them.

A potential buyer would first need to assess how much additional costs they would incur in order to relocate the production equipment. Additionally, there is a possibility that the potential buyer may want to establish a production line with different levels of productivity.

If a potential buyer, being an effective owner [23], wants to leave the existing production line in its place, then it is more likely that he will acquire the entire production complex. It would not be advisable for him to buy it disassembled, and then spend money, time and other resources on moving and assembling this complex. The purchase of property in separate lots, which includes elements of a single production complex, may not be profitable if it leads to additional costs. This is because such a need arises when selling immovable property (premises) or movable property (production equipment) separately. An efficient owner, based on the principles of building an existing business and minimizing transaction costs, would strive to avoid these unnecessary costs by avoiding the relocation of industrial lines [24].

Accordingly, the costs associated with dismantling, relocating, and reassembling the production line impose an additional burden on the new owner. These costs can be significantly higher than the cost of purchasing a well-established production facility that includes all necessary facilities and equipment.

It's important to understand that selling a property as a single unit may not be the most efficient or economically feasible option for a potential buyer, especially if the production line needs to be dismantled and the production process disrupted. Additionally, there may be illiquid assets in the property that are not essential to the new production plan.

Considering the above, it is likely that the sale of a single production facility at an existing location would result in the new owner-buyer being willing to pay more due to the lack of the need for relocation. However, it should also be noted that the process of registering the acquisition of the property complex has its own legal aspects, but this task is manageable and not particularly challenging or expensive [25]. At the same time, purchasing individual pieces of equipment with the obligation to relocate them may lead to an overall reduction in cost. By selling the entire property complex, the buyer would avoid additional costs associated with transferring and organizing production, including obtaining permits. This would provide the buyer with economic benefits, as it would eliminate the need for these additional expenses. Given the competitive nature of the property sale process, it is likely that the buyer would be willing to pay even more for the property.

Based on the research conducted, the author reports on the lack of a unified, universal approach to determining the method for selecting the algorithm for selling the assets of a bankrupt company. At the same time, the author presents two fundamentally different approaches, the choice between which depends on available factors. This analysis can be considered as a reasonable algorithm for decision-making.

1. Selling industrial and real estate on-site would be more appropriate if the production process was destroyed, some equipment was dismantled, and the potential buyers were not interested in restoring the existing production to its original form.

2. Selling the property as a single lot (single production complex) would have a significant economic impact under the following circumstances:

- The production line is operating normally and has the capacity to produce products within its production capacity.
- The property being sold does not require relocation.

- The property complex has relevant intangible assets, such as permits, technological documentation, trademarks, etc.

- It is vital to maintain business reputation and relationships with partners.

- The share of non-essential assets in the property complex is relatively low.

At the same time, it may be beneficial to sell other assets that are not directly related to the production process on a case-by-case basis, rather than as part of the entire property complex.

The author hopes that these findings will help facilitate the process of selling properties of bankrupt entities more efficiently.

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Economic Growth through Rent Streams, Financial Development and Institutional Quality in MENA

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ABSTRACT

This study examines the relationships between natural rent streams, financial development, institutional quality, and economic growth in the Middle East and North Africa (MENA) region and is the development of fixed effects panel models during 1990–2020. The analysis of the MENA region sheds light on the complex, dynamic nature of the region's economies and societies, as this region is an interesting case study where economic, political and cultural dynamics are diverse. The region faces economic diversification needs, conflicts, migration, and climate change, making this study timely and relevant. To this end, fixed effects regressions and scenario approaches were applied to the collected panel data. The findings reveal natural resource rents as the primary driver of economic growth, their effectiveness dependent on financial development and institutional quality levels. A well-developed financial sector facilitates efficient channeling of rents into productive investments, while strong institutions mitigate resource curse effects. In contrast, while remittances and foreign aid do not directly impact growth, their effectiveness is enhanced by financial development and institutional frameworks. The results highlight the critical roles of financial sector development, institutional quality, and robust governance in shaping the impacts of resource rents in this resource-rich region. The policy recommendations emphasize strategies for managing resource wealth, strengthening financial systems, promoting inclusion, improving institutions, and fostering an enabling environment for remittances and foreign aid to promote sustainable economic growth.

Keywords: dutch disease; financial development; rent streams; structural change

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INTRODUCTION

Rent theory has gained popularity after various phenomena, such as the 2008 financial crisis, financialization processes [1], the increasing market power of high-tech firms such as Google or Amazon [2], and the reappearance of industrial policies [3]. The academic in rent highlights the strengths of political-economic approaches in the field. Rent is a source of income that becomes available due to political interference in the economy, often linked to powerful actors. Moreover, rent can also be conceptualized as a particular form of economic surplus, as Karl Marx supposed it in *Theories of Surplus Value*. In this regard, the political economy of rent illuminates the intersections between the political and economic realms. Pure political science approaches and pure economic approaches do not grasp these intersections [4].

The sources of rent include natural resources (e.g., oil, copper, bauxite), remittances from labor migration, foreign aid, and geopolitical rents [5]. Differentiating these sources from their appropriation methods is crucial to understanding their influence on political and economic spheres and their impact on economic growth in rent-dependent countries. This distinction is significant for natural resources, remittances, and international aid, as they challenge existing institutional frameworks [6].

Traditional rent theory often links rents to specific commodities, such as oil and gas, but this can obscure the distinction between natural resource extraction and financial generation of rents in global markets. Although resource rents are significant for GDP and exports, they have a limited impact on employment and general economic development [7]. Including remittances and international aid in the analysis can enhance the predictive capacity of rent theory by highlighting the transformative impacts of monetary transfers and the institutional contexts where economic and political spheres intersect [8].

Remittances are a unique form of economic income within rent theory. They are funds sent by migrants to their home countries and play a crucial role in the global economy. Unlike traditional rent sources, remittances are non-market phenomena without immediate substitutes in terms of products or locations, challenging conventional economic structures by connecting individuals and households across borders [9]. Remittances are a significant source of foreign exchange for developing countries [10], affecting approximately a billion people worldwide who send and receive migrant money [11]. In 2017, remittances to the global South were nearly equivalent to OPEC's net oil revenues, and globally, their value was approximately one third of the net natural resource rent.¹

In 2018, remittances were more than three times the amount of official development assistance (ODA) and almost equal to global foreign direct investments (FDI). They have grown exponentially since 1990, increasing by 440.42% over 20 years, highlighting their growing importance in the economy [12]. Remittances impact both the micro and macro levels: they support recipient households by enabling investments in education, healthcare, and entrepreneurship, and influence exchange rates, investment patterns, and macroeconomic stability [13].

Foreign aid, within rent theory, is a form of rent appropriation through political mechanisms. Donor countries, international organizations, and NGOs provide aid as grants, concessional loans, and technical assistance to recipient countries. Foreign aid plays a significant role in financing public investments, reducing poverty, and supporting various sectors, aligning with the redistributive aspect of rent theory [14]. However, the effectiveness of aid and its impact on local institutions are debated, highlighting the need to carefully consider the appropriation process within rent theory.

Rent theory allows for analyzing the interplay between resource rent, remittances, and foreign aid by considering their sources, modes of appropriation, and financialization effects. Incorporating rent theory provides insight into how these rent sources shape institutional qualities and the distribution of power within societies [15]. This approach deepens our understanding of rent-based economies, such as those in the Middle East and North Africa (MENA). Understanding the implications of resource rent, remittances, and foreign aid in the context of rent theory is crucial for policymakers, researchers, and development practitioners. These income sources represent distinct forms of economic surplus, and their analysis through rent theory sheds light on their sources, modes of appropriation, and implications for economic growth.

Research often fails to consider different rent streams collectively, leading to potential biases. This study addresses this limitation by incorporating remittances, resource rents, and foreign aid to estimate their effects on economic growth. Meta-analysis shows that studies omitting other sources of income mismeasure the effect of natural resource rent. A correct regression specification, including all rent sources, is crucial to accurately identifying the effect of rents on economic growth.

Region-specific analyses are essential to capture unique economic and institutional contexts. The MENA region, with its significant wealth in natural resources and its reliance on various rents, presents a compelling case for such an investigation. Understanding the dynamics through which natural resource rents influence economic growth in the MENA context is vital for effective policy making. The MENA region also receives substantial remittances and foreign aid, shaping its economic landscape.

¹ World Bank. World development report 2023: Migrants, refugees, and societies: World Development Report. World Bank. 2023. URL: <https://doi.org/10.1596/978-1-4648-1941-4> (accessed on 01.06.2024).

Examining its interaction with financial development and institutional quality is crucial.

This study focuses on the MENA region to provide insight into the interactions between various forms of rent, financial development, institutional quality, and their collective impact on economic growth. The findings aim to inform policy recommendations to effectively leverage these rents, promote the development of the financial sector, and strengthen institutional frameworks within the context of the MENA.

LITERATURE REVIEW

Resource-rich countries often experience an economic “resource curse” where abundant natural resources and the rents derived from them can paradoxically undermine development due to factors like rent-seeking behavior, crowding out of productive sectors, weakening of institutions, and enabling of entrenched authoritarian regimes [16, 17]. This phenomenon is linked to the strong dependence of many resource-rich economies on exports of primary commodities like oil and gas, which can distort economic policies and governance structures. The seminal work by Sachs et al. (1995) highlighted how resource abundance tends to be associated with lower levels of financial development in practice [17]. The rentier state concept relates this pattern to economic barriers and authoritarianism in oil-exporting MENA nations [18, 19].

However, a growing literature is challenging this resource curse narrative, finding evidence of a potentially positive relationship between resource rents and financial development, particularly in recent years and in contexts with sound institutional quality [20–23]. The financialization of resource windfalls could provide opportunities to channel these revenues into productive investments that foster broader economic development, if equipped with robust financial infrastructure and effective resource management policies. But an underdeveloped financial system can hinder oil economies [24], while commodity price volatility can impede financial sector growth [25]. Ultimately, institutional quality crucially shapes this relationship [26].

In the case of remittances, around 40% of studies find a positive impact on overall economic growth in recipient countries [27–29], while 20% find a negative effect [30, 31]. However, nearly 40% find no significant relationship [32], highlighting conflicting evidence. Proponents like Ratha (2005, 2015) argue remittance flows provide an important source of investment financing, but critics caution the potential costs of exchange rate volatility, loss of competitiveness, and economic distortions mirroring the resource curse [13, 33]. The financialization of remittances (FOR) aims to incorporate migrants into global financial markets and development processes [34–36].

Parallel debates exist on the role of foreign aid, with research finding both positive and negative influences of aid flows on financial development and economic growth. Some studies find no growth impact [37], while others show positive effects given sound economic policies and strong institutions [38, 39]. The extent of aid effectiveness may depend on contextual conditions like the quality of governance, economic policies, and institutional capacity of recipient nations [40]. Aid coordination and alignment with national strategies is also emphasized [41].

Common themes emerge regarding the importance of strong institutions, robust governance, strategic resource management, and coordination of aid for productive outcomes. Many analysts suggest that while resource rents, remittances, and aid can provide financing that boosts investment and growth under certain circumstances, the lack of appropriate policies, institutional frameworks, and absorptive capacities can lead to economic distortions and undermine development impacts.

Overall, the literature reveals a complex, context-dependent relationship shaped by governance quality, policy coherence, institutional capacity, and absorptive mechanisms. More research is needed to unpack the specific transmission channels and contextual factors that determine whether resource windfalls, remittance flows, and aid contribute to broader financial deepening and long-term development outcomes. Rigorous examination across diverse economic contexts will shed light on policies to mitigate risks and harness these external flows as productive development financing.

According to *Table 1*, the MENA countries exhibit a distinct propensity to derive substantial proportions of their GDP from natural resource rents, and this region has a higher average natural resource rent than most other regions. In contrast, East Asia; the Pacific, Europe; Central Asia, Latin America; and the Caribbean have comparatively lower natural resource rents, implying a more diversified economic base. The data reveal a consistent upward trajectory, with the region’s average total natural resource rent rising from 18.36% during 1990–1999 to 24.961% in the subsequent decade (2000–2009). In 2010–2019, a marginal contraction to 22.35% is observed, indicating both the region’s dependence on resource-based revenues and potential fluctuations driven by global market dynamics.

DATA AND METHODOLOGY

This study uses data from international sources such as the World Development Indicators, the World Governance Index, and the IMF. The data set covers panel data from 1990 to 2020 and includes 21 Middle Eastern and North African countries. In this paper, the fixed effects panel model has been applied. Researchers rely on Fixed Effects for causal inference in panel data settings [42, 43]. Imai and Kim (2021) refer to

Table 1

Comparing the Average Rate of Rents

Ave Remittance				Ave Natural Resources Rent			Ave OFA		
Region	1990–1999	2000–2009	2010–2019	1990–1999	2000–2009	2010–2019	1990–1999	2000–2009	2010–2019
East Asia & Pacific	0.21	0.36	0.45	0.96	2.13	2.17	0.13	0.08	0.04
Europe & Central Asia	0.42	0.51	0.74	0.71	1.49	1.78	0.03	0.04	0.04
Latin America & Caribbean	0.70	1.54	1.34	2.97	5.06	4.12	0.33	0.23	0.18
Middle East & North Africa	–	1.73	1.95	18.36	24.96	22.35	1.17	0.78	0.69
South Asia	2.07	3.58	4.11	2.11	3.10	2.63	1.15	0.77	0.55
Sub-Saharan Africa	0.94	1.78	2.35	8.93	11.69	9.85	4.81	3.97	2.90
World	0.35	0.53	0.71	1.55	2.87	2.92	0.12	0.18	0.19

Source: Author calculation according to World Development Indicators.

FE as the “default methodology for estimating causal effects with panel data” [44], while Hill et al. (2020) mention that “fixed effects models for panel data are now widely recognized as a powerful analytic tool for longitudinal data analysis” [45]. From a causal inference perspective, the advantage of the FE estimator over pooled ordinary least squares (POLS) is that the FE estimator, by removing both observed and unobserved time-invariant unit-specific heterogeneity, requires a more palatable assumption to be unbiased. Fixed effects will deal with omitted variable bias and control for cross-country heterogeneity in addition to period-specific factors. The unobserved country-specific effects may capture differences in the initial level of efficiency, while the period-specific intercepts capture changes that occur across all countries.

Table 2 describes the variables of interest, their abbreviations and descriptions. It should be noted that in the empirical models, our dependent variable growth is measured by the logarithm of GDP per capita (GDPPC) and all other variables are independent variables.

Table 3 shows the variables and descriptions of data used in this paper. The mean GDPPC is \$ 15,278, reflecting the average GDP per person. Natural resource rents contribute an average of 18.07% to GDP, while remittances account for 4.15% of GDP. The official development assistance is 1.34% of the GNI. Financial development constitutes 33.53%, and institutional quality averages –0.16. Gross capital formation and government final consumption contribute approximately 25.75% and 17.76% to GDP, respectively. Trade open-

ness is 98.77% of GDP, and inflation averages 6.68%. We also used boxplot visualization to remove outliers from the data set and replaced missing values with linear interpolation.

The Base Model for Estimation of the Impact of Independent Variables: RERENT (Resource Rent), REMI (Remittances), ODA (Official Development Assistant), FD (Financial Development), INST (Institutional Quality) Control variables: GCF (Gross Capital Formation), GCFC (Government Final Consumption), TRADE (Trade Openness), INF (Inflation).

$$\begin{aligned}
 \ln(\text{Growth}_{it}) = & \beta_0 + \beta_1 \text{ReRe}nt_{it} + \\
 & + \beta_2 \text{Re}mi_{it} + \beta_3 \text{ODA}_{it} + \beta_4 \text{Inst}_{it} + \\
 & + \beta_5 \text{ReRe}nt_{it} \times \text{FDI}_{it} + \beta_6 \text{ReRe}nt_{it} \times \text{Inst}_{it} + \\
 & + \beta_7 \text{FDI}_{it} \times \text{Inst}_{it} + \beta_8 \text{ReRe}nt_{it} \times \\
 & \times \text{FDI}_{it} \times \text{Inst}_{it} + X_{it}\beta + \gamma_i + \delta_t + \varepsilon_{it}.
 \end{aligned} \quad (1)$$

By understanding that rent is the main factor in this region, in 3, the main variable of interest is the three-way interaction term that includes natural resource rent, financial development, and institutional quality. In order to interpret the results of this three-way interaction variable, the marginal effect analysis was applied, which shows the effect of resource rent on economic growth in changing according to varying levels of financial development and institutional quality [46–48]. In this approach, the different slopes represent the effect of resource rent on economic growth when the moderating variables, financial development, and institutional quality, are held

Table 2

Description of the Variables Used in this Study

Variable	Abbreviation	Description
Log of GDP per capita	GDPPC	GDP is converted to international dollars using purchasing power parity rates. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy, plus any product taxes and minus any subsidies not included in the value of the products
Natural Resource Rent (% of GDP)	RENT	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents, mineral rents and forest rents
Remittances to GDP	REMI	It comprises personal transfers and compensation of employees
Aid to GNI	ODA	Consists of disbursements of loans made on concessional terms (net of repayments of principal)
Financial Development	FD	FD is a relative ranking of countries on the depth, access, and efficiency of their financial institutions and financial markets. It is an aggregate of the Financial Institutions Index and the Financial Market Index
Institutional quality	INST	Average of 6 variables: Rule of law, Regulatory quality, Control of corruption
Gross fixed capital formation as percentage of GDP	GCF	It includes land improvements (fences, ditches, drains, etc.); plant, machinery, and equipment purchases; and the construction of roads, railways, schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings
Trade openness as percentage of GDP	GGFC	This is calculated as the total of exports and imports divided by GDP. Imports of goods and services reflect the value of all goods and other market services received from the rest of the world
General government final consumption expenditure as percentage of GDP	TRADE	This indicator includes all government current expenditures for purchases of goods and services (including compensation of employees)
Percentage change in inflation rate	INF	Reflects the annual percentage change in inflation

Source: Authors' Estimation.

constant at different combinations of high or low values. The model represents below:

$$\ln(\text{Growth}_{it}) = (\beta_1 + \beta_4 \text{FDI}_{it} + \beta_5 \text{INST}_{it} + \beta_7 \text{FDI}_{it} \times \text{Inst}_{it}) \text{ReRent}_{it} + (\beta_0 + \beta_2 \text{FDI}_{it} + \beta_3 \text{Inst}_{it} + \beta_6 \text{FDI}_{it} \times \text{Inst}_{it} + X_{it} \beta + \gamma_i + \delta_t + \varepsilon_{it}). \quad (2)$$

RESULTS

In the first three models, the impact of natural resource rent, remittances, and foreign aid was estimated in different models by the fixed effect panel regression method (see Table 4). In model (1), RERENT (Resource Rent) is highly significant, which shows an increase in the rents of natural resources is associated with an increase in economic growth in the MENA region. FD coefficient indicates that financial development positively impacts economic growth. RERENT*FD (Interaction of

Resource Rent and Financial Development) is -0.014 and is highly significant. This negative coefficient suggests that, while resource rents and financial development individually promote growth, their interaction could lead to diminishing returns. Institutional Quality does not have a significant impact on growth in this model. RERENT*INST (Interaction of Resource Rent and Institutional Quality) is significant. This indicates that better institutional quality improves the positive impact of resource rents on economic growth. The GDPPC is highly significant, indicating that a higher GDP per capita is strongly associated with higher economic growth. Trade openness is significant and suggests that greater trade openness positively impacts economic growth. GCF is 0.0001 , indicating that there is no significant effect on growth. The GGFC coefficient is -0.0034 and significant. This indicates that higher

Table 3

Descriptions of Variables

Variables	Observations	Mean	Std. Dev.	Minimum	Maximum
GDPPC	418	15,278.03	15,742.26	1,668.37	73,493.27
RERENT	418	18.0673	16.7152	0.0000	66.0599
REMI	418	4.1537	6.3758	0.0000	26.4248
ODA	418	1.3395	2.5099	-0.0352	24.1228
FD	418	0.3353	0.1296	0.1138	0.5859
INST	418	-0.1585	0.5864	-1.7638	1.2647
GCF	418	25.7478	7.8244	7.9052	50.7807
GGFC	418	17.7648	5.9814	6.7330	50.8365
TRADE	418	98.7680	56.9272	29.2282	343.3621
INF	418	6.6807	12.1417	-25.9584	97.4338

Source: Authors' Estimation.

government consumption is associated with lower economic growth. The INF coefficient is -0.0008 and significant. This suggests that higher inflation negatively impacts economic growth.

Model (1) highlights the positive impact of natural resource rents and financial development on economic growth in the MENA region. However, their interaction shows diminishing returns, indicating complexity in their combined effects.

Model (2): Remi does not have a significant impact on growth in this model. FD marginally significant. This suggests a potential negative impact of financial development on growth when considering remittances. Remi*FD (Interaction of Remittances and Financial Development) is a positive coefficient that indicates that financial development improves the positive impact of remittances on growth. The INST (institutional quality) is 0.0657 and significant, indicating that better institutional quality positively impacts growth. Model (2) shows that remittances alone do not significantly impact growth, but when combined with financial development, they have a positive effect. Institutional quality also positively influences growth.

Model (3) examines the impact of ODA. The results show that ODA alone has a negative impact on growth, but financial development can mitigate this negative effect. Institutional quality, although positive, is not significant in this model.

Model (4) incorporates all rents (resource rent, remittances, and ODA) and their interactions with financial development and institutional quality. The key findings are as follows. Resource rents have a positive impact on growth and this effect is enhanced by better institutional

quality. The interaction between resource rent and financial development is negative, indicating diminishing returns. The impacts of remittances and ODA on growth are not significant on their own, but show complex interactions with financial development and institutional quality. Financial development has a marginally positive impact on growth, while better institutional quality enhances the impact of resource rents and mitigates the negative impact of ODA.

The four models collectively show that remittance and foreign aid do not have a significant effect on economic growth in the MENA region, while institutional quality alone does not show a significant impact on growth; its interaction with natural resource rents has a positive effect. These findings underscore the importance of considering the interplay between natural resources, financial development, and institutional quality in driving economic growth.

Various scenarios were estimated on the basis of the estimate described in Table 5. In the first scenario (see Table 6), where there is high financial development and high institutional quality, a 1 percent increase in natural resources as a percentage of GDP leads to an approximately 0.23% increase in the economic growth in this region. This scenario highlights the synergy between well-developed financial systems and strong institutions in enhancing the positive impact of natural resources on growth. In the second scenario where there is low financial development and low institutional quality, a one percent increase in natural resources leads to a 0.21% decrease in economic growth, which strongly supports the natural resource curse hypothesis and the financial resource curse, suggesting that without robust financial

Table 4

Fixed Effect Regression Results

Variable	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	2.0611*	(0.0000)	1.9518*	(0.0000)	1.9731*	(0.0000)	1.7514*	(0.0000)
RERENT	0.0077*	(0.0000)					0.0087	(0.0000)
Remi			−0.0043	(0.1207)			0.0068	(0.1181)
ODA					−0.0232*	(0.0096)	−0.0096	(0.3679)
FD	0.2135*	(0.0134)	−0.1384**	(0.0738)	−0.1545*	(0.0510)	0.2670	(0.0542)
RERENT*FD	0.0149*	(0.0000)					−0.0164	(0.0000)
Remi*FD			0.0157*	(0.0446)			−0.0098	(0.3135)
ODA*FD					0.0373*	(0.0402)	0.0077	(0.7219)
INST	−0.0219	(0.4393)	0.0657*	(0.0288)	0.0480	(0.1007)	−0.042963	(0.2796)
RERENT*Inst	0.0034*	(0.0002)					0.0042	(0.0000)
Remi*Inst			−0.0030	(0.4242)			−0.0031	(0.4596)
ODA*Inst	0.0072	(0.5583)					0.0288	(0.0477)
ln(GDPPC)	0.7673*	(0.0000)	0.7975*	(0.0000)	0.7944*	(0.0000)	0.7635*	(0.0000)
TRADE	0.0005**	(0.0136)	0.0006*	(0.0019)	0.0008*	(0.0000)	0.0006*	(0.0108)
GCF	0.0001	(0.8244)	−0.0005	(0.4988)	−0.0009	(0.2123)	−0.0003	(0.6534)
GGFC	−0.0034*	(0.0012)	−0.0038*	(0.0000)	−0.0038*	(0.0000)	−0.0036*	(0.0011)
INF	−0.0008*	(0.0124)	−0.0008*	(0.0275)	−0.0008*	(0.0280)	−0.0010*	(0.0043)
R-squared	0.9972		0.9969		0.9969		0.9968	

Source: Authors' Estimation.

Note: * denotes statistical significance at a 5% level; ** denotes statistical significance at a 1% level.

systems and institutions, natural resources can negatively impact growth.

In the next scenario, where there is high financial development but the institutions are not developed, a one percent increase in natural resources decreases economic growth by 0.17%. This indicates that even with developed financial systems, poor institutional quality can negate the positive effects of natural resources.

In the last scenario with high institutional quality but low financial development, a one percent increase in resource rent stimulates economic growth by 0.60%. This highlights the importance of strong institutions in leveraging natural resources for economic growth, even when financial development is low.

Table 7 shows the results of a robustness check of fixed effects regression on four models that exclude control variables: gross capital formation, trade openness, government expense, and inflation. Although significance is

reduced, all the models confirm the results of the original model by showing similar results.

The robustness check confirms the findings of the original model, indicating that the results are not driven by any specific control variable. The key relationships between natural resource rents, financial development, institutional quality, and economic growth remain consistent across different model specifications. This strengthens the validity of the conclusions drawn from the original fixed-effects regression analysis.

The findings of this study highlight the intricate relationships between natural resources, financial development, institutional quality, and economic growth in the MENA region. The positive impact of natural resource rents on growth is clear, but this effect is significantly influenced by the quality of financial systems and institutions. Financial development alone promotes growth, but when combined with resource rents, the benefits show

Table 5

Fixed Effects Regression

Variable	Coefficient	Prob.	Std. Error
C	2.0514*	(0.0000)	0.2409
RERENT	0.0076*	(0.0000)	0.0015
FD	0.2070*	(0.0204)	0.0889
RERENT*FD	-0.0146*	(0.0000)	0.0031
INST	-0.0312	(0.5054)	0.0468
RERENT*INST	0.0032**	(0.0528)	0.0016
RERENT*FD*INST	0.0005	(0.9006)	0.0047
FD*INST	0.0240	(0.8265)	0.1095
ln(GDPPC(-1))	0.7680*	(0.0000)	0.0258
TRADE	0.0004*	(0.0205)	0.0002
GCF	0.0001	(0.7790)	0.0006
GGFC	-0.0033*	(0.0033)	0.0011
INF	-0.0008*	(0.0120)	0.0003
R-squared	0.9971		

Source: Authors' Estimation.

Note: * denotes statistical significance at a 5% level; ** denotes statistical significance at a 1% level.

diminishing returns, suggesting complexities and potential inefficiencies. Strong institutional quality enhances the positive impact of natural resources and mitigates the negative effects of foreign aid. Trade openness and higher GDP per capita consistently drive growth, while excessive government consumption and high inflation hinder it. The scenarios further illustrate that well-developed financial systems and robust institutions are crucial for maximizing the benefits of natural resources and avoiding the pitfalls of the resource curse. These results underscore the need for comprehensive policy strategies that improve governance and financial infrastructure to support sustainable economic growth in the region.

CONCLUSION AND POLICY IMPLICATIONS

The rent of natural resources is the main driver of economic growth in the MENA region, especially when there is high institutional quality and financial development. This finding is consistent with several other studies that have examined the role of natural resource rents in economic growth.

The contrasting finding in the study on the insignificant impact of remittances on economic growth in the MENA region might be attributed to region-specific factors, such as the allocation of remittances to consump-

tion rather than productive investments or the presence of institutional barriers that hinder the effective channeling of remittances into growth-promoting activities.

This study finds that foreign aid does not significantly impact economic growth in the MENA region. This result is consistent with some existing literature that questions the effectiveness of foreign aid in promoting economic growth, particularly in the absence of complementary policies and institutional reforms.

This paper provides valuable information on the dynamics of natural resource rents, remittances, and foreign aid, and their interactions with financial development and institutional quality in the MENA region. It is essential to consider the context-specific factors and complementary policies that can enhance or hinder the effectiveness of these rent streams in promoting economic growth.

The results revealed that the rent of natural resources is the only rent that has a significant impact on economic growth in this region. So, the policymakers should pay more attention to channeling these windfall revenues for investment. In addition, the priority in this region should be improving the institutional quality. The results show that this factor is the causal factor that leads to financial development.

Table 6

Levels of Financial Development and Institutional Quality in Each Scenario

Scenario	Financial Development Level	Institutional Quality Level
High Financial Development, High Institutional Quality	0.4649	0.4279
Low Financial Development, Low Institutional Quality	0.2057	-0.7449
High Financial Development, Low Institutional Quality	0.4649	-0.7449
Low Financial Development, High Institutional Quality	0.2056	0.4279

Source: Author Estimation.

Table 7

Robustness Check: Excluding Different Control Variables

Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	2.0181*	(0.0000)	1.9006*	(0.0000)	1.8907*	(0.0000)	1.9928*	(0.0000)
RERENT	0.0074*	(0.0000)	0.0079*	(0.0000)	0.0061*	(0.0000)	0.0086*	(0.0000)
FD	0.2166*	(0.0160)	0.1685**	(0.0587)	0.2087	(0.0158)	0.2598*	(0.0028)
RERENT*FD	-0.0151*	(0.0000)	-0.0131*	(0.0000)	-0.0127*	(0.0000)	-0.0159*	(0.0000)
INST	-0.0126	(0.7868)	-0.0230	(0.6261)	0.0923*	(0.0094)	-0.0412	(0.3801)
RERENT*INST	0.0029**	(0.0800)	0.0013	(0.4117)	0.0045*	(0.0040)	0.0033*	(0.0479)
FD*INST	0.0031	(0.9773)	0.0268	(0.8088)	-0.1776**	(0.0680)	0.0911	(0.3921)
RERENT*FD*INST	0.0005	(0.9087)	0.0051	(0.2633)	0.0036	(0.4219)	0.0005	(0.9119)
LOG(GDPPC(-1))	0.7699*	(0.0000)	0.7779*	(0.0000)	0.7883*	(0.0000)	0.7750*	(0.0000)
TRADE	0.0005*	(0.0210)	0.0004**	(0.0684)	0.0007*	(0.0006)		
GCF	0.0004	(0.5546)	0.0004	(0.5927)			0.0003	(0.6245)
GGFC	-0.0027*	(0.0138)			-0.0047*	0.0000	-0.0029*	(0.0101)
Inf			-0.0006**	0.0544			-0.0009	(0.0123)
R-Square	0.9971		0.9971		0.9975		0.9971	

Source: Authors' Estimation.

Note: * denotes statistical significance at a 5% level; ** denotes statistical significance at a 1% level.

1. Enhancing Institutional Quality: Policymakers should prioritize efforts to improve institutional quality, including governance structures, regulatory frameworks, and the rule of law. Strengthening institutions can help mitigate the adverse effects of resource dependency and promote sustainable economic growth.

2. Diversification of the Economy: To reduce vulnerability to fluctuations in the prices of natural resources and mitigate the curse of resources, policymakers must focus on diversifying the economy. This can be achieved by promoting investment in non-resource sectors, fostering innovation and entrepreneurship, and encouraging the development of human capital.

3. Promoting Financial Development: policies aimed at improving financial development can help unlock the potential of natural resource wealth to stimulate economic growth. This includes measures to improve ac-

cess to finance, develop capital markets, and strengthen financial institutions. However, it is essential to ensure that financial development is accompanied by effective regulatory frameworks to prevent financial instability and promote sustainable growth.

4. Sustainable Resource Management: Governments should adopt policies to ensure sustainable management of natural resources, including transparent revenue management, environmental protection measures, and an equitable distribution of resource wealth. This can help maximize the long-term benefits of resource extraction while minimizing negative social and environmental impacts.

5. International Cooperation: Given the global nature of resource markets, international cooperation and coordination are essential to address challenges related to natural resource management and to promote sus-

tainable development. Collaboration between resource-rich and resource-poor countries, as well as multilateral institutions, can help foster best practices, knowledge sharing, and capacity building.

By implementing these policy recommendations, policymakers can harness the potential of natural resources to drive economic growth, promote sustainable development, and improve the well-being of their citizens.

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Developing Trust, Developing Economies: The Role of ESG Disclosure in Attracting Foreign Investment

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ABSTRACT

Legitimacy theory posits that organizations strive to align with societal expectations to gain advantages, yet its focus has primarily been at the company level. The **purpose** of the study is to investigate the global applicability of legitimacy theory by examining the relationship between Environmental, Social, and Governance (ESG) disclosures and Foreign Direct Investment (FDI). In particular, the study sets the **task**: analyze the impact of ESG disclosures on FDI across twenty-eight countries; compare the ESG performance of different nations; and explore the role of regional ESG standards in influencing ESG performance and FDI. The application of the Kruskal-Wallis test revealed the dominant position of Western nations with developed ESG standards. The Bonferroni adjustment post hoc test on World Bank data indicated that countries with well-developed ESG standards act as global investors, trusting the high standards of rapidly improving Western regions. Statistical tests confirmed that countries in the developing stage, with values somewhat similar to the most developed areas, present attractive alternatives for foreign investors. However, the lack of standardized norms hinders the establishment of trustworthy economic relationships. These findings suggest that just as businesses use Corporate Social Responsibility (CSR) to gain legitimacy, countries can adopt ESG practices to align with global norms and attract FDI. Although this transition may be time-consuming, developing regional ESG disclosure norms could serve as an effective stepping stone.

Keywords: ESG disclosure; foreign direct investment; legitimacy theory; non-financial report; green finance; development

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INTRODUCTION

Building trust is crucial for developing economies. ESG (Environmental, Social, Governance) practices play a central role in this process. Strong ESG disclosure reflects commitment to operating ethically and sustainably, fostering trust, and attracting investment. Investors may be more likely to invest in countries with strong ESG practices due to factors such as reduced environmental risk, strong labor practices, and a stable political climate. The concept of non-financial reporting is based on the idea, that traditional financial statements alone do not provide a comprehensive insight into a company's operation. As businesses broaden their influence and border, demand grows for more comprehensive and transparent information about their non-financial performance. The interconnections and globalization further raised the need for a "standardized report". ESG has become a cornerstone of ethical business practices over the past twenty years. With roots in ancient Chinese ethics, the concept was convened by the United Nations (U.N.) in 2004 to promote ethical investment [1, 2].

In 2006, the U.N. initiated the Principles for Responsible Investment (PRI) to help investors integrate ESG considerations into their strategies.¹ The differences in the regulatory frameworks [3–5], cultural norms [6, 7] and even the stage of economic development [8, 9] hinder the standardization of such non-financial reports. Just like financial reports, non-financial reports face manipulation too.² The lack of guidelines, audits, and international controlling bodies also set back the unification of the ESG disclosure [10–12]. Despite these shortcomings, according to Deloitte (2020),³ the share of nonfinancial sustainability reporting within the S&P 500 companies from 2011 to 2018 turned around, making these disclosures widely used. In 2022, 98% of these companies reported ESG information,⁴ demonstrating its widespread acceptance and mainstream status.

The concept of ESG disclosure has been extensively researched and applied. Many studies analyzed the influence of a solo factor or the whole ESG disclosure on the firm performance [13–15]. Single-industry or country-focused investigations are also widely published [16, 17]. However, the ESG disclosure's differentiating roles on the global level, especially the focus on FDI patterns, has received relatively less attention. This is where the legitimacy theory could become rel-

evant. It posits that organizations seek to align their actions with societal norms, values, and expectations to maintain their legitimacy [18]. This theory suggests that businesses engage in activities such as Corporate Social Responsibility (CSR) to appear responsible and ethical, thereby securing their acceptance and approval from stakeholders and the broader society. Extending legitimacy theory to the international level is relevant because just as businesses use CSR to gain legitimacy, countries can also use ESG practices to align with global norms, thereby attracting foreign investment. By implementing strong ESG disclosure practices, countries can increase transparency regarding their environmental, social, and governance practices, enhancing their legitimacy in the eyes of international investors who value responsible business conduct. This broader application of legitimacy theory underscores that investors find those countries more credible and reliable, which demonstrate strong ESG commitments, similar to how they view individual companies with robust CSR practices. To analyze the hypothetical patterns, first, publications related to the ESG disclosure were reviewed. Then the research database and the applied methodologies are presented. This section is followed by the statistical tests used to compare FDI flows between countries with different levels of development in terms of ESG disclosure. The here highlighted findings are particularly significant for the least developed countries and their businesses. The final section contains recommendations and possible actions for development addressed to the above-mentioned actors.

MATERIALS AND METHODS

To analyze the ESG disclosure potential effect on the FDI, an international ESG disclosure framework was sought. Organizations such as the World Bank and the International Monetary Fund, typically aggregate and analyze ESG data based on a broad range of economic and developmental indicators. These classifications often reflect a country's overall economic status and development level, incorporating data from multiple sources, including self-reported information by the countries themselves. In contrast, the involved study employs a specific framework focused exclusively on the analysis of ESG regulations. This framework uses a structured and objective scoring system to assess the implementation and rigor of ESG practices across different countries. This methodology is designed to provide an unbiased comparison based on well-defined principles and criteria specifically related to ESG factors. This approach allows for a detailed and nuanced understanding of how countries perform in terms of ESG practices, which is particularly relevant for evaluating their attractiveness for FDI.

¹ United Nations. Who Cares Wins. 2004.

² PRI Association. PRI Reporting Framework Main definitions. 2018.

³ Deloitte. #DeloitteESGnow — Sustainability Disclosure Goes Mainstream. 2020.

⁴ Center for Audit Quality. S&P 500 ESG Reporting and Assurance Analysis.

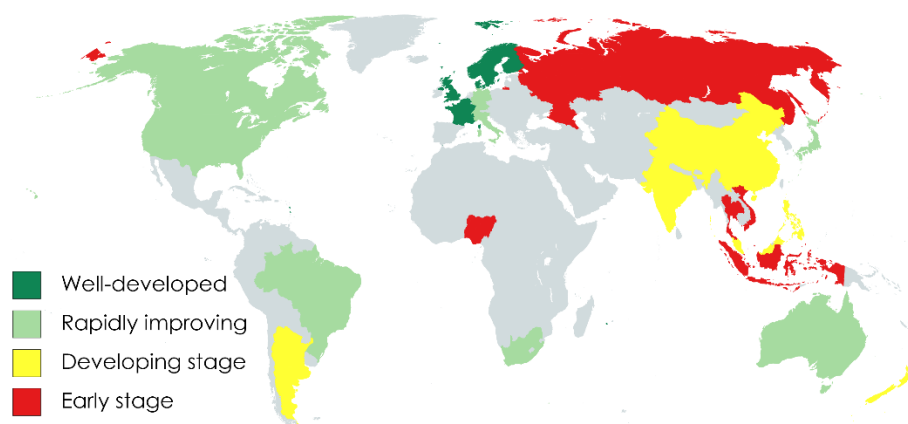


Fig. 1. The Analyzed Countries

Source: Compiled the authors 2024, based on [9].

The work of [9] benchmarked thirty ESG regulations across twenty-eight countries worldwide. The research employed external and practical benchmarking techniques to assess the involved countries according to their ESG regulations. Data on practices and regulations related to ESG factors were gathered from various global sources. Each category was limited to ten regulations for benchmarking purposes. For quantifying ESG scores, the researchers analyzed the implemented regulations across all countries and assigned scores to each regulation based on its implementation level: three points for fully implemented or mandatory regulations, two points for partially implemented or voluntary regulations, one point for regulations under consideration or forthcoming, and zero points for regulations that were absent. According to this scoring method, the highest achievable score across the three factors was determined to be ninety points, reflecting comprehensive ESG performance. Country scores were calculated by summing the scores of all regulations within the ESG framework. Finally, an overall ESG score was computed by averaging the individual scores of each category (the countries studied are shown in *Table* in the *Appendix*.)

The studied countries were divided into four groups (Well-developed, Rapidly improving, Developing stage, Early stage, where the Well-developed countries are the most developed, and the Early stage countries are the least developed) based on the obtained points, which are a measure of their ESG development. The studied nations' geographical location and their final clusters are presented in *Fig. 1*.

To quantify the net inflows of FDI (BoP, current US\$) the World Bank database was used.⁵ Considering the SDGs were adopted in 2016, the current work involved the relevant data for the period 2016–2022 (the UK

should be considered a pre-Brexit EU member, given that it was a member for a larger part of the period under review than not a member).

This short time frame could be one of the limitations. The study is based on secondary data that deals with a limited number of countries, in addition, not ESG disclosure is the only factor that can affect the FDI. In the last years, some extraordinary cases like pandemics, war, and sanctions further complicated the global situation and could distort the outcomes too.

Considering the characteristics of the dataset, Shapiro-Wilk and the Kolmogorov-Smirnov test were run to study the distribution of the variables. These methods were used before running the one-way ANOVA test to check that the conditions were met. The Kolmogorov-Smirnov test is a nonparametric statistical test [19]. It is used to assess whether two populations have the same distribution. The test compares the empirical distribution functions of the samples. This function represents the probability that a random variable from the population will be less than or equal to a given value [20]. The Kolmogorov-Smirnov test defines D-statistic, which is the maximum absolute difference between the two empirical distributions' functions. If the D value is high, then the null hypothesis has to be rejected, which means the two populations do not have the same distribution [21]. The Shapiro-Wilk test similar to the previous one could be used to define the distribution of the studied variables [22]. It is ideal to test a variety of data types. Since it is a nonparametric test, it does not have any assumptions related to the distributions of the studied variables [23]. The Shapiro-Wilk test is generally considered to be a more powerful test of normality than the Kolmogorov-Smirnov. Because it is more likely to correctly identify samples that are not normally distributed [24]. Since both of the tests rejected the normal distribution of the dataset, the prerequisites for one-way ANOVA were not fulfilled.

⁵ World Bank. DataBank 2024.

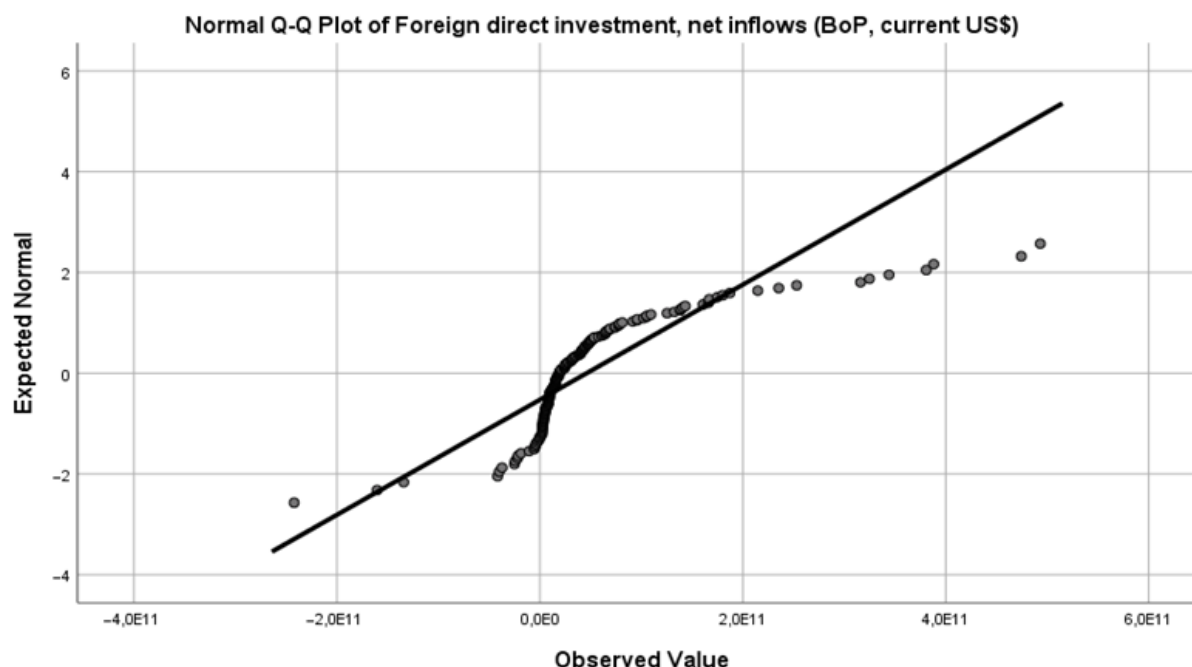


Fig. 2. The distribution of FDI

Source: Compiled the authors, 2024.

The nonparametric alternative of the Kruskal-Wallis test can be used to compare the medians of two or more independent samples [25]. However, compared to the one-way ANOVA, it does not require the normal distribution of the dataset. It can identify the dissimilarities between the samples but cannot indicate the place of them [26]. A Bonferroni adjustment post hoc test was run to point out from the pairwise comparison which groups differ from each other significantly [27]. This method applies adjusted p-values from multiple pairwise comparisons to control the family-wise error rate (FWER). So it is less likely to reject the null hypothesis when it is false [28]. After the differences between the groups are highlighted, the magnitudes of them get studied. For this, Cohen's d test was involved. It quantifies the effect size of a between-group comparison, so we can gain a clearer understanding of the true depth of the differences between the studied cases. The larger its value, the larger the contrast between the groups [29]. It is important to choose the correct form of Cohen's d since it is sensitive to the differences in the standard deviations [30]. To take the right one, we examined the homogeneity of variances by Levene's test. Since it revealed the lack of homogeneity, for the quantification of differences, Cohen's d for Two-Sample with Unequal SD was used [31].

RESULTS AND DISCUSSION

To identify the potential differences within the clusters, one-way ANOVA could have been applied. However, the necessary prerequisites for the test were not

met. Both the Shapiro-Wilk test and the Kolmogorov-Smirnov test indicate that the dataset does not fit a normal distribution, as shown in Fig. 2.

The Kruskal-Wallis test seemed to be the proper nonparametric alternative to the one-way ANOVA since it is not so sensitive to violations of normality. At first, the dataset suitability for this statistical analysis was checked. The scale FDI and the ordinal ESG disclosure variables could be analyzed with it because they fulfill the variables-related requirements of the test. The independence of the group members is also provided. Even though the Q-Q plots have shown some outliers in the dataset, they are valid data points and not errors in the data collection or measurement process.

Based on the Kruskal-Wallis test, we had to reject the null hypothesis, so the distribution of FDI is not the same across the studied groups. Figure 3 presents the difference in the FDI's distribution within the analyzed clusters. Considering only the violin plots, there is a high probability of differences between the clusters studied.

To identify the statistically significant differences between the four groups, the Bonferroni adjustment post hoc test was applied. It is a conservative adjustment that is less likely to reject the true null hypotheses. The result of the pairwise comparison is presented in Table.

The addressed method pointed out differences between the Early stage and Developing stage, Early stage and Rapidly improving in addition to the Well-developed and Rapidly improving nations. The revealed

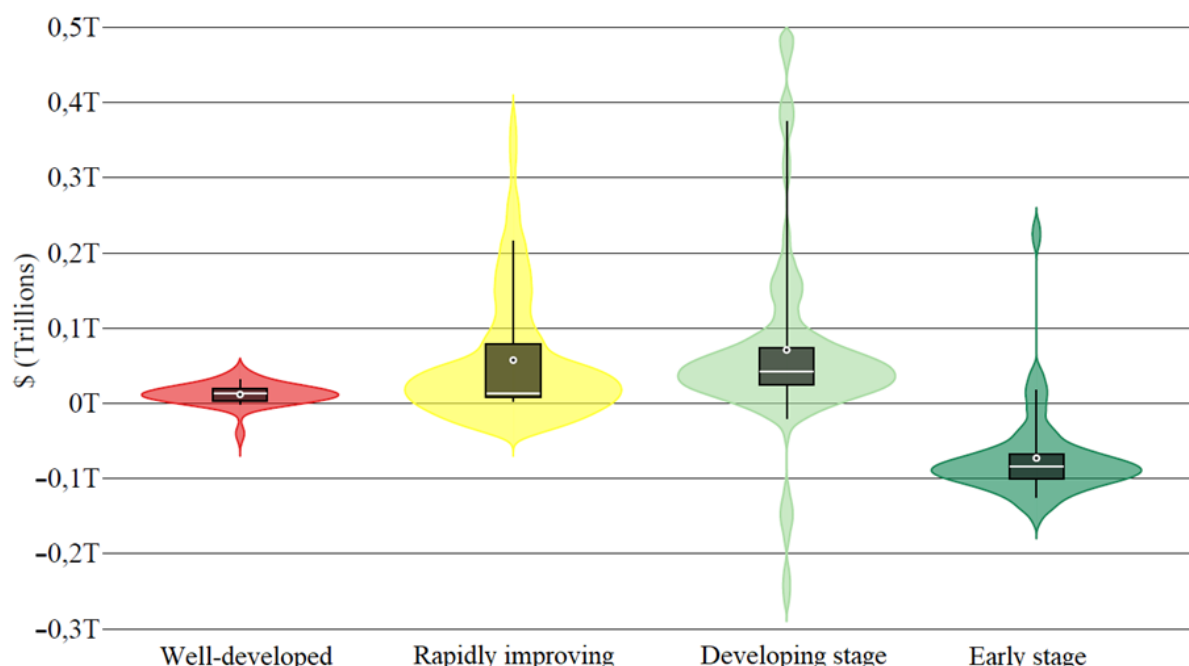


Fig. 3. The FDI's Distribution Across the Studied Groups

Source: Compiled the authors, 2024.

contrasts between the Early stage and Developing stage, Rapidly improving countries reflect the wide gaps regarding the received FDIs, which are probably caused by the different levels of ESG disclosure. In light of these results, it can be argued that even a low level of development also significantly increases the received FDI. The differences highlighted between the two most developed clusters by the Bonferroni adjustment post hoc test indicate a relevant matter. Even though significant dissimilarities were defined by the test, it cannot be used to measure their magnitude. For this purpose, Cohen's *d* for Two-Sample with Unequal SD was involved in the research. It has to do so because the use of Levene's test for examining the homogeneity of variances highlighted that the samples are not homogenous. The applied Cohen's *d* made possible the quantification of the standardized difference between the means. The explored dissimilarities were major in each case. Between the Early stage and Developing stage countries was the highest (0.81), which supports the significant difference between their FDI. The contrast was relatively similar between the Early stage and Rapidly improving regions too. Even though the outliers of the Rapidly improving countries, the difference between the two most developed groups indicated by the high Cohen's *d* value reflects, that the investor role is definitely played by the well-developed nations.

The findings revealing substantial differences between developed and least developed countries align with several studies that have shown a positive relationship between non-financial disclosure and investor

sentiment. According to [32] and [33], investors are inclined to invest in countries and companies demonstrating a commitment to sustainability. Some studies, however, highlight the limited impact of ESG disclosure. For instance, the research of [34] indicates that ESG press releases have an insignificant effect on investors, likening their reaction to routine portfolio rebalancing activities. Conversely, the study of [35] examined the added value of extended ESG disclosure, specifically looking at the implementation of the EU directive in Italy. This research found that the new element did not provide value-relevant information for investors. It is worth noting that these latter studies focused on well-developed disclosures rather than the mere existence or basic aspects of such reports.

As it is seen, the direct relationship between the ESG disclosure and FDI has not been widely studied. It stresses the novel approach of the research but also hinders putting the results into scientific context. However, the main and subfactors of ESG are broadly researched at the business level. Probably some of these could have an impact on investors' decisions at a higher level too. The political environment is one of the most obvious factors that can be considered by investors [36, 37]. The stable governance and clear regulations build trust and encourage transparency [38, 39]. The economic growth and the development of infrastructure as partial results of the local economic policy could impact the decision-making of the investors too [40, 41]. Taxation is an important issue in all cases, not just for investment [42, 43].

Table

The Bonferroni Adjustment Post Hoc Test of the Defined Groups

Pairwise comparisons of group					
Sample 1 – Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Early stage – Well-developed	–11.718	12.554	–0.933	0.351	1.000
Early stage – Developing stage	33.167	12.554	2.642	0.008	0.049
Early stage – Rapidly improving	–55.356	11.959	–4.629	0.000	0.000
Well-developed – Developing stage	21.449	11.46	1.872	0.061	0.368
Well-developed – Rapidly improving	43.637	10.805	4.039	0.000	0.000
Developing stage – Rapidly improving	–22.188	10.805	–2.054	0.04	0.24

Source: Compiled the authors, 2024.

Strong human capital and fair labor practices are key considerations, which can attract green investors [44, 45]. However, the various local norms and business practices could be considered as relevant factors too [46, 47]. The pandemic, running armed conflicts, and restrictions also can influence the assessment of potential investments [48–53].

Although ESG disclosure is very popular and comprehensively studied, the extension of the legitimacy theory has not been applied to analyze the potential impact of the ESG framework's development on FDI. The current study confirmed that this firm-level approach could be seen at the country level. Within the group of countries studied, it's important to consider the specific role of the European Union member states. These countries share similar values and norms. In addition, the pressure caused by the Green Deal could lead more investors to prefer alternatives from this region. Even countries with less developed regulations can become potential targets for investors in the hope of higher profits. However, those companies located in areas with low ESG standards are generally not preferred by investors. To avoid the investment gap deepening further, the least developed countries' ESG regulations should adapt the Western practices. Notwithstanding, often the less developed nations belong to economic communities (out of the EU), e.g., the Eurasian Economic Union, following higher standards

could open new markets for them. Through the adaptation, the governments could enhance the regional and international competitiveness of their companies. The existence of a standardized ESG disclosure could significantly facilitate the situation of the least developed regions. However, with the current circumstances, the change in the local regulation could take time, so it might be worth it for the companies to go beyond the local standards to enhance their international competitiveness, even though this shift could be costly.

CONCLUSION

Building trust in business is a priority, especially when partners with diverse norms are involved. As the geographical distance increases, the differences are also likely to grow. In many countries, demonstrating commitment to sustainable development is regulated by the law. While in other regions it is not so. Even though international endeavors for sustainability have an impact on the financial sector too, where green investment gains increasing attention. Through the extension of the legitimacy theory, the work proved, that the enterprise-level approach is applicable at a higher scale. Similar to how businesses leverage CSR to establish legitimacy, countries can implement ESG practices to conform to global standards and attract FDI. The findings revealed significant disparities between the studied groups, aligning

with the official theory. The results highlighted the importance of ESG practices in influencing investment patterns. The leading position of the developed Western countries is unambiguous, but the gap between the countries in their Developing and Early stages is huge. It suggests that the continued rise of green finance could further crowd out firms located in narrowing regions from international investments. The lack of global standards could further deepen the inequalities. To address these concerns, exploring regional ESG disclosure norms as a stepping stone to international ones could be a valuable path forward. While the development of international standards

may take time, businesses in less developed economies can take proactive steps to enhance their ESG disclosure practices. By adopting the good ESG practices of the developed Western countries and actively engaging with regional sustainability initiatives, these companies can demonstrate their commitment to responsible growth and attract the attention of foreign investors. As the demand for ESG transparency continues to rise, proactive businesses have the opportunity to become pioneers in their regions, paving the way for a more sustainable and prosperous future. The upcoming works could discover the feasibility of developing regional ESG disclosure norms.

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Appendix

Table

The Analyzed Countries' Classification

Well-developed	Rapidly improving	Developing stage	Early stage
Belgium	Australia	Argentina	Indonesia
Denmark	Brazil	China	Nigeria
Finland	Canada	India	Russia
France	Germany	Malaysia	Thailand
Norway	Italy	New Zealand	Vietnam
Sweden	Japan	Philippines	
UK	South Africa	Singapore	
	Switzerland		
	USA		

Source: Compiled the authors, based on [20].

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Improving the Accuracy of Precious Metal Prices Forecasts When Used as Stabilization Assets

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ABSTRACT

Precious metals are key elements of the asset class in the international financial market. They have a number of advantages: they are a valuable tool for preserving wealth, they are not at risk of default, and they provide effective protection against inflation. In addition, they are considered safe-haven assets during periods of unfavorable geopolitical conditions. **The purpose** of this research is to find methods for improving the accuracy of predicting the price of precious metals through the use of advanced machine learning models. **The methodological basis** is the concept of predicting the effectiveness of precious metals as a stabilizing asset (and a safe-haven asset) in the context of future financial instability. The research methodology is based on evaluating the effectiveness of machine learning models using information criteria such as AIC and BIC, determination coefficients R^2 and Adj- R^2 , and RMSE and MAPE as measures of the closeness between the actual and predicted values of time series and error measures. The information base for this study was based on daily data on the prices of four precious metals (gold, silver, platinum, and palladium), provided by Investing.com. Given the increasing importance of precious metals as indicators of investor sentiment and the state of the global economy, and in light of the escalating geopolitical tensions from 2020 to 2025, we conducted a comparative analysis using modern machine learning models. The results obtained demonstrate the advantages of the KAN model as a promising tool for improving the accuracy of forecasts and the interpretability of results in various scenarios. This is highly significant for the development of an effective investment strategy in the precious metal markets.

Keywords: precious metal market; price forecasts; investment strategy; stabilization assets; machine learning models; LSTM network; Kolmogorov-Arnold network

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INTRODUCTION

Since the beginning of 2020, the global economy has been affected by various economic and humanitarian shocks, which have triggered geopolitical risks and uncertainty, leading to a fundamental change in the investment landscape in financial markets. The search for hedging assets to address challenges and threats of an economic and humanitarian nature highlights the attractiveness of the precious metals market, which is being explored by many economists [1, 2]. Precious metals have become important financial assets and investments due to their safe haven characteristics from potential market risks [3–5].

Precious metals have several advantages over other investment assets. They are not affected by currency devaluation, unlimited issuance, or credit risk, making them safer than stocks and bonds. Unlike real estate, which can be less liquid over long periods, gold can not only preserve but also increase your capital. Precious metals are considered a reliable investment and are less volatile than cryptocurrencies due to regulatory risks and technological disruptions.

In recent years, a new geopolitical factor has added to these traditional arguments. The freezing of Russia's foreign exchange reserves showed that foreign currency assets held in foreign banks may be unavailable for political reasons. Gold reserves provide a stable foundation for state strategic independence, reducing dependence on volatile oil and gas revenues and creating sustainable protection against external shocks.

The stabilizing role of precious metals extends beyond gold. Silver, platinum, and palladium are all used to diversify investment portfolios, providing both protective assets and industrial metals. Over the past few years, all four of these precious metals have seen steady price increases on both the global and Russian markets.

Gold has led the way in absolute growth, with silver and platinum leading in relative growth. These metals have shown steady and significant increases over time, confirming their status as safe assets. Despite their volatility and occasional price fluctuations, silver, platinum, and palladium remain attractive for diversifying investment portfolios and potentially earning higher returns.

The global financial markets, including the market for precious metals, are becoming more complex and volatile. These markets are characterized by speculative transactions that increase systemic and price risks. Under these circumstances, it is crucial for investors, policymakers, and experts to accurately forecast the prices of precious metals.

Traditional statistical methods for predicting the price of precious metals have limitations when dealing with multidimensional, non-linear, non-stationary time series that contain significant noise. These methods typically operate under the assumption of time series stationarity, linear relationships, and normal probability distributions, making it difficult to accurately predict future trends based on historical data.

Recent advances in machine learning and deep learning have led to new breakthroughs in this area, with models based on recurrent neural networks (RNNs) with long- and short-term memory (LSTMs) and the Kolmogorov-Arnold Network (KAN) showing promising results [6]. These models are able to learn complex patterns and rules from high-dimensional, non-linear data, leading to improved prediction accuracy compared to traditional methods.

The aim of the research is to discover methods to enhance the accuracy of predicting the price of precious metals through the use of advanced machine learning algorithms.

To achieve this goal, the study has identified the following objectives:

- Identification of precious metals as a tool for capital protection during periods of market volatility and uncertainty.
- Investigation of the role of machine learning techniques in scientific and practical studies on forecasting precious metal prices.
- Comparative analysis of the accuracy of predictions made by the LSTM and KAN models for precious metal prices for the period from January 1, 2024 to May 1, 2025.
- Discussion of the findings and justification of conclusions regarding the use of the KAN model as a potential tool for improving the accuracy of precious metal price forecasts.

PRECIOUS METALS AS A STABILIZING ASSET IN A VOLATILE ECONOMY: LITERATURE REVIEW

Precious metals have unique properties that make them a reliable investment tool. They retain or even increase in value when other financial instruments suffer significant losses. This makes precious metals a valuable asset for protecting investment portfolios from systemic risks.

Among all precious metals, gold is the most resilient, demonstrating its value even during times of financial crisis. Gold is characterized by its high liquidity and stability in conditions of geopolitical and economic uncertainty. Silver, on the other hand, is often used to diversify investment portfolios due to its relatively low investment cost. Now, both gold and silver are included in many investment strategies and are considered strategically important assets. This is supported by scientific studies that show silver's potential as a stabilizing asset in investment portfolios [7].

Platinoids (platinum and palladium) also form a significant share of investment portfolios, taking into account the rarity of these metals and the wide range of uses both in the jewelry industry and in the manufacturing sector. The platinum market is facing several challenges: limited stocks, logistical difficulties due to sanctions, price fluctuations, and increasing demand in the automotive industry. Despite these challenges, innovations are opening up new opportunities for growth that align with the principles of sustainable development and the transition towards a "green" economy in various countries [8]. Platinum group metals are considered safe assets around the world due to their high profitability and their ability to diversify portfolios [9].

Global Economic Policy Uncertainty (GEPU) increases the risk of unexpected changes, especially in fiscal and regulatory policies. Due to the ongoing rise in geopolitical tensions, increased uncertainty has become a significant factor in financial markets. When uncertainty is high, the risk of investing in speculative assets increases [10]. GEPU influences the precious metals market in several ways, affecting the investment and purchasing decisions of economic actors. This, in turn,

can lead to significant fluctuations in the price of these metals in the commodity market [11].

Precious metals are important investments for an expanded portfolio, however, they are very sensitive to economic uncertainty. Since January 2020 (during the COVID-19 pandemic), prices for precious metals have shown an upward trend. For example, gold prices rose from almost \$ 1,500 (USD) to \$1,900 per ounce at the end of 2020.

T. Nuunkh, T. Burggraf and M. Nasir [12] revealed that economic uncertainty increases the demand for precious metals during the crisis. Similarly, S. Thongkairat, V. Yamaka, and S. Sri-bonchitta [13] identified the strong influence of GEPU on the gold market. In addition, the GEPU shock is more volatile for gold prices in developing countries compared to developed economies. Thus, it is assumed that precious metals are assets that counteract market risks [14]. Therefore, numerous modern studies focus on the use of precious metals as a stabilizing asset in order to identify and use their capabilities in conditions of financial instability [15, 16]. Global financial markets are interconnected through a variety of channels. One of the key factors integrating the foreign exchange and precious metals markets is the dynamics of oil prices [17].

A wide variety of research methods were used to predict the prices of precious metals. For example, T. Mingming and Z. Yingliang [18] used the MWRNN (Multiple Wavelet Recurrent Network) model to predict the price of crude oil, taking into account the price of gold. In the work of V.A. Al-Dhuraibi and J. Ali [19] used both traditional statistical methods and machine learning methods for short-term forecasting of the gold price trend: Decision Tree (DT), K-Nearest Neighbor (KNN), Support Vector Machine (SVM) and Linear Regression (LR).

In the article [20], gold price trends were studied using the ICA-GRUNN hybrid method, which combines the methods of Independent Component Analysis (ICA) and Gate Recurrent Unit Network (GRUNN).

B. Guha and G. Bandepadhyay [21] used the classical ARIMA method to predict the price of gold. G. Tsokhen [22] tried to predict the prices of precious metals using approaches such as Bol-

linger bands (BB), Darvas boxes (DB) and linear regression (LR). In his work, F. Weng, Y. Chen, Z. Wang, and others [23] proposed using data from open sources to predict gold prices using the Genetic Algorithm Regulation Online Extreme Learning Machine (GA-ROSEUM) model. T. Duts Huynh, T. Burggraf, M. Wang [24] investigated the possibility of predicting the ratio of gold and platinum using the multiple wavelet correlation method in the short term.

MACHINE LEARNING METHODS IN SCIENTIFIC AND PRACTICAL RESEARCH ON PREDICTING THE PRICE OF PRECIOUS METALS

The use of machine learning techniques provides powerful new tools for analyzing and predicting the behavior of financial and commodity markets. Predicting the prices of precious metals using machine learning algorithms has become a crucial tool for investors, central banks, and mining companies. This has led to increased interest in scientific research in this field [25].

In a scientific article [26], the authors analyzed and predicted daily prices for precious metals using the method of artificial neural networks (ANN). They found that the ANN-based model demonstrated high accuracy and efficiency in predicting the value of gold and palladium, but forecasts for silver and platinum were less accurate. The study emphasizes the potential of ANNs as a promising tool for predicting precious metals prices.

A. Varshini, P. Kayal, and M. Maiti [27] used machine learning and deep learning models, such as Stacked LSTM, Convolutional LSTM, Bidirectional LSTM, SVR EGB, and Gated Recurrent Unit, to predict future metal prices in commodity markets. The effectiveness of these models was assessed using three indicators: RMSE, MAE, and MAPE. Their results showed that the accuracy of the forecasts varied significantly depending on the type of metal being forecasted, the time period being forecasted over, and the specific input data used.

T. Liu and Z. Zheng [28] proposed a three-stage hybrid learning method to predict the price of silver, palladium, and platinum. They found that

their hybrid model outperformed other models, emphasizing the importance of combining different components to improve forecasting accuracy and generalization power.

P. Sarangi, R. Verma, S. Inder and N. Mittal [29] evaluated the effectiveness of a hybrid model based on machine learning and ANN-PSO particle swarm optimization for predicting the monthly gold price in India. Their results showed that the model can effectively predict future gold prices.

S. Oztoprak and Z. Orman [30] reviewed the use of explainable artificial intelligence (XAI) for predicting precious metal values, as well as conducting a thorough review of existing research on this topic.

S. Kangalli Uyar, U. Uyar and E. Balkan [31] described a two-stage approach to forecasting price bubbles in the precious metals markets. They used various machine learning methods to detect and evaluate factors contributing to bubble formation. These methods included logistic regression, SVM, CART, random forests, EGB and neural networks. Their study showed that macro-economic factors influenced monthly fluctuations in prices of gold, silver, palladium and platinum between 1990 and 2022. This led to the formation of price bubbles.

The paper [32] explores the use of machine learning techniques to predict the price of precious metals, including gold, silver, palladium, and platinum, from 2017 to 2023. The authors employed machine learning algorithms, specifically the Gaussian mixture model (GMM), for evaluation. The effectiveness of these models was assessed using various metrics, such as entropy, log likelihood, normalized entropy criterion (NEC), integrated complete likelihood (ICL), Akaike information criterion (AIC), and Bayesian information criterion (BIC).

The findings indicate that machine learning models have the potential to achieve high accuracy in predicting precious metal prices. The results also suggest that prices have significantly increased during the COVID-19 pandemic, driven by factors such as increased demand for safe investment, industrial usage of metals, favorable monetary policies, concerns about inflation, and the devaluation of the US dollar [33].

Based on the results of a review of scientific publications, it can be concluded that modern machine learning methods are actively used to model investment strategies and predict price dynamics in precious metals markets [34, 35]. Scientific approaches for analyzing and evaluating this field are constantly improving, and their results are finding wide practical application and further development, contributing to the deepening of scientific research and the use of hybrid models in the learning processes.

However, taking into account multiple influencing factors, it is difficult to determine which machine learning model is most effective. There are still many unanswered questions regarding the use of these methods, making it necessary to continue studying this topic and conducting comprehensive scientific research.

INITIAL DATA AND RESEARCH METHODS

To conduct a scientific study, the initial data of the daily values of the price of gold (XAU), silver (XAG), platinum (XPT), palladium (XPD) in US dollars (USD) were uploaded from the website Investing.com.¹

Figure 1 shows the dynamics of the price per gram, the time series XAU, XAG, XPT, XPD from

¹ Investing.com. Futures prices for metals. URL: <https://ru.investing.com/commodities/metals> (accessed on 06.09.2025).

01.01.2020 to 01.05.2025. According to the data presented, the largest increase in gold and silver prices was observed from the beginning of 2024 to the beginning of 2025. During this time interval, the cost of one gram of gold increased from 50 to more than 100 dollars, and silver — from 0.85 to 1.1 dollars. This significant increase in precious metals prices is a record over the past five years and is due to several factors such as geopolitical instability, inflationary processes and changes in the market structure.

In this regard, reliable estimates of the prospects for further price increases for gold and other precious metals are extremely important.

In order to provide a theoretical basis for analyzing price trends for precious metals, the paper provides a comparative analysis of the accuracy of forecasts of the price of 1 gram of XAU, XAG, XPT, XPD for the period 01.01.2024–05.01.2025 (Fig. 2).

The research question is to find methods to improve the accuracy of predicting the price of precious metals using advanced machine learning models. To answer the research question, the article tests the hypothesis about the advantages of forecasting methods by conducting a comparative analysis of the accuracy of time series forecasting models based on daily values of precious metals: gold (XAU), silver (XAG), platinum (XPT), palladium (XPD) for the period 01.01.2024–05.01.2025.

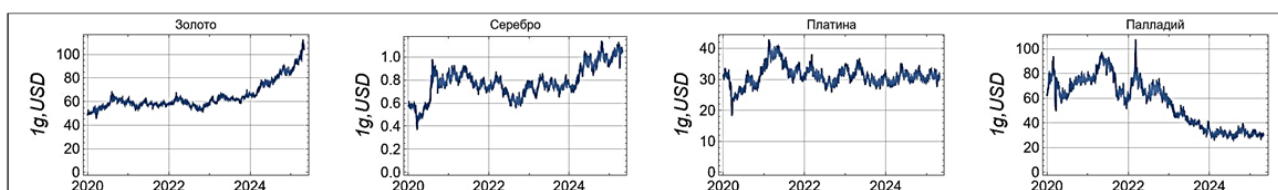


Fig. 1. Price Dynamics of 1 Gram of Precious Metals, in USD, (01.01.2020–01.05.2025)

Source: Authors' calculations based on data from Investing.com. Metal futures prices. URL: <https://ru.investing.com/commodities/metals> (accessed on 06.12.2025).

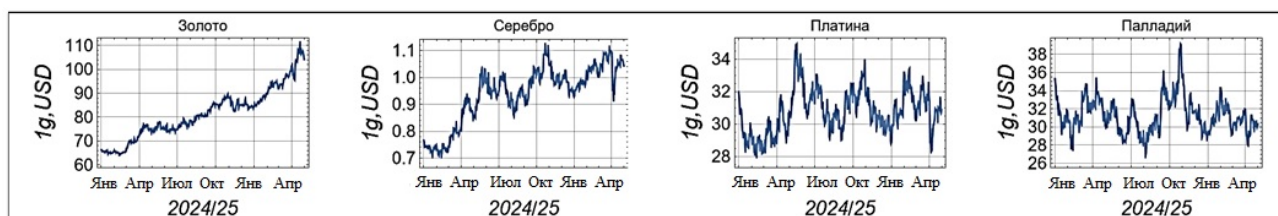


Fig. 2. Price Dynamics of 1 Gram of Precious Metals, in USD (01.01.2024–01.05.2025)

Source: Authors' calculations based on data from Investing.com. Metal futures prices. URL: <https://ru.investing.com/commodities/metals> (accessed on 06.12.2025).

Hypothesis testing is based on an assessment of the strengths and weaknesses of the most advanced modern forecasting models such as LSTM and KAN.

The effectiveness of the models is evaluated taking into account information criteria (AIC and BIC), coefficient of determination (R2 and Adj-R2) and RMSE, MAPE indicators, as a measure of proximity between actual and predicted time series values and error measures.

The KAN Forecasting Model

To create the KAN prediction model, the main conclusions of the Kolmogorov-Arnold superposition theorem are applied. This theorem states that any continuous function of several variables can be represented as a finite set of continuous functions of one variable [36, 37]. Formally, for any continuous function f of n variables $f: [0, 1]^n \rightarrow R$ there are continuous functions of one variable: ϕ_i and ψ_{ij} , so that:

$$f(x_1, x_2, \dots, x_n) = \sum_{i=1}^{2n+1} \phi_i \left(\sum_{j=1}^n \psi_{ij}(x_j) \right). \quad (1)$$

This theorem provides a formal justification for the possibility of neural networks to approximate complex functional dependencies [38].

Input layer: processing of input variables

The KAN input layer accepts multidimensional input data $\mathbf{x} = (x_1, x_2, \dots, x_n)$ and prepares them for processing through hidden layers. Each input variable x_j is individually transformed by a set of one-dimensional functions ψ_{ij} .

Hidden layers: the role of functions ψ_{ij}

The hidden layers in KAN are responsible for applying one-dimensional functions ψ_{ij} to input variables: each function ψ_{ij} transforms one input variable x_j into an intermediate representation.

Mathematically:

1. For each input variable x_j , calculate:

$$\psi_{ij}(x_j) \text{ для } i = 1, 2, \dots, 2n + 1.$$

Calculate the intermediate sums by combining the results of applying the functions ψ_{ij} :

$$z_i = \sum_{j=1}^n \psi_{ij}(x_j),$$

where each z_i is a combination of transformed input variables.

Output layer: the role of functions ϕ_i

The KAN output layer takes the intermediate sums z_i and applies another set of one-dimensional functions ϕ_i to them. These functions ϕ_i produce the final results, which are then summarized to produce the output of the network.

Mathematically:

1. For each intermediate sum z_i , calculate: $\phi_i(z_i)$ for $i = 1, 2, \dots, 2n + 1$
2. The functions ϕ_i are summed to obtain the final result:

$$f(x) = \sum_{i=1}^{2n+1} \phi_i(z_i). \quad (2)$$

KAN activation functions. MLP-based neural networks usually use a single activation function (for example, Sigmoid, $S(x) = \frac{1}{1+e^{-x}}$), which is

used by all nodes of the network. In contrast, KAN uses activation functions for each node that combine a smooth basis function $b(x)$ with a component based on B-splines:

$$\phi(x) = \omega_b b(x) + \omega_s \text{spline } x, \quad (3)$$

where ω_b and ω_s are trainable scaling factors. The basis function $b(x)$ is usually chosen as:

$$b(x) = \frac{x}{1+e^{-x}}. \quad (4)$$

The spline function $\text{spline } x$ is a linear combination of basic B-spline functions:

$$\text{spline } x = \sum_i c_i B_i(x), \quad (5)$$

where the coefficients c_i are the trainable parameters. In practice the parameters $\{\omega_b; \omega_s; c_i\}$ are trained through standard back-propagation, providing reliable flexibility while maintaining interpretability. Moreover, this activation function design facilitates locally accurate approximation of complex relationships and enhances the model's ability to capture even excessively nonlinear function behavior [39].

For practical application and development of a forecasting model based on KAN in the WolframMathematica system, the method proposed by A. Hafver was used [40].

Hafwer's approach indicates that the K-A (Kolmogorov-Arnold) theorem can be interpreted as a two-layer neural network of direct propagation. Based on this, a way is proposed to expand it to more layers. The second important element of the approach is the idea of representing the basis function in each layer using B-splines [0,1], where m is the number of intervals, i is the index of the basis function, and p is the order of the B-spline polynomial.

Ultimately, the Kolmogorov-Arnold network layer design is implemented, **KANlayer** [inputs, outputs, m , p], on the basis of which models of forecasting the price of precious metals are formed:

```
kan_xau = NetTrain [NetChain [{KANlayer [1, 1, 170, 2]}], x(xau)→y(xau)]
kan_xag = NetTrain [NetChain [{KANlayer [1, 1, 170, 2]}], x(xag)→y(xag)]
kan_xpt = NetTrain [NetChain [{KANlayer [1, 1, 170, 2]}], x(xpt)→y(xpt)]
kan_xpd = NetTrain [NetChain [{KANlayer [1, 1, 170, 2]}], x(xpd)→y(xpd)].
```

In the considered models for predicting the price of precious metals based on the Kolmogorov-Arnold network (KAN): m is the number of intervals = 170; p is the order of the B-spline polynomial = 2.

The forecast of the time series compiled from the daily values of the price of 1 gram in USD: XAU; XAG; XPT; XPD is presented for the period from January 1, 2024 to May 1, 2025. Calculations were carried out with the division of the entire data set (observations) – 487 points into 2 sections, including training and test datasets, in the ratio of 90/10:

- from 1 to 437 – training data collection (01.01.2024–11.03.2025);
- 438 to 487 – test data collection (12.03.2025–01.05.2025).

A Forecast Model Based on a Recurrent LSTM Network

The study uses a forecasting model based on the LSTM algorithm, developed in accordance with the methodology proposed by S. Nagpal [41]. The software implementation of this model is performed using the Wolfram Mathematica system.

Data preparation for neural network training

To prepare the initial data for training neural networks, you first need to apply the Enhanced Dickey-Fuller test (ADF, Test) to verify the stationarity of the time series. The ADF test returns the probability of a null hypothesis that confirms the existence of a single root. Table 1 shows the results of applying the ADF test to verify the stationarity of the original time series.

Table 1

The Augmented Dickey–Fuller (ADF) Test for Stationarity of the Original Time Series

p -Value of Null Hypothesis			
XAU	XAG	XPT	XPD
0.783	0.671	0.7565	0.798

Source: Compiled by the authors.

Table 2

The Augmented Dickey–Fuller (ADF) Test for Stationarity of Transformed Time Series

p - Value of Null Hypothesis			
XAU	XAG	XPT	XPD
$7 \cdot 10^{-8}$	$4 \cdot 10^{-7}$	$1.6 \cdot 10^{-8}$	$5 \cdot 10^{-10}$

Source: Compiled by the authors.

As can be seen from Table 1, the p -Value of Null Hypothesis values are high, and therefore, the initial time series are unstable and are not suitable for direct use in neural network training.

To improve the normality of the data, we apply the Box-Cox transform with $\lambda = 0$ (logarithmic transformation) of all the original time series and evaluate the stationarity of the transformed time series by applying the ADF test to the transformed time series (Table 2).

As can be seen from Table 2, the logarithmic transformation of the data gives very small p -values for the null hypothesis, which confirms the existence of a unit root, and, therefore, the transformed time series can be considered stationary, and, therefore, suitable for training neural networks.

Next, we need to divide the source data into parts that we can feed to the input of neural networks for their training. It is also necessary to determine the delay (lag) of the training data. The lag can be assumed to be three (lag = 3), based on the assumption that differentiation of the order above three is extremely unlikely for any time series.

Just like in the KAN model, the calculations were carried out with the division of the entire data set (observations) — 487 points, into 2 sections:

- from 1 to 437 – training data collection (01.01.2024–11.03.2025);
- from 438 to 487 – test data collection (12.03.2025–01.05.2025).

Data preparation for neural network training:

The next step is to create associations that use three consecutive values from each time series and associate them with a fourth, neighboring value. This procedure is repeated for all precious metals (gold, silver, platinum, palladium).

For the design of the LSTM model, the approach [41] uses a 10-layer neural network LSTM, which can be trained on time series data of individual precious metals:

modell =

```
NetChain [{ReshapeLayer [{1, lag}],
  ConvolutionLayer [16, 2, "Input" -> {1, lag}],
  PoolingLayer [2, "Function" -> Mean], LongShortTermMemoryLayer [50],
  BatchNormalizationLayer [], DropoutLayer [0.4], LinearLayer [64],
  BatchNormalizationLayer [], DropoutLayer [0.2], LinearLayer [1]]
```

Next, the model is trained on precious metals data with 500 training iterations:

```
xautrained1 = NetTrain[modell, xautrain, ValidationSet -> xautest, MaxTrainingRounds -> 500]
xagtrained1 = NetTrain[modell, xagtrain, ValidationSet -> xagtest, MaxTrainingRounds -> 500]
xpttrained1 = NetTrain[modell, xpttrain, ValidationSet -> xpttest, MaxTrainingRounds -> 500]
xpdtrained1 = NetTrain[modell, xpdtrain, ValidationSet -> xpdtest, MaxTrainingRounds -> 500]
```

It should be noted that after the neural network data is trained on the corresponding test sets for 500 iterations, the p -values of the null hypothesis that the residuals are random are also calculated.

Since the Box-Cox transformation (logarithmic) was initially applied to the source data, then the inverse exponential transformation is used to obtain the predicted market values of precious metals, as well as visualization of the predicted market values in comparison with real data.

RESULTS AND DISCUSSION

The results obtained from a comparative analysis of the accuracy of forecasts of the price of 1 gram in USD of precious metals (XAU, XAG, XPT, XPD) of the LSTM and KAN models for the period 01.01.2024–01.05.2025 are presented in

Table 3, taking into account information criteria and accuracy measures: AIC (Akaike Information Criterion); BIC (Bayesian Information Criterion); Adj- R^2 (adjusted coefficient of determination); R^2 (coefficient of determination); RMSE (Root Mean Square Error); MAPE (Mean Absolute Percentage Error).

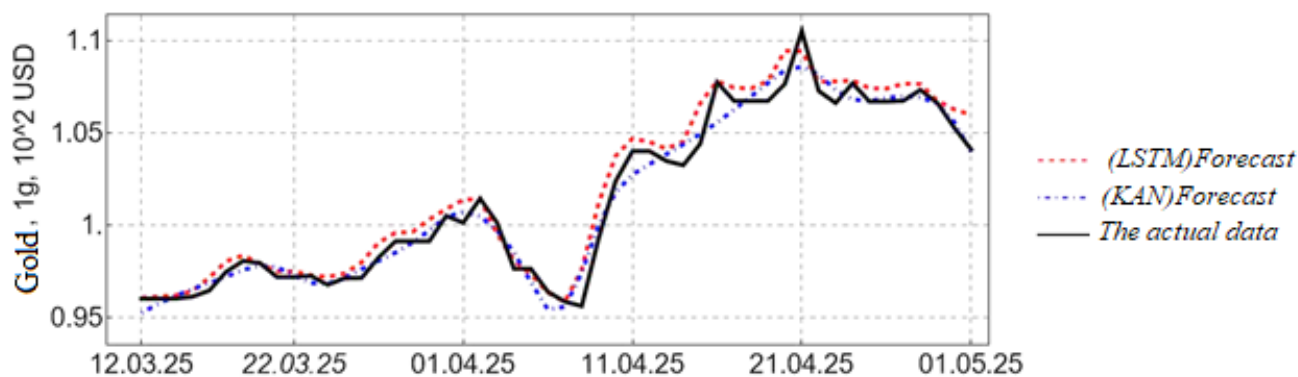


Fig. 3. The Dynamics of the Fit Between Forecast Data: LSTM Model; KAN Model; and the Actual Daily Gold Prices of 1 g (in 10^2 USD) from March 12, 2025, to May 1, 2025

Source: Authors' calculations.

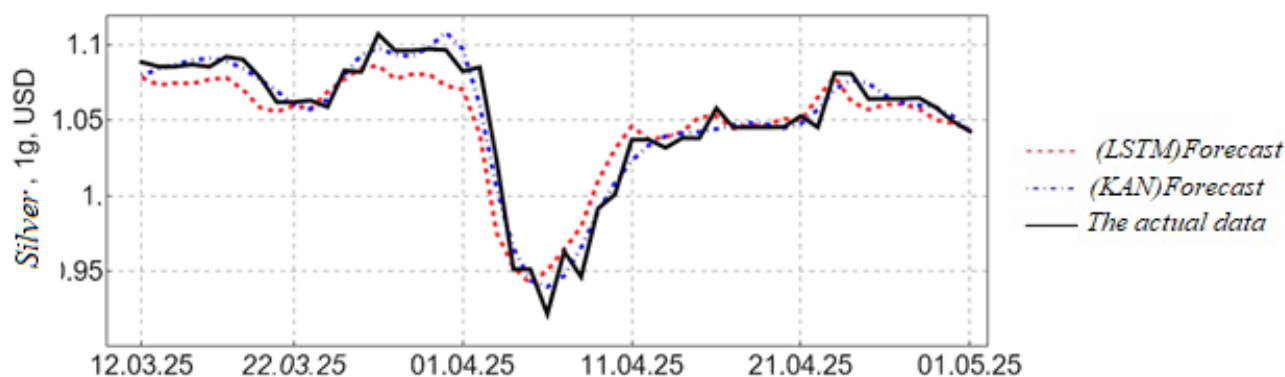


Fig. 4. The Dynamics of the Fit of Forecast Data: LSTM Model, KAN Model and the Actual Daily Prices of 1 g of Silver (in USD) from March 12, 2025, to May 1, 2025

Source: Authors' calculations.

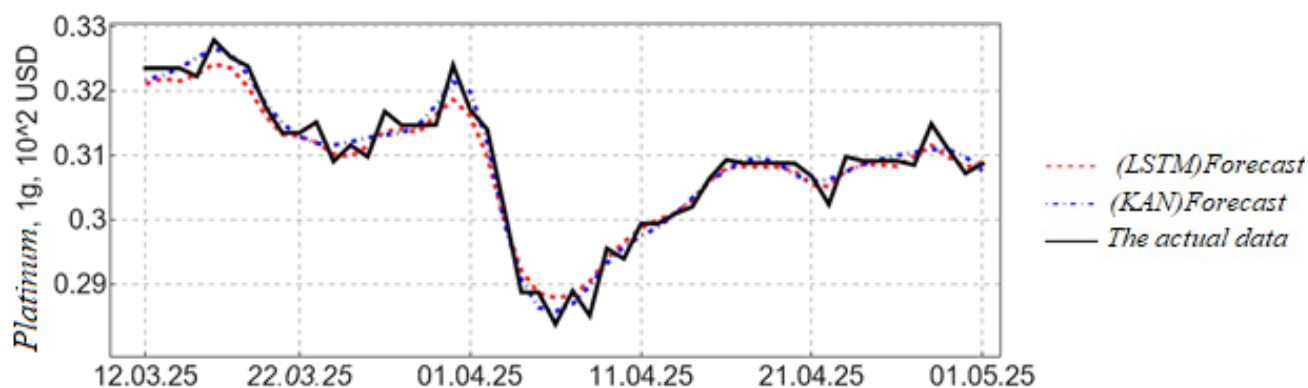


Fig. 5. The Dynamics of the fit Between Forecast Data: LSTM Model; KAN Model; and the Actual Daily Platinum Prices of 1 g (in 10^2 USD) from March 12, 2025, to May 1, 2025

Source: Authors' calculations.

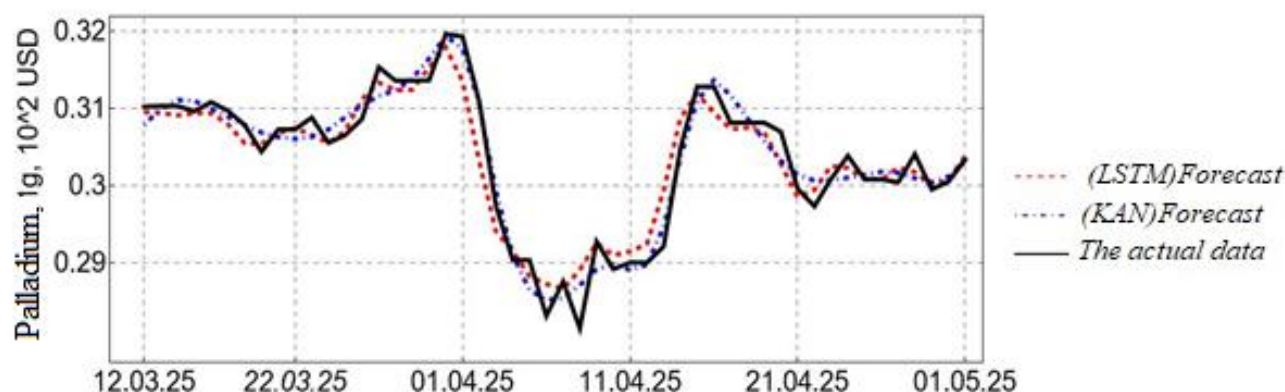


Fig. 6. The Dynamics of the fit Between Forecast Data: LSTM Model; KAN Model; and the Actual Daily Palladium Prices of 1 g (in 10^2 USD) from March 12, 2025, to May 1, 2025

Source: Authors' calculations.

Forecasting the gold price. The results of efficiency — matching the predicted values based on the KAN and LSTM models to the actual values of a time series made up of daily values of the price of 1 gram of gold (in 10^2 USD) from 12.03.2025 to 01.05.2025 are shown in Fig. 3 and in Table 3. As can be seen from Fig. 3, both models are visually characterized by high accuracy in matching large-scale changes in the predicted values to the actual ones. It should be noted that the high-frequency actual changes are more accurately reproduced by the predictive LSTM model. As follows from Table 3, the LSTM model surpasses the KAN model in terms of AIC (-359.62), BIC (-353.89), R^2 (0.980), Adj R^2 (0.979). At the same time, according to the RMSE and MAPE error metrics, the KAN model predicts test values with lower errors: 0.0074 and 0.5593 versus 0.0088 and 0.6550 , respectively.

Hence, calculations have shown that in forecasting the gold price, the LSTM forecasting model is characterized by a higher degree of conformity - proximity to actual values compared to the KAN forecasting model.

Forecasting the price of silver. The results of the correspondence of the forecast values obtained on the basis of the KAN and LSTM models to the actual values of the time series made up of the daily values of the price of 1 gram of silver (USD) from 12.03.2025 to 01.05.2025 are shown in Fig. 4 and in Table 3. As can be seen from Fig. 4, both models are visually characterized by high accuracy of matching large-scale changes the predicted val-

ues are actual. However, the high-frequency actual changes are more accurately reproduced by the KAN predictive model. As we can observe in Table 3, the KAN model surpasses the LSTM model in terms of AIC (-323.22), BIC (-317.48), R^2 (0.956), Adj R^2 (0.955). According to the RMSE and MAPE error metrics, the KAN model also predicts test values with lower errors: 0.0090 and 0.6670 versus 0.0160 and 1.1308 , respectively.

Consequently, the conclusion suggests itself that in forecasting the silver price, the KAN forecasting model is characterized by a higher degree of correspondence between the forecast values and the actual test values compared to the LSTM forecasting model.

Forecasting the platinum price. The results of efficiency — the correspondence of the predicted values to the actual values of a time series made up of the daily values of the price of 1 gram of platinum (in 10^2 USD) from 12.03.2025 to 01.05.2025 are shown in Fig. 5 and in Table 3. Both models are visually characterized by high accuracy in matching large-scale changes in predicted values to actual ones (see Fig. 5). At the same time, high-frequency actual changes are more accurately reproduced by the LSTM predictive model. The LSTM model surpasses the KAN model in terms of AIC (-490.06), BIC (-484.33), R^2 (0.9743), Adj R^2 (0.9738), and in terms of error metrics RMSE and MAPE, the KAN model predicts test values with lower errors than the LSTM model: 0.00201 and 0.5403 versus 0.0021 and 0.5428 , accordingly (Table 3).

Table 3

The Effectiveness of KAN and LSTM Models in Predicting Daily Prices of 1 Gram of Gold (XAU), Silver (XAG), Platinum (XPT), and Palladium (XPD) for the Period 12.03.25–01.05.25

Precious metal	Forecasting model	AIC	BIC	Adj-R ²	R ²	RMSE	MAPE
Gold, XAU	LSTM	–359.62	–353.89	0.9798	0.980	0.0088	0.655
	KAN	–343.21	–337.47	0.9720	0.9725	0.0074	0.5593
Silver, XAG	LSTM	–273.90	–268.16	0.8798	0.882	0.0160	1.1308
	KAN	–323.22	–317.48	0.955	0.956	0.0090	0.6670
Platinum, XPT	LSTM	–490.06	–484.33	0.9738	0.9743	0.0021	0.5428
	KAN	–472.87	–467.14	0.963	0.964	0.00201	0.5403
Palladium, XPD	LSTM	–451.21	–445.47	0.922	0.924	0.0027	0.6360
	KAN	–469.62	–463.89	0.946	0.947	0.00207	0.5590

Source: Authors' calculations.

Conclusion: in predicting the platinum price, the LSTM model is characterized by a higher degree of correspondence and proximity of forecast values to actual *Forecasting the palladium price*. The results of efficiency — matching the predicted values based on the KAN and LSTM models to the actual values of a time series made up of daily values of the price of 1 gram of palladium (in 10² USD) from 12.03.2025 to 01.05.2025 are shown in Fig. 6 and in the Table 3. Both models are visually characterized by high accuracy in matching large-scale changes in the predicted values to the actual ones. The high-frequency actual changes are more accurately reproduced by the KAN predictive model. As follows from Table 3, the KAN model surpasses the LSTM model in all information indicators and error metrics: AIC (–469.24), BIC (–463.45), R² (0.947), Adj R² (0.946), RMSE (0.00207), MAPE (0.5590).

In this way, in forecasting the price of 1 gram of palladium, the KAN forecasting model is char-

acterized by a higher degree of accuracy compared to the LSTM model, i.e., it is close to the actual values.

For all the analyzed precious metals for the period 12.03.25–01.05.25, the KAN model demonstrated its effectiveness, reaching the lowest values of the average absolute percentage error (MAPE) and RMS error (RMSE). In addition, the KAN model surpasses the LSTM model in predicting the price of 1 gram of silver and palladium in terms of AIC, BIC, Adj-R², R². These results confirm the ability of the KAN model to effectively predict and capture complex nonlinear dependencies of changes in the price of precious metals, surpassing advanced neural network architectures such as the LSTM network, not to mention traditional statistical methods such as ARMA/ARIMA.

However, for gold and platinum, the LSTM model showed the best results in terms of AIC, BIC, Adj-R², R². In terms of error metrics (MAPE) and (RMSE) it also showed higher values

compared to the KAN model, although in these cases the KAN model demonstrated its competitiveness.

The results obtained in the work show that traditional advanced machine learning models, in particular the LSTM model, can be effective in predicting the behavior of objects that are described by a simple set of data. The KAN model demonstrates high efficiency in analyzing objects with an extensive and diverse array of data, which makes it suitable for complex economic forecasts.

The KAN network makes it possible to solve critical predictive modeling tasks by identifying complex nonlinear relationships and providing a theoretically sound basis for feature decomposition. It shows a clear advantage by using its spline-based architecture to train one-dimensional functions that are composable, scalable, and interpretable. Unlike LSTM models, the KAN network-based model provides a flexible framework for modeling nonlinear dependencies with theoretical rigor and empirical stability, and also works excellently with multidimensional nonlinear data, as evidenced by its high performance.

CONCLUSIONS

In the context of geopolitical instability, it is particularly important to obtain accurate forecasts of the dynamics of prices for precious metals. This information is crucial for the formation of effective investment strategies, both at the state level and for private investors. The use of modern analysis methods allows not only to minimize potential risks and reduce volatility, but also to identify new investment opportunities in the precious metals market.

The research question was to select and evaluate the application of methods to improve the accuracy of forecasting prices for precious metals through the use of advanced machine learning models. A significant problem with ML-based forecasting models is the interpretability of the results obtained due to their opacity, the so-called “black box nature”. Machine learning models are referred to as a “black box” in the scientific literature, because the assumptions

and calculations used in them may not always be fully understood. In this context, they can be assessed as a step forward in accuracy and a step back in interpretability of the results obtained [42]. As one of the most advanced AI technologies, the KAN network [43] opens up new opportunities for improving the interpretability of ML models [44].

As part of this research, the hypothesis that using a model based on the Kolmogorov-Arnold network (KAN) could improve the accuracy and transparency of forecasts for precious metal prices was tested. To achieve this goal, a comparative analysis of forecasting accuracy for time series, including daily values of precious metal prices, was conducted. The effectiveness and drawbacks of modern advanced forecasting models, such as recurrent neural networks with long- and short-term memory (LSTM), and Kolmogorov-Arnold networks, were evaluated.

The study aimed to compare the accuracy and efficacy of the two most advanced models for forecasting precious metal prices. It revealed the significant potential of the KAN model in improving forecast accuracy in real-world conditions.

The research conducted has convincingly demonstrated that the KAN model has extensive analytical capabilities and adaptability, making it a valuable tool for working with large data sets. The KAN model can be used for making management decisions within the framework of selecting an investment strategy.

To predict prices in the precious metals market, the use of the KAN model provides more accurate forecasts in uncertain conditions, explains market mechanisms by taking into account both objective and subjective factors, and allows for the use of flexible risk management strategies.

It can be concluded that the KAN accumulates innovative methods and approaches to analyzing complex financial and economic data, including that of the precious metals market, through the use of a new neural network architecture. The main advantage of the KAN model is its high ability to perceive and adapt to complex relationships.

From a practical standpoint, the research findings have significant implications for developing an optimal investment strategy in precious metal markets [45]. This strategy should be based on accurate forecasts of price fluctuations and provide for effective risk management. To ensure informed decision-making in a dynamic international trade and financial system, it is necessary to integrate advanced technological solutions with the results of empirical research [46].

As future research directions, it is suggested to investigate the impact of investor sentiment during periods of economic and geopolitical uncertainty on the dynamics of precious metal prices. Research based on investor behavior could contribute to more accurate market forecasts. In this regard, analysis of public sentiment in social media and assessment of financial transactions could be promising areas for research. These approaches could significantly expand analytical and practical tools, and improve the accuracy of forecasting models.

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A.K. Karaev — conducted model calculations and configured them, and formulated the conclusions.

V.V. Ponkratov — collected data and analyzed scientific research on precious metal price forecasting, described the model and experiments, and performed pre-processing and post-processing of the data.

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JEL H21, H26, H27

Government Policy Impact on the Development of the VAT Rates

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ABSTRACT

The relevance of the research topic is due to the Indonesian government's policy plan which will increase the VAT rate from 11% to 12% in early 2025, and has become a hot topic. **The aim** of this research is to provide the best alternative policy options by providing comprehensive solutions. The research **method** uses a system dynamics simulation model, employing qualitative and quantitative approaches facilitated by Powersim constructor software by considering three scenarios: pessimistic, moderate, and optimistic. This study uses six main variables and three additional variables. **The research results** reveal that, in a pessimistic simulation scenario, an increase in the VAT rate will reduce people's purchasing power and increase tax avoidance. In a moderate scenario simulation, there will be a balance in economic conditions, but in the future, this will reduce the potential for taxes and increase tax avoidance. In an optimistic scenario, reducing the VAT rate will reduce the tax burden, increase potential tax purchasing power, increase exports, and reduce imports, while decreasing tax avoidance and increase tax potential. This research **concludes** that, of the three scenarios, the best choice is to use the optimistic scenario because it will benefit overall economic conditions. It recommends that the government should reduce the tax avoidance ratio and simplify the supply chain, as supply chain complexity contributes to increased costs.

Keywords: government policy; tax policy; VAT rate; dynamic system; simulation; tax avoidance; tax evasion; tax gap; Indonesia

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INTRODUCTION

After the COVID-19 pandemic, Indonesia's debt has increased. Data shows that in 2021, the state debt ratio reached its highest figure at 41% of GDP since the reform. This indicates that state debt has doubled, posing high risks for the future, especially with additional hidden debt from State-Owned Enterprises debt [1]. Although the government does not always bear all SOE losses directly, the government's debt may exceed US\$ 451.6 billion.¹ In 2022, the state debt ratio decreased slightly to 38.65%, but in nominal terms, government debt has increased by US\$ 198.1 billion since the pandemic.² In 2023, the state debt position began to decline every month. The government's debt position was US\$ 506.5 billion, with a debt-to-GDP ratio of 38.15%. In both nominal and ratio terms, Indonesia's debt decreased compared to March 31, 2023, when the debt ratio was 39.17% or US\$ 508.3 billion. The debt ratio also decreased compared to April 2022, when it was 39.09% of GDP, even though nominal debt increased from the previous year by US\$ 454.2 billion. The government has assessed that state debt remained within safe limits.³

Even though the debt ratio is still within safe limits, the Government is urged to remain vigilant about the rate of increase in debt in the medium term, especially given the recent economic situation due to the wars in Ukraine and Palestine. Therefore, the government has undertaken various efforts to manage high debt, including increasing the VAT rate from 10% to 11% on April 1, 2022,⁴ and further increasing it from 11% to 12%, in early January 2025. Additionally, the government increased premium prices and Motor Vehicle Fuel Tax rates from 5% to 10%, plus VAT.⁵ The government

also plans to increase several other taxes, such as the entertainment tax, which previously had a rate of 30%, now set to increase to 75%, and the land and building tax. On the other hand, prices have increased, especially for essentials such as rice, eggs and other necessities.

However, increasing the VAT rate will reduce people's purchasing power and increase resistance among small and medium-sized entrepreneurs, leading to higher rates of tax evasion. These entrepreneurs may try to hide their income to remain in the category of businesses earning below US\$ 300,000 per year, which exempts them from paying VAT and reporting it. VAT avoidance is likely to become more common, with consumers increasingly shopping at traditional markets and grocery stalls that are not subject to VAT. According to an online Jakpat survey with respondents from across Indonesia, the number of people shopping at traditional markets, grocery stalls, and e-commerce platforms is starting to increase, with 50.05% of respondents choosing traditional markets over supermarkets.

This research seeks to provide three comprehensive tax policy alternatives using a system dynamics simulation program. It aims to determine whether the government should increase the VAT rate to 12% in 2025, maintain the 11% rate applicable in 2024, or reduce the VAT rate to 10% as an alternative to a lower-rate policy scenario.

The distribution of respondents' monthly household shopping channels is presented in Fig. 1. The figure shows that supermarkets account for the largest share, followed by traditional markets, grocery stalls, hypermarkets, and e-commerce.

The hypothesis is:

Ha 1: An increase in the VAT rate can raise the price of goods and decrease people's purchasing power.

Ha 2: Increasing the VAT rate can lead to higher tax avoidance among lower-middle-class entrepreneurs.

LITERATURE REVIEW

In recent decades, VAT has become the most important single tax in most developing countries and countries in transition. The Government has implemented VAT using various models with distinct characteristics to address several critical fiscal issues related to VAT [2, 3].

Over the past 25 years, VAT has been introduced in several large developing countries and transition economies [4]. The IMF has indicated that VAT can effectively increase resources and modernize the tax sys-

¹ Sayekti N.W. DPR RI notes on macroeconomic framework and fiscal policy 2024 [Internet]. Analysis Expertise Agency of DPR RI Expertise Agency of DPR RI. 2023. Center for Parliamentary Analysis. URL: https://berkas.dpr.go.id/puslit/files/info_singkat/InfoSingkat-XV-10-II-P3DI-Mei-2023-163-EN.pdf (accessed on 09.05.2024).

² Agnes T. Maintain Fiscal Strength, Debt Continues to Be Reduced. Kompas.com. 2023. URL: <https://www.kompas.id/baca/english/2023/09/23/en-utang-baru-ditekan-rasio-utang-ri-masih-jauh-dari-kondisi-prapandemi> (accessed on 09.05.2024).

³ Pratiwi D.R. Menilik Potensi Dampak Kenaikan PPN Menjadi 11 Persen di Tengah Ketidakpastian Global. *Budget Issue Brief Ekonomi dan Keuangan*. 2022;2(6):1–2. URL: <https://repositori.dpr.go.id/id/eprint/972/1/Budget%20Issue%20Brief%20Ekonomi%20dan%20Keuangan%20Vol%202%20Edisi%206%202022.pdf> (accessed on 09.05.2024). (In Indonesian).

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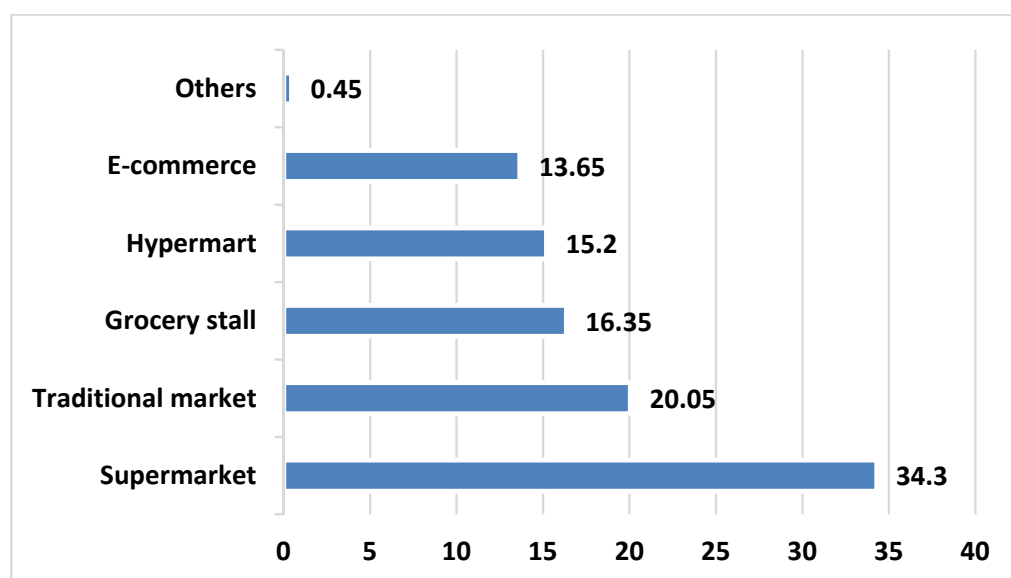


Fig. 1. Percentage of Respondents by Monthly Household Shopping Channel in Indonesia

Source: <https://databoks.katadata.co.id/datapublish/2022/06/09/survei-warga-yang-belanja-bulanan-di-e-commerce-masih-sedikit> (accessed on 09.05.2024).

tem. However, this requires well-designed and properly implemented tax policies. A significant challenge for the future is the proper implementation and management of the financial sector, which is subject to VAT, and the reduction of losses due to varying rates and applications. Therefore, it is necessary to review the VAT system with a clear and consistent logic [5].

Regarding the increase in VAT rates, research conducted by Aaron, published by Ernst & Young, shows that a 1% increase in the VAT rate will impact the aggregate price level by 1%. The prices of goods will rise and service activities will increase by 34.4%. People's purchasing power and their intention to buy property will fall between 30 and 38%. However, Japan's experience with increasing VAT rates shows that such increases cannot boost consumption and instead lead to economic growth and inflation. In 2019, EU countries experienced a 12.2% decrease in VAT revenues after the increase in VAT rates. Specifically, VAT revenues decreased by 36% in Romania, 34% in Greece, 24% in Italy, 23% in Slovakia, and 11% in the UK [6].

Indonesia has had VAT since 1951, when it was first called Sales Tax. This is an indirect and general tax regulating the sales tax on both domestic and imported goods [7]. Indonesia experienced inflation due to VAT increases from 10% to 11% in 2022, resulting in a 5.51% inflation rate, and 2023, the inflation rate was 5.28%.

VAT in Indonesia

In Indonesia, VAT is a tax on value added by individuals and business entities at every stage of providing services or producing goods [8]. VAT taxpayers include individuals and entities who act as taxpayers, with-

holding tax agents, and tax collectors with the rights and obligations to carry out taxation. The current VAT rate is set at 11% and it can change by up to 15% according to VAT Law No. 7 of 2021 [9]. The potential tax that the government can collect comes from the delivery of taxable goods and services of the Customs Area by entrepreneurs, the import of taxable goods, and the use of intangible taxable goods from inside and outside the Customs Area [10]. The law also regulates the exemption and reduction of VAT, as stipulated in the Minister of Finance Regulation No. 116/PMK.010/2017.

Supply Chain Stage

In Indonesia, the increase in the VAT rate affects various supply chains, from factories to consumers [11]. There are six stages in the supply chain: Factory to Main Distributor, Main Distributor to Distributor, Distributor to Main Agent, Main Agent to Agent, Agent to Seller (retailer), and finally, Seller to Consumer. *Table 1* presents an example of VAT calculation using the supply chain stage flow in Indonesia, starting from the factory level and ending with the final consumer [12, 13].

Table 1 shows that the government planned to increase VAT from 11% to 12% in 2025, which means an increase of 1.09% (the new VAT rate is 12% compared to the old rate of 11%). This example illustrates that the prices of goods become more expensive due to the numerous stages in the supply chain, coupled with the increasing the VAT rate, resulting in a heavy tax burden for society [14]. This simulation can serve as a consideration for the government to reduce the public taxation and increase purchasing power by removing one or

Table 1

Supply Simulation of Flow Chain Stages in VAT on Goods (US\$)

No.	Business actor	Factory Price	Average of Marketing Cost, others [10%] ^	Average of Expected Profit [10%] ^	VAT 11%	Selling price [VAT 11%]	VAT 12%	Selling price [VAT 12%]
1	Factory: Price of shoes*	3.33	0.11	0.33	0.4	4.07	0.44	4.11
2	Main Distributor**	4.07	0.41	0.81	0.58	5.87	0.63	5.93
3	Distributor**	5.87	0.59	1.17	0.84	8.47	0.92	8.55
4	Main Agent**	8.47	0.85	1.69	1.21	12.23	1.32	12.34
5	Agent**	12.23	1.22	2.45	1.75	17.65	1.91	17.81
6	Seller/Reseller**	17.65	1.76	3.53	2.52	25.46	2.75	25.69
7	Consumer Society	25.46	2.55	5.09	3.64	36.74	3.97	37.08
					10.95		11.95	

Source: Author's own simulation and calculation based on the VAT rates stipulated in the Law of the Republic of Indonesia No. 7 of 2021 on the Harmonization of Tax Regulations. URL: <https://jdih.kemenkeu.go.id/dok/uu-7-tahun-2021> (accessed on 09.05.2024).

Note: * Materials and production costs; ** Transportation, Marketing Costs, and others. ^ Percentage Estimates are generally accepted.

two supply chain stages, such as the main Distributor and Main Agent.

VAT Gaps

Tax gap analysis measures the loss of tax revenue due to non-compliance, evasion, and policy impacts. There are two main components of the VAT gap, namely the impact of the compliance gap and the policy gap [15, 16]. However, these two components are interrelated, as one gap can influence the other [17]. Tadesse [18] further divides the policy gap into two categories: the tariff differentiation gap, which includes the application of lower or zero VAT rates for essential goods and services, and the exception gap, which includes exemptions from taxation for certain goods and services from taxation [19, 20].

METHODOLOGY

Simulation Model of System Dynamics

This research uses a system dynamics simulation model with a qualitative and quantitative approach [21]. It employs a qualitative system-thinking approach using a soft systems methodology, facilitated by Power-sim constructor software as a cognitive mapping tool, by designing models using quantitative system-thinking approaches such as system dynamics [22, 23]. The main objective of dynamic system analysis is to answer three questions [24]: Why should the government increase the VAT rate? When or where should the government

consider increasing the effectiveness of the VAT rate? Is there a better alternative to increasing the VAT rate besides increasing it? The last question mainly concerns administration and policy implementation.

Stock and Rate on Flow Diagrams is a development of the Causal Loop Diagram [25]. Causal Loop Diagram visualizes two types of variables, Stock and Flow, which will show the dynamics of the modeling process. Stock and Flow are activities in the feedback loop that explain the cause-and-effect relationship diagram. Rate-on-Flow Diagram emphasizes the influence of time on the relationship between variables so that each variable shows the accumulated results from the level and rate of system activity over time. The accumulated result is called the Rate [26]. Dynamic system simulations must determine initial values in the form of constants, function tables, and indicator levels that are useful for describing the relationship model between variables in the model. For example, VAT rate ratios can be derived from constant values, eliminating complicated initial value calculations. Therefore, determining initial parameter values is very important to observe their effect on model sensitivity [27, 28]. Table 2 presents the initial values and model parameters used in the 2023 simulation. These values were mostly derived from secondary data and reputable references, while several some other values were obtained from reliable qualitative information considered [29].

RESEARCH RESULTS

Flowchart of Data VAT Model

Data from the Central Statistics Agency, reputable secondary sources, expert estimates, and scenario assumptions were used to answer the research questions. As shown in *Table 2*, initial values and model parameters were derived from secondary data, reputable references, and expert-based qualitative information. These data were used to determine the effect of increasing VAT from 11% to 12% and to examine the impact on supply chain stages. The results of this analysis describe a generic causal loop model based on systems thinking [30].

Data analysis focuses on system dynamics simulation, which generally outlines the steps for analyzing VAT problems from a system dynamics perspective. This analysis produces system understanding, problem identification and definition, system conceptualization, model formulation, model simulation, and validation [31, 32]. Additionally, this analysis leads to alternative policy improvements within the model [33].

Statistical Test Models

Statistical tests will measure the model's confidence level by establishing and testing its validity [34]. In dynamic system modeling, historical data can be used to construct models, thereby producing measurements of the model's suitability to actual conditions (goodness-of-fit) [35]. The significance test will determine the accuracy of the model [36]. In order to measure the magnitude and nature of the error, this study employs the Root Mean Square Percent Error (RMSPE) and Theil Inequality Statistics [37].

RMSPE measures the average percentage error between the predicted and actual values [38]. A low RMSE value indicates that the variation in values produced by a forecast model is close to the variation in observed values, so RMSE calculates how different a set of values is. The smaller the RMSE value, the closer the predicted and measured values are [39]. As for Theil's inequality, statistics require measuring the accuracy of model estimates. The Theil's U value ranges from 0 to 1, where 0 indicates perfect suitability, and 1 indicates no conformity [40]. Then, bias error, denoted by U^m , represents systematic errors between the model and reality or in determining specification parameters. It is crucial to identify and minimize bias in order to improve the accuracy of the model [41].

Test Results

Table 3 below shows the results of statistical tests. There are bias errors in the variables explained by U^m . These errors may arise from systematic discrepancies between the model and reality or inaccuracies in determining specification parameters.

Table 3 shows that there are errors in the RMSPE value. These errors are called systematic errors between the model and reality. These errors were likely caused by the determination of the specification parameters. For example, in the VAT rates, a large U^m and small U^s and U^c indicate errors due to bias, namely systematic errors or errors in determining the specification parameters, even if they are relatively small. Regarding tax potential, the triggering factors include VAT reductions, supply chain stages, tax gaps, and exemptions.

The U^s is big, the U^m is small, and the correlation with U^c shows the same mean value but a different mean variance between the simulated and actual values. This shows different trends between simulated values and actual ones. On the other hand, high VAT revenues with low U^c and U^m and U^s show low error due to inequality in covariance. Thus, all values are acceptable because these values do not exceed 1.

State Tax Revenue

In Indonesia, implementing the VAT policy has resulted in relatively increasing state revenues every year. The Ministry of Finance shows that VAT revenues consistently exceed Land and Building Tax, Import Duty and Excise, and International Trade Tax but are still below Income tax. This data can be simulated based on data for 2020–2021 at a rate of 10% and 2022–2023 at 11%. *Table 4* presents a comparison of state tax revenues from 2020 to 2023 and shows the relative position of VAT revenue compared to other major sources of state taxation.

Simulation and Scenario Analysis

This research describes intervention actions in three simulation scenarios by increasing or decreasing variable values. The third scenario is:

- a pessimistic scenario with a rate of 11%, current conditions;
- the government implements a moderate scenario with a 12% tariff in early 2025;
- an optimistic scenario where the government restores the 10% tariff imposed prior to 2022.

Based on the assumptions and parameters used in the system dynamics model, we developed and simulated three VAT growth scenarios. *Figure 2* presents the simulation and analysis of VAT growth under these three scenarios, showing the projected differences in patterns of VAT growth across the modelled policy alternatives.

The Pessimistic Scenario

The pessimistic scenario is a basic scenario that follows current developments and trends. Therefore, the study does not intervene in modeling variables and

Table 2

Initial Values and Model Parameters (2023)

No.	Indicators	Initial Value/Parameter [endogenous variable]	Unit	Source
A	General Information:			
1	Number of tax ID number/taxpayers	17,360,621	Unit	S
2	Number of VAT Collecting Companies	127	Unit	S
3	Tax Ratio	10.21	Percent	S
4	Average increase in VAT Revenue per year	0.5	Percent	E
5	Amount of VAT revenue	47,89	billion US\$	S
6	GDP	20,892,000	billion US\$	S
7	Import	221.89	billion US\$	S
8	Investment Value	8,97	billion US\$	S
B	Public Consumption:			
1	Government Consumption	2.95	Percent	S
2	Number of people shopping in Supermarkets and others (VAT)	49.72	Percent	S
3	No. of Population Shopping in Trad. market (non-VAT)	50.28	Percent	S
4	VAT Tariff 2022	11	Percent	S
5	VAT Tariff 2025	12	Percent	S
C	Exemption:			
1	Average VAT exemption for products and services	20	Percent	E
2	Estimated average VAT taxpayer non-compliance	20	Percent	S
3	VAT Gap	30	Percent	E
4	Non-tax compliance	20	Percent	E
D	Supporting data:			
1	Increase in investor	9.4	Percent	E
2	Company growth	4	Percent	E
3	Public consumption	8	Percent	E
4	Decline in public consumption	1.6	Percent	E
5	Import	11.4	Percent	S
6	Decline Import	3.13	Percent	S
7	Export	6.76	Percent	S
8	Decline Export	0.53	Percent	S
9	Supply chain stage [6 levels]	1.09	Percent	S
10	Inflation	5.28	Percent	S
11	Purchasing power shift to traditional markets [and Factors triggering price increases]	36.74	Percent	S
E	Scenario [10 years simulation]:			
1	Scenario 1 [Pessimistic VAT rate: 11%]	11	Percent	Sc
2	Scenario 2 [Moderate VAT rate: 12%]	12	Percent	Sc
3	Scenario 2 [Optimistic VAT Rate: 10%]	10	Percent	Sc

Source: Author's compilation and calculation based on Statistics Indonesia (BPS), Directorate General of Taxes, Ministry of Finance, Ministry of Investment/BKPM, Jakpat/Databoks survey data, and Law No. 7 of 2021. URL: <https://www.bps.go.id/en/publication/2024/02/28/c1bacde03256343b2bf769b0/statistical-yearbook-of-indonesia-2024.html>; <https://www.pajak.go.id/id/laporan-tahunan-2023>; <https://media.kemenkeu.go.id/getmedia/00d3acf5-5aa8-499a-b7e3-ceadc5be7094/Publikasi-APBN-KiTa-Edisi-Januari-2024.pdf?ext=.pdf>; <https://data.bkpm.go.id/visualisasi-detail/statistik-realisis-investasi-2023>; <https://databoks.katadata.co.id/datapublish/2022/06/09/survei-warga-yang-belanja-bulanan-di-e-commerce-masih-sedikit>; <https://peraturan.bpk.go.id/details/185162/uu-no-7-tahun-2021> (accessed on 09.05.2024).

Note: S = Obtained from secondary data; E = Estimation based on qualitative information; C = Calculated in accounting; Sc = Scenario model.

Table 3

Model Conformity Statistical Test Results

No.	Variables	RMSPE	Theil Inequality Statistics		
			U ^m	U ^s	U ^c
1	The VAT Rate	0.123	0.131	0.111	0.121
2	VAT Income	0.231	0.128	0.122	0.236
3	Tax Potential	0.355	0.164	0.222	0.197
4	Trigger factors Reducing VAT	0.371	0.243	0.203	0.378
5	Supply Chain Stage	0.234	0.231	0.426	0.197
6	Tax Gap and Exemption	0.414	0.329	0.475	0.337

Source: Author's own calculation based on the historical behavior test of the VAT system dynamics simulation model.

Table 4

State Tax Revenue 2020–2023 (US\$ million)

No	Types of State Taxes	2020	2021	2022	2023	Average 4 year	Average Rate
							11% [2022–2023]
1	Income tax	3960,20	4644,47	6654.73	6938.67	2,95	2.48
2	Value added tax	3002,20	3679,33	4584.07	4948.4	2,83	2.33
3	Land and building tax	139,67	126,13	155.07	163.07	2,48	2.28
4	Excise and Import Duties	1419,00	1793,40	2118.67	1514.73	2,68	1.9
5	International Trade Tax	244,80	491,27	605.93	486	3,51	2.04
6	Other Taxes	45,27	74,20	51.27	64.73	2,75	1.95

Source: Author's calculation based on Statistics Indonesia (BPS). Realisasi Pendapatan Negara (Milyar Rupiah). 2020–2023. URL: <https://www.bps.go.id/id/statistics-table/2/MTA3MCMY/realisasi-pendapatan-negara-milyar-rupiah.html> (accessed on 09.05.2024).

values in the pessimistic scenario. The simulation flow chart data [+] shows VAT growth data for:

1. Tariff 11%.
2. The simulation carried out in 2023–2032 [10 years].
3. Import 11.40%.
4. An increase in investors by 9.40%.
5. The taxpayer increase is calculated from [company growth of 3% and an increase in public consumption of 6%].
6. Supply chain stage: 6 levels [1.09%].

The data flow diagram [–] explains the balance caused by a decrease in VAT revenues by several factors as follows:

1. A tax exemption of 24%.
2. Non-Tax Compliance 22.30%.
3. A decrease in public consumption by 1.6%.
4. A decreased exports of 0.53%.
5. A shift in purchasing power towards traditional markets 24.20%.

6. An inflation rate of 5.28%.

The simulation results in Fig. 3.

In Fig. 3, the pessimistic simulation uses eight intervention variables at a VAT rate of 11%: the transfer of purchasing power to traditional markets, trigger factors for reducing VAT (tax avoidance), Import VAT, tax exemptions, tax guarantees, Exports, Imports, and supply chains. The simulation will predict for six years to determine the VAT revenue amount at the end of 2032.

The results of this flow diagram show that since the beginning of 2023, the curve on the right shows an increase in VAT revenue each year, following the rate pattern of the loop [+] and loop [–] as balancers, where the prediction for VAT revenue 6 years later (2032) reaches US\$383.1 billion.

The Moderate Scenario

The moderate simulation illustrates the growth in VAT revenues starting from January 1, 2025 – variable in-

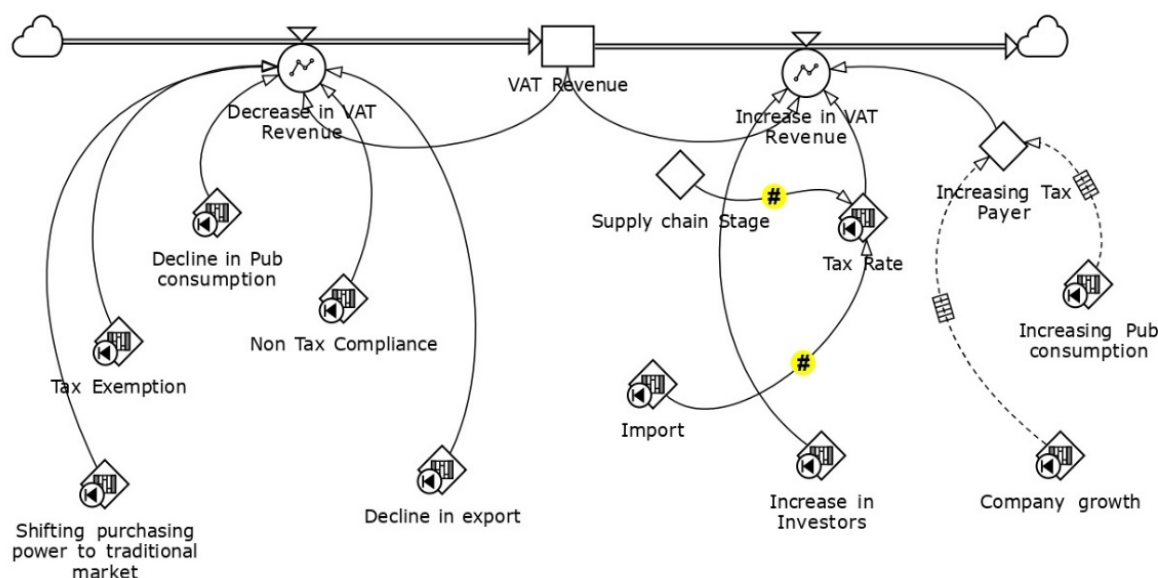


Fig. 2. Simulation and Analysis of VAT Growth Scenarios

Source: Author's own simulation based on the VAT system dynamics model developed in Powersim Studio. Software URL: <https://powersim.com/>

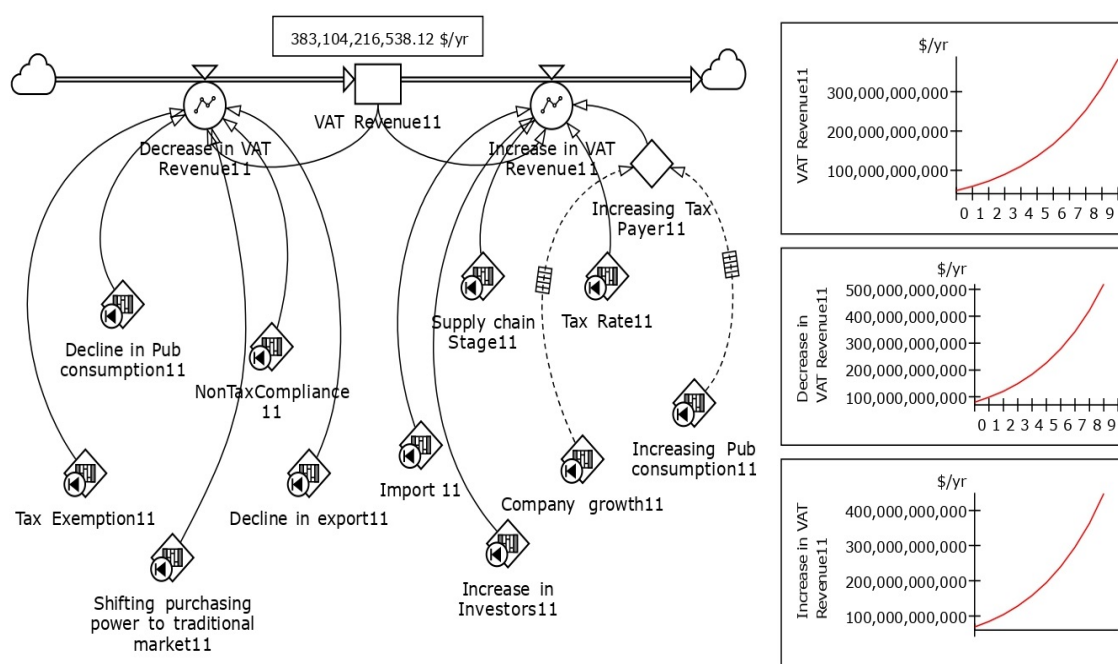


Fig. 3. Simulation of VAT Growth Based on a Pessimistic Scenario

Source: Author's own simulation based on the VAT system dynamics model developed in Powersim Studio. Software. URL: <https://powersim.com/>

tervention by adding or reducing variable values that will affect VAT revenue. For example, by intervening with certain variables, whether they influence public purchases, increase tax avoidance, and others. The illustration in loop 1 shows the flow diagram [+] of VAT growth:

1. Tariff 12%.
2. The simulation is carried out in 2023–2032 (10 years).

3. Import 12.20%.
4. Increase in investors by 9.40%.
5. The increase in the number of taxpayers is calculated from company growth of 2% and an increase in public consumption of 4%.
6. Supply chain stage: 6 levels [1.09%].

The loop in the flow diagram [–] explains the balance caused by a decrease in VAT revenues caused by several factors, including:

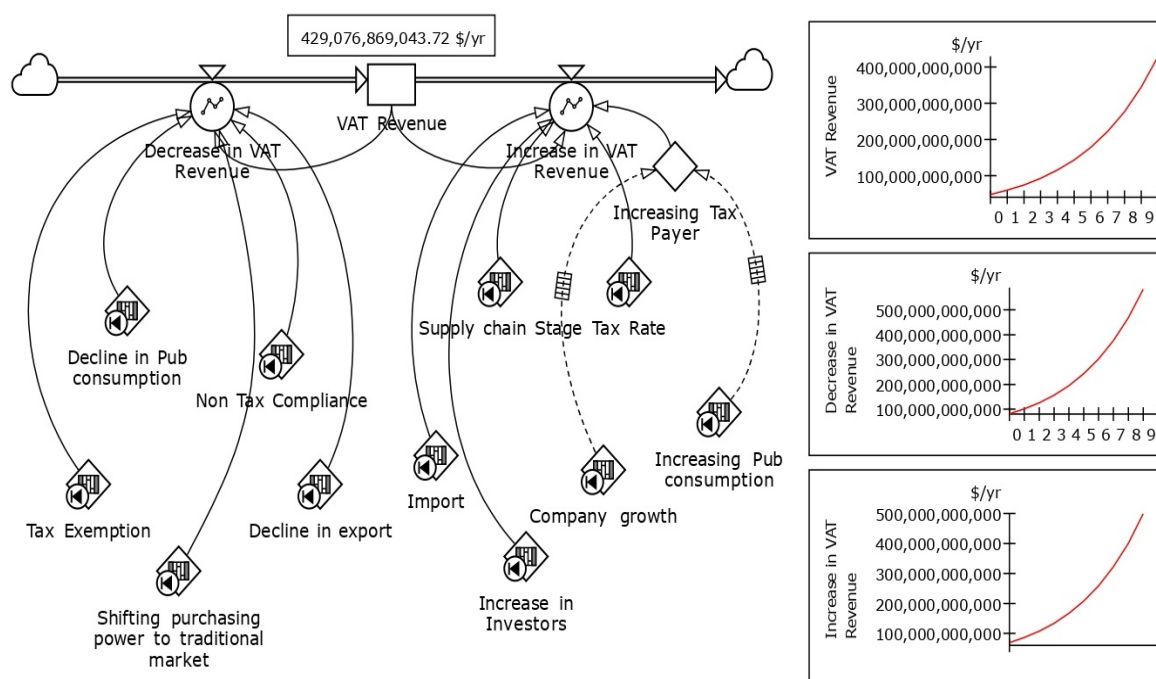


Fig. 4. VAT Growth Simulation Based on Moderate Scenario

Source: Author's own simulation based on the VAT system dynamics model developed in Powersim Studio. Software URL: <https://powersim.com/>

1. Tax exemption of 20%
2. Non-Tax Compliance 28.15%.
3. A decrease in public consumption by 1.6%.
4. Decreased exports of 2.96%.
5. A shift in purchasing power towards traditional markets of 37%.

6. An inflation rate of 7.24%.

The Fig. 4 shows the results of this simulation.

In Fig. 4 the moderate simulation still uses eight variables. The VAT rate is 12% (this rate applies from January 1, 2025). In this simulation, the increase in VAT rates has reduced people's purchasing power. However, the moderate simulation estimates that as many as 35% of people will switch to traditional markets for tax avoidance. The simulation shows that the curve on the right is increasing and follows the speed pattern of the loop [+] and loop [-] as balances.

The results of this simulation illustrate that VAT revenues will reach US\$429.1 billion at the end of 2032, but the potential for taxes will decrease by US\$241.36 billion (36%), and VAT losses due to tax avoidance and tax evasion will increase by US\$182.71 billion.

The Optimistic Scenario

Furthermore, this analysis presents an optimistic simulation to illustrate the growth in VAT revenues by reducing the VAT rate from 11% to 10%. In Loop 1, the flow diagram [+] shows the simulation data:

1. Tariff 10%.
2. The simulation is carried out in 2023–2032 (10 years).

3. Import 10.10%.
4. Increase in investors by 9.40%.
5. The taxpayer increase is calculated from company growth of 4% and an increase in public consumption of 8%.

6. Supply chain stage: 6 levels [1.09%].

The loop flow diagram [-] explains the balance because there will be a decrease in VAT revenues caused by several factors as follows:

1. Tax exemption, 12%.
2. Non-Tax Compliance 11.15%.
3. A decrease in public consumption by 1.6%.
4. Decreased exports of 0.31%.
5. A shift in purchasing power to traditional markets 18.2%.
6. An inflation rate of 3.42%.

The simulation produces Fig. 5 as follows.

From Fig. 5, the simulation depicts an optimistic scenario with a VAT rate of 10%. In this scenario eight variables are used to intervene in the model. The optimistic simulation results showed an increase in the average export value by 20.11% and the average import value by 4.11%. The curve on the right shows the dynamic movement since the beginning of 2023, following a rate pattern influenced by Loop [+] and Loop [-] as balancing. The optimistic simulation results show that VAT revenues will reach US\$421.4 billion by the end of 2032, and VAT tax losses due to tax evasion and tax avoidance will fall to US\$ 91.95 billion. Interesting. The optimistic simulation depicts the potential for taxes to increase to US\$ 513.36 billion (54.92%) every year. This

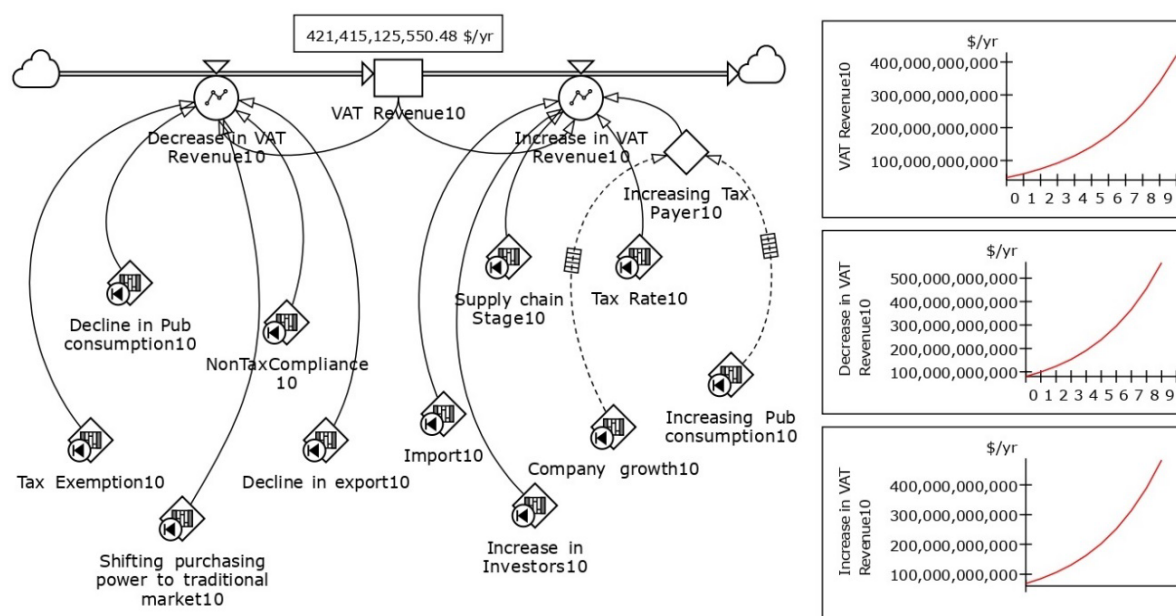


Fig. 5. VAT Growth Simulation Based on Optimistic Scenario

Source: Author's own simulation based on the VAT system dynamics model developed in Powersim Studio. Software URL: <https://powersim.com/>

optimistic simulation shows the widening potential of VAT every year and benefits decision-makers.

Discussion of the Results

Furthermore, the Table 5 compares the results of three simulations under consideration.

In the pessimistic scenario, the tax avoidance value was set at 22.30% with an estimated VAT revenue loss of US\$ 13.409 billion, assuming the Government does not consider reducing the tax avoidance value. This scenario proved the hypothesis of the research.

In the moderate simulation, there was an increase in VAT revenue by an average of 2.33%. This figure is relatively low compared to the average VAT revenue data before 2023, namely 2.83%. This condition concludes that the increase in the VAT rate from 11% to 12% in 2025 hampered the realization of VAT revenues. In the moderate scenario, the value of tax avoidance increases to 28.15%, resulting in an estimated VAT revenue loss of US\$ 19.155 billion. The policy of increasing the tariff from 12% at the beginning of 2025 could lead to increased tax avoidance for lower-middle-class entrepreneurs.

In the optimistic scenario, if the government reduces the VAT rate to 10%, followed by a decrease in the value of tax exemptions by 12% and tax avoidance by 11.15%, then the results will reduce the burden on individuals, increase purchasing power, and increase exports, while reducing imports. Additionally, the government could control taxpayers who engage in tax evasion, leading to the reduction of amount of tax evaded to 11.15% (or 50% of the current condition). As a result, with a 10%

VAT rate, VAT revenues from tax evasion would be estimated to reach US\$ 53.635 billion by the end of 2032.

This research found two main causes of the high prices of goods in Indonesia: The Flow of the Supply Chain Stage and the increase in tariffs. These factors have a significant impact on society.

Therefore, the optimistic scenario with a reduction in the VAT rate to 10% could be considered by the government in the future in order to increase people's purchasing power by reducing or eliminating 1 to 2 Supply Chain Stage, for example, distributors and main agents. Of three scenarios presented, the best option is to pursue the optimistic scenario. Thus, the hypothesis of this research can be considered confirmed.

CONCLUSION

In the pessimistic simulation scenario, increasing the VAT rate to 12% will reduce people's purchasing power and increase tax avoidance. However, in the moderate scenario, maintaining the current 11% rate would balance present economic conditions, but in the future, it will reduce the potential for taxes and increase tax avoidance. In the optimistic scenario, reducing the VAT rate to 10% is considered the best option as it would reduce the tax burden, increase tax potential purchasing power, and stimulate exports, while reducing imports. This scenario predicts that tax avoidance and supply chain simplification will decrease, benefiting the overall economy. The government can also reduce tax exemptions by 50% for large mineral, coal, and geothermal mining companies, resulting in additional VAT revenue.

Table 5

Analysis of Simulation Calculations Using Three Scenarios

No.	Variable	Value	2023			2032		
			Pessimist	Moderate	Optimistic	Pessimist	Moderate	Optimistic
			11%	12%	10%	11%	12%	10%
1	Export	0.53	258.820	257.448	309.218	2.070.560	2.059.586	2.473.744
2	Import	0.11	221.890	221.983	231.184	1.775.120	1.775.863	1.849.468
3	Inflation	0.53	0.53	0.72	0.34	2.89	3.96	0.47
4	Supply Chain Stage		6	6	6	6	6	6
5	Purchasing power shift to traditional markets. and Trigger factors Reducing VAT [tax avoidance]	0.37	4.308	2.725	7.033	34.462	21.801	56.263
6	Import VAT	0.11	24.408	24.418	25.430	195.263	195.345	203.442
7	Tax Exemption [50%]	0.2	-9.578	- [4.310]	4.789	76.621	34.479	38.311
8	Tax Evasion [50%]	0.28	-13.409	-19.155	6.704	-107.269	-153.242	53.635
9	VAT revenue received		47.888	53.635	52.677	383.104	429.077	421.415
10	VAT Receipt Should Be [Potential tax]		24.902	30.169	64.170	199.214	241.356	513.360
11	Loss of VAT revenue		-22.986	-23.465	11.493	-183.890	-187.721	91.945

Source: Compiled by the author based on the simulation results.

Recommendation

- The government should adjust its policy by adopting an optimistic scenario, namely reducing the VAT rate to 10%.
- The government should reform taxes by reducing tax avoidance and simplifying supply chains in order to increase VAT revenue without increasing the burden on consumers.
- The government should continuously monitor economic indicators in order to adjust the VAT rates

by prioritizing the reduction of the tax burden on society.

Policy Implications

- The research suggests that reducing tax avoidance by 50% and eliminating one level of supply chain I could improve VAT revenues.
- It is recommended to review tax exemptions for large mineral coal and geothermal mining companies is recommended to boost VAT collection.

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Comparative Analysis of Financial Systems of Metaverses in the Public Sector: DEFI vs CBDC

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ABSTRACT

The article provides a comparative analysis of the principles behind the organization and operation of financial systems of metaverses in the public sector based on decentralized finance (DEFI) and digital currencies of central banks (CBDC). The purpose of the study is to assess the effectiveness of financial systems based on DEFI and CBDC in order to develop scientifically supported recommendations for choosing the optimal model of financial organization for the state metaverse. The objectives of the study are to systematize the characteristics of DEFI and CBDC, identify the potential opportunities and limitations of each system, and develop recommendations for selecting a metaverse financial model. The research methodology includes a comprehensive comparative analysis of these systems based on several key criteria, including centralization, legal regulations, accessibility, technological aspects, inflation control, security, scalability, and other relevant parameters. Based on the results of the study, the authors conclude that the choice between DEFI and CBDC is determined by the state's goals, level of trust in financial institutions, and readiness for digital transformation. Both systems have their own advantages and limitations, which require a tailored approach based on the national characteristics and strategic goals of each country's development plan. The practical significance of the study lies in the potential application of the developed recommendations to the formation of the country's financial strategy within the context of developing the digital economy and metaverses.

Keywords: metaverse; decentralized finance; DEFI; central bank digital currencies; CBDC; public administration; digital economy; blockchain

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INTRODUCTION

The rapid development of digital technologies has led to the emergence of the concept of the metaverse, an integrative ecosystem of virtual worlds that offers users an immersive and exciting experience. This new phenomenon is transforming existing systems and creating new values in terms of economics, environment, society, and culture.¹

Technically, the metaverse represents a qualitatively new stage in the evolution of media hardware and software, featuring improved touch interfaces that enhance user interaction [1].

Taking into account the advantages of using metaverses for different user groups [1–8], their implementation in public administration opens up great prospects for improving its efficiency [1, 2, 9, 10].

Despite the fact that the metaverse is still at an early stage of development, its concept in the public sector has already been implemented in countries such as the USA, China,² the UAE,³ South Korea,⁴ Singapore, Spain, etc. [11–14].

At the same time, there are different approaches to the organization of the metaverse in public administration. One of the main questions is which system of finance organization in the state metaverse would be most effective — based on decentralized finance (DEFI) or central bank digital currencies (CBDC). Both systems have their own positive and negative features, both objectively and subjectively.

DEFI VS. CBDC

To compare these two options for building a financial system for state metaverses, we will fo-

cus on several basic criteria to conduct a more detailed analysis of each one. The proposed criteria for this analysis are shown in *Fig. 1*.

The first and most important criterion for comparative analysis is centralization vs. decentralization. The essence of the DEFI system lies in its decentralized nature, which is its main advantage for certain categories of users. DEFI is a model of financial organization that does not have intermediaries, transactions are carried out automatically through distributed ledger technology (DLT), which represents a conceptually new data storage model, where users exercise direct control over their assets,⁵ and the most common type of technology used is blockchain. On its basis, metaverses and related instruments such as cryptocurrency, stablecoins and NFTs function.

Experts identify the following advantages of using decentralized finance technology (*Fig. 2*).⁶

As noted by F.-Y. Wang, R. Qin, X. Wang, B. Hu, the metaverse should not be under the control of any particular organization. The ideal scenario would involve an open space where users can fully own their assets and influence the future direction of the platform [15].

The fusion of metaverse and blockchain technologies offers new opportunities for enhancing transparency and optimizing government processes in various areas, such as public procurement, electronic voting, healthcare, education, land management, and digital identification of citizens. The metaverse based on DEFI can be used for virtual consultations with authorities, public discussions, and modeling the effects of new laws. Automated smart contracts can also be implemented to simplify and expedite the fulfillment of government obligations such as distributing subsidies and grants. Moreover, the use of blockchain and metaverse contributes to creating an open and decentralized system where citizens can monitor pro-

¹ International Telecommunications Union (ITU). Definition of metaverse 2023. URL: https://www.itu.int/dms_pub/itu-t/opb/fg/T-FG-MV-2023-PDF-E.pdf (accessed on 22.06.2025).

² Interesse G. China's Debut in the Metaverse: Trends to Watch (Updated). China Briefing. URL: <https://www.china-briefing.com/news/metaverse-in-china-trends> (accessed on 20.08.2025).

³ Dubai Future Foundation launches new report on future of the metaverse. URL: <https://www.wam.ae/en/details/1395303113683> (accessed on 10.08.2025).

⁴ Press Conference. Mayor Oh Se-hoon, a citizen of the world's first city 'Metaverse Seoul' Invitation. Seoul City Hall Website. URL: <https://opengov.seoul.go.kr/press/27671570> (accessed on 22.08.2025).

⁵ Decentralized Finance. Moscow: Bank of Russia, 2022. 51 p. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 22.06.2025).

⁶ Decentralized Finance. Moscow: Bank of Russia, 2022. 51 p. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 22.06.2025).

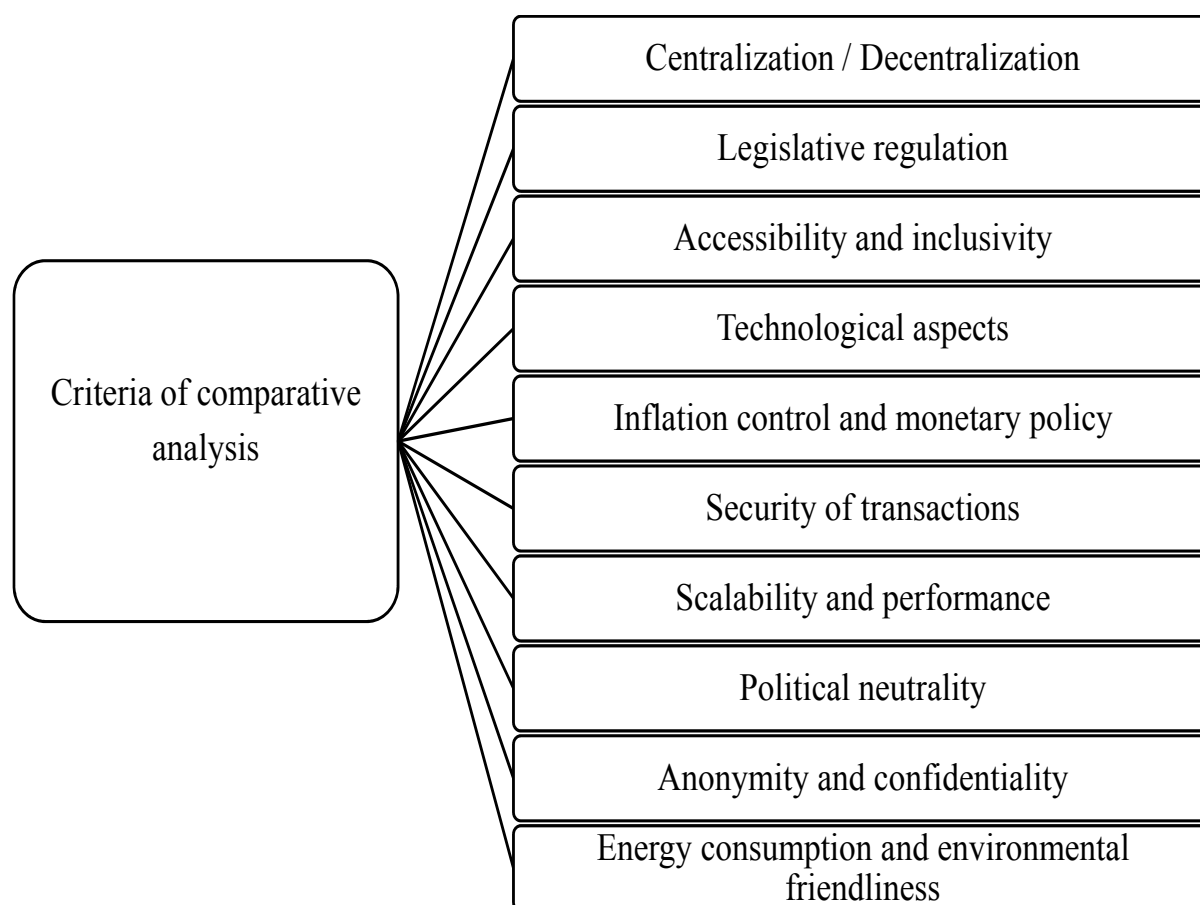


Fig. 1. Criteria for a Comparative Analysis of the Organization of Finance in the State Metaverse Based on Decentralized Finance (DEFI) or Central Bank Digital Currencies (CBDC)

Source: Compiled by the authors.

cesses in real-time, which increases trust in government institutions and makes governance more efficient and transparent [4, 16].⁷

Thus, the DEFI system operates independently of direct government control, which allows users to avoid excessive regulation. At the same time, decentralized systems offer equal access to financial services for everyone. However, this system has some weaknesses, as it is vulnerable to fraudulent projects due to lack of strict regulatory standards and centralized government control.

In turn, the digital currency of central banks — CBDC, based on its essence, is a centralized system, as it is issued by the central bank of the state and managed by government

agencies. That is, it retains elements of centralization and control by regulators, which is an advantage for some categories of users, but a disadvantage for others [5].

From the perspective of maintaining financial stability in a country, the use of CBDC provides the central bank with an opportunity to better control the management of funds movements. This helps to increase the effectiveness of monetary policy implementation. To enhance the transparency of the economy, CBDC provides government agencies with access to data on users and their digital currency transactions. This improves government control and monitoring of financial flows, making it easier to detect and prevent illegal activities. Increasing the transparency of CBDC transactions also contributes to the fight against corruption and other illegal activities such as tax and fee evasion, which

⁷ Gaurav K. The Metaverse and Blockchain Technology: What the Future Holds. Open Source. URL: <https://www.opensourceforu.com/2024/06/the-metaverse-and-blockchain-technology-what-the-future-holds/> (accessed on 15.08.2025).

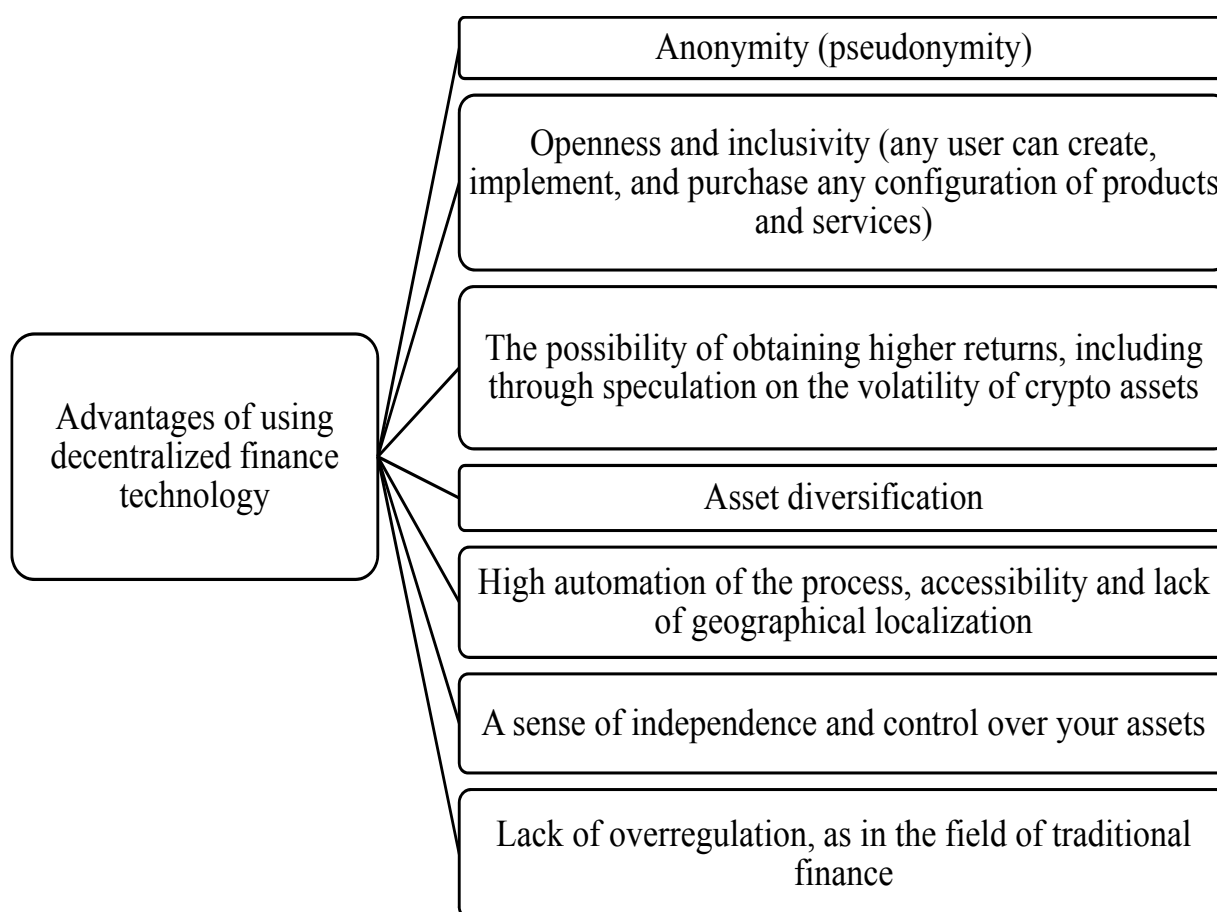


Fig. 2. Advantages of Using Decentralized Finance Technology DEFI

Source: Compiled by the authors.

increases the effectiveness of fiscal policy and the effectiveness of anti-corruption measures [17–19]. The possibility of CBDC programming opens up new horizons for the implementation of various control and management mechanisms [20].

According to experts, the introduction of a central bank digital currency allows for the use of “colouring” technology, which ensures targeted use of funds. This means that CBDC can be used to pay for specific goods and services. This measure increases government spending efficiency, especially in public procurement and government contracts. A coloured CBDC is a component of the money supply, as well as common CBDC or cash, and it is used in settlements alongside them.⁸

⁸ The main directions of the unified state monetary policy for 2023 and the period 2024 and 2025. The Bank of Russia. URL: https://www.consultant.ru/document/cons_doc_LAW_430425/ (accessed on 18.07.2025).

Using the CBDC system in the state metaverse has a number of advantages, combining the capabilities of digital technologies with the financial system (Fig. 3).⁹

Thus, a comparison of the proposed systems based on the criterion of “centralization/decentralization” leads to the following conclusion: the DEFI system provides transparency of operations and relative independence from regulatory authorities, but it carries risks of fraud and vulnerabilities in the blockchain. On the other hand, CBDC provides stability and reliability through government control, but limits user autonomy and market freedom.

The next criterion of comparison is legislative regulation.

⁹ Chernyshova E. Experts assessed the benefits of international settlements in digital rubles. Who can save money on a new form of currency and how? RBC. URL: <https://www.rbc.ru/finances/14/02/2024/65ca2d8f9a794710fcdff4e3> (accessed on 25.07.2025).

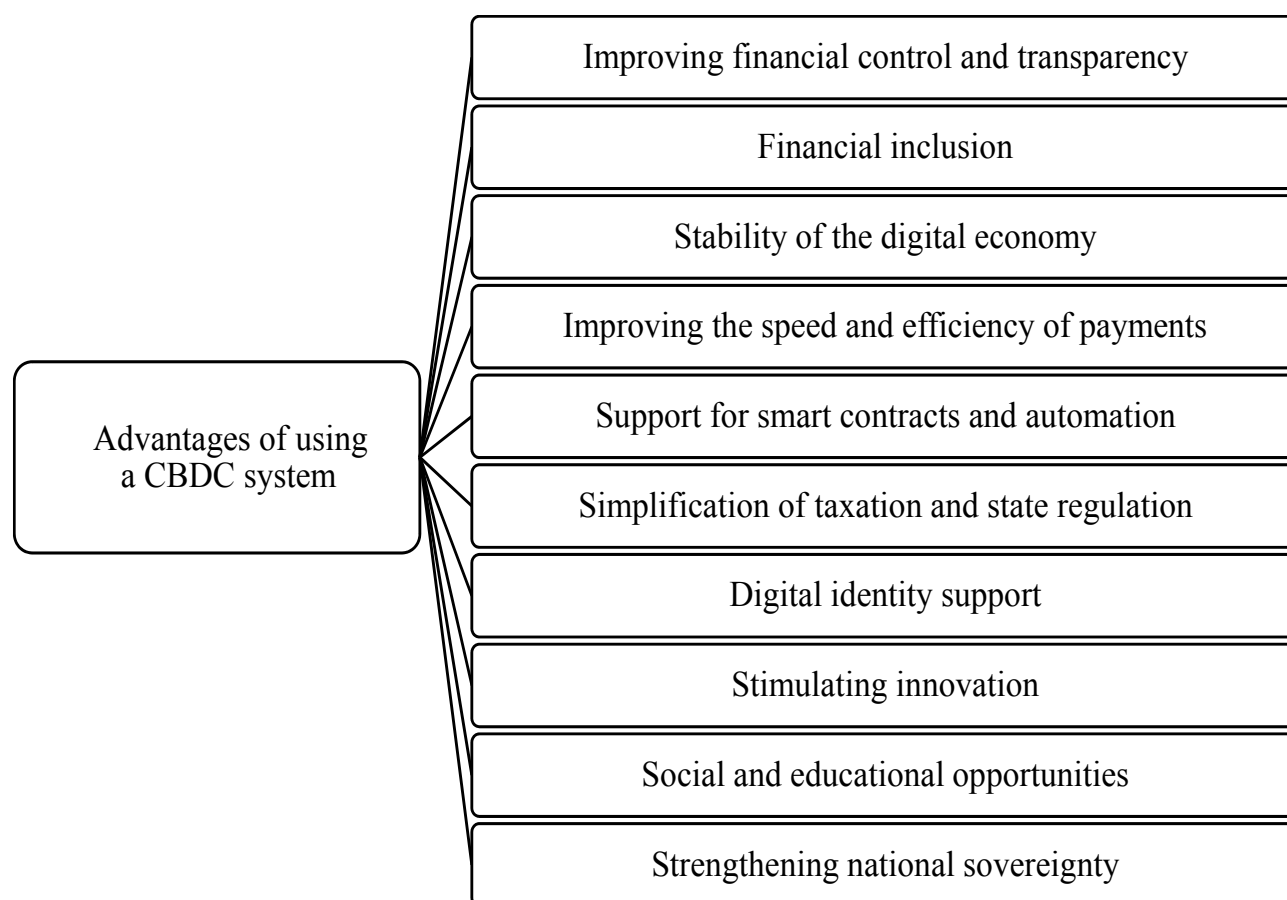


Fig. 3. Advantages of Using the CBDC System in the Financial System of the State Metaverse

Source: Compiled by the authors based on data [19–22].

The DEFI system, which operates either outside government regulation or within insufficiently effective regulation, often ignores tax obligations and international sanctions. Anonymous transactions make it difficult to identify taxpayers, while the absence of government control or its ineffectiveness, and the international nature of the transactions in the system, may lead to problems with compliance with legislation related to money laundering and terrorism financing.¹⁰

According to experts of the Bank of Russia, strengthening the relationship between traditional finance and DEFI protocols without regulatory guarantees can lead to a domino effect on investors around the world, losses of financial intermediaries, uncontrolled move-

ment of market participants into the unregulated segment, and realization of systemic risks for the entire financial market.¹¹

The CBDC system, in turn, is fully regulated by the state, integrated into the country's current financial system, and allows for capital controls, tax collection, and anti-money laundering [5].¹² China is a prime example of such successful work in the field of CBDC regulation [23].

However, there are some significant drawbacks for users: reduced financial freedom due to strict government control and excessive government interference in the economic activities of citizens.

¹⁰ Decentralized Finance. Moscow: Bank of Russia, 2022. 51 p. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 22.06.2025).

¹¹ Decentralized Finance. Moscow: Bank of Russia, 2022. 51 p. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 22.06.2025).

¹² The concept of the digital ruble. Moscow: Bank of Russia, 2021. 30 p. URL: https://cbr.ru/Content/Document/File/120075/concept_08042021.pdf (accessed on 12.07.2025).

Therefore, comparing DEFI and CBDC according to the criterion of “legislative regulation”, we can note that the absence or low level of legislative control in DEFI promotes flexibility and innovation, while making it difficult to comply with legal norms. The total legislative regulation of CBDC simplifies administration, increases user trust, but is perceived as government interference in economic activity and requires significant resources for development of a legal and regulatory infrastructure.

The next criterion for comparison is accessibility and inclusivity.

The DEFI system is open to all internet users, regardless of location, nationality or status; it minimizes barriers to entry into the financial services sector by allowing people without a bank account to use financial instruments. According to experts from the Bank for International Settlements, cross-border transactions are a particularly important aspect of metaverses, as users can potentially be located in different jurisdictions [5].¹³ However, the openness and accessibility of DEFI can create risks of abuse, when, for example, some users may intentionally act to the detriment of the protocol and other users. For example, if a group of individuals simultaneously owns more than 50% of the control tokens of two protocols, the assets of one of them may be fraudulently included in the second protocol (“pumping out the protocol”).¹⁴

The CBDC system loses in this sense, as it is mainly limited to citizens of a certain country and their level of access to banking services, even despite the fact, that due to the ready infrastructure, transparency, and (often) free of charge operations with CBDC, it ensures an increase of financial inclusion and the accessibility of financial services for citizens and businesses by providing them with access to a wider range of services based on CBDC [18, 20].

¹³ Volkova O.V. Economics of the future: metaverses. An economic conversation. URL: <https://econs.online/articles/techno/ekonomika-budushchego-metavselennye/?ysclid=lxeezlm1262032088> (accessed on 22.06.2025).

¹⁴ Decentralized Finance. Moscow: Bank of Russia, 2022. 51 p. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 22.06.2025).

It should also be noted that the diversity of CBDC creates a need for their compatibility in order to facilitate international settlements, particularly in the context of globalization and the development of digital economies. However, differences in standards, legislation, and technological solutions used by different central banks significantly complicate cross-border payment implementation, leading to fragmentation and decreased efficiency of the system [24]. In addition, the use of digital currencies by central banks faces legal and regulatory barriers. The main challenges include ensuring transparency in financial transactions, preventing money laundering and terrorist financing, and protecting personal data. These aspects often conflict with national interests, as each country has its own requirements for regulating financial flows.

To address these issues, it is essential to develop international standards and interaction protocols, as well as universal technical standards and agreed rules for integrating CBDC. It is also necessary to coordinate between countries to establish agreed legal norms for the use of CBDC, develop a global system to unite various CBDC, and ensure seamless conversion between them. Additionally, to strengthen international cooperation while taking into account national specificities is crucial. However, implementing these measures requires significant efforts, time, and consideration of the geopolitical and economic situations in the world, including the impact of economic sanctions imposed by different countries.

Overall, a CBDC has significant potential to simplify cross-border payments. This is due to the fact that traditional international transfers often take up to several days due to the need to go through many intermediaries and correspondent banks, whereas settlements using CBDC can technologically allow for instant and direct transfer of funds [24].

Consequently, according to the criterion of “accessibility and inclusivity”, the DEFI system, despite the lack of consumer protection, expands the international availability of financial services. The CBDC system also expands access

to financial services inside the country, but is usually limited by its jurisdiction.

Technological aspects are also an important issue, for which it is advisable to compare the proposed financial management systems in the state metaverse.

The DEFI system, as mentioned earlier, is based on distributed ledger technology (DLT) or blockchain, which is the most common version, and has both advantages and disadvantages. Blockchain solves a wide range of tasks in the metaverse, such as digital identity and asset management, providing secure management of user data across platforms, and simplifying the transfer of assets between virtual environments while preserving their value and ownership rights.¹⁵ Blockchain also opens up opportunities for decentralized management: with the help of this technology, users can jointly manage virtual spaces and allocate resources. The technology provides a high degree of anonymity.¹⁶ Transparency and low fees attract many enthusiasts and entrepreneurs, but the specifics of the interfaces and other technical difficulties of using the technology reduce its widespread use. However, in general, the DEFI system demonstrates a high potential for the development of innovative technologies.

The CBDC system utilizes traditional banking technologies and the infrastructure of central banks, ensuring stable network operations and low transaction fees. At the same time, it is possible to integrate with existing banking systems. Due to its simplicity and clarity, digital money is an attractive alternative for most citizens, contributing to the widespread adoption of the technology among the general public.

Therefore, according to the criteria of comparison “technological aspects” it can be concluded that the DEFI system has a high poten-

tial for developing innovative technologies, but it faces problems with productivity and sustainability. The CBDC system, on the other hand, has high reliability and compatibility with traditional financial institutions, but it is less open to technological experimentation.

Inflation control and monetary policy are the next criteria for comparison.

The system based on decentralized finance is largely independent of government policy and subject to fluctuations in the value of cryptocurrencies and market factors.¹⁷ At the same time, insufficient control over the money supply can lead to hyperinflation or deflation. Researchers argue that the transition to a fully decentralized financial system is questionable due to states’ desire to control cash flows [25].

At the same time, when using the CBDC system, the money supply is controlled by the central bank, which makes it possible to regulate inflation and maintain the stability of the national currency. The state controls the issuance and circulation of CBDC, which, on the one hand, gives it the opportunity to implement an effective monetary policy, and, on the other hand, reduces the possibility of influencing the market by other participants.

Consequently, a comparison of DEFI and CBDC systems based on the criterion of “inflation control and monetary policy” shows that DEFI promotes the development of free markets and reduces state influence on the economy, but also causes price instability and risks of inflation, whereas, the CBDC system provides economic stability and confidence in the currency, while reducing the ability of independent market participants to influence it.

The next criterion is the security of transactions. Security in the metaverse must be ensured in two different directions: data security and software security [4].

According to experts, the metaverse, which is built on distributed ledger technology, is considered as a secure environment for introducing

¹⁵ Ghatak A. Worldline Shaping the Future of Payments in the Metaverse and Beyond. DQ India. URL: <https://www.dqindia.com/interview/worldline-shaping-the-future-of-payments-in-the-metaverse-and-beyond-4755194> (accessed on 15.08.2025).

¹⁶ Gaurav K. The Metaverse and Blockchain Technology: What the Future Holds. Open Source. URL: <https://www.opensourceforu.com/2024/06/the-metaverse-and-blockchain-technology-what-the-future-holds/> (accessed on 15.08.2025).

¹⁷ Volkova O.V. Economics of the future: metaverses. An economic conversation. URL: <https://econs.online/articles/techno/ekonomika-budushchego-metavselennyye/?ysclid=lxeezlm1262032088> (accessed on 22.06.2025).

digital technologies and expanding the range of services beyond traditional online platforms. Decentralized systems securely and transparently store and manage data. Digital ledgers like the blockchain record all system transactions. After being added to the blockchain and confirmed by the nodes, the data cannot be changed or deleted [26]. The blockchain protects confidential data using a consensus mechanism that allows you to change stored data only with the consent of all nodes participating in the blockchain [4, 27]. This protects the integrity and immutability of the data. Therefore, in the blockchain network, users can safely make transactions with virtual goods, virtual real estate, virtual currency and digital money online [16].

The concept of decentralized identity, when used in conjunction with Web3, by attaching information to digital wallets, makes it possible to eliminate fake accounts, spam and bots that currently undermine people's trust in the Internet. This, in turn, helps to reduce cybercrime and financial fraud in the network, providing users with a greater sense of security and convenience [28].

At the same time, the DEFI system is based on open-source and publicly available blockchain technology, which makes it susceptible to hacking and programming errors. While transparency of transactions is undoubtedly an advantage, inadequate verification of contracts can result in significant asset losses. The current level of self-regulation in these systems does not ensure adequate risk management.¹⁸

The CBDC system ensures high transaction security and data security through centralized management and the use of proven infrastructure solutions. Government support minimizes the risks of hacking and fraud. At the same time, the novelty of the CBDC is that it provides access to completely secure assets that allow for large-scale operations without any additional encumbrances, guarantees and costs [18].

¹⁸ Decentralized Finance. Moscow: Bank of Russia, 2022. 51 p. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 22.06.2025).

CBDC's technical support makes it possible to reduce and/or eliminate a significant number of user risks. A CBDC (unlike cryptocurrency, for which the situation may vary) has the status of a legal tender [19].¹⁹

However, the centralized structure of a CBDC creates a single point of failure, making it susceptible to large-scale attacks. Additionally, data leaks can occur, as all transactions are stored in a single location. To mitigate these risks, governments should invest in developing innovative protection technologies and continuously update security systems to prevent cyber threats associated with the use of digital currencies [19].

Thus, comparing DEFI and CBDC systems in terms of "transaction security", we can see that each has its own advantages and disadvantages, due to the different technological foundations of these systems. Despite the claimed security, both systems still face the risk of cyber attacks.

Another criterion for comparison is the scalability and performance of the system. Despite its international nature and extensive cross-border capabilities, the DEFI system loses significantly, as modern blockchains have limitations on the number of transactions processed per second, which slow down the processing of large volume of payments and increase fees. Network congestion (limited bandwidth leading to delays and increased transaction costs), or, conversely, underloading due to lack of a critical mass of users (small number of nodes), leads to weakened security.²⁰ Therefore, this may become an obstacle to widespread adoption and reduce efficiency as transactions increase.

Bank of Russia experts have noted that possible failures in the infrastructure during mass (algorithmic) settlement transactions due to

¹⁹ Central bank digital currency. EDPS TechDispatch. European data protection supervisor. URL: https://www.edps.europa.eu/data-protection/our-work/publications/techdispatch/2023-03-29-techdispatch-12023-central-bank-digital-currency_en (accessed on 10.08.2025).

²⁰ Decentralized Finance. Moscow: Bank of Russia, 2022. 51 p. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 22.06.2025).

abnormal operation of large DEFI solutions or limited capacity could become a serious issue.²¹

In turn, in the CBDC system, central banks can create specialized high-performance solutions that ensure fast processing of a large number of transactions, reducing network load and increasing user convenience. However, this scalability is usually limited to a single state.

Therefore, comparing DEFI and CBDC according to the criterion of “scalability and system performance”, we can note the low degree of scalability of the CBDC system and the low level of performance and the possibility of failures of the DEFI system.

The next sign of comparing the principles of organization and functioning of financial systems in metaverses based on DEFI or CBDC is political neutrality. From this point of view, DEFI is in a better position because it is less dependent on government regulations (or even independent from them), which attracts foreign users and projects and potentially strengthens international cooperation and diversification of the economy. In contrast, CBDC, as a project of a central bank, is directly affected by the state. Any political decisions directly affect its functionality. According to experts, this causes a low level of trust in CBDC on the part of users [29].

Therefore, a comparison based on “political neutrality” demonstrates the advantages of the DEFI system over the CBDC system as the most free from the influence of political decisions.

It is also worth noting such features of comparison as anonymity and confidentiality. In this case, we can note that the DEFI system is characterized by a high degree of confidentiality and anonymity, attracting both ordinary users and intruders. This creates both privileges for users and risks to the security of the system [16].

In contrast, the CBDC system has a direct connection with the government and regulatory structures, which may cause distrust on the part of some users and organizations that fear government interference in private affairs.

Strict state control allows for increased security, but potentially limits privacy [21].

Thus, according to the criterion of “anonymity and confidentiality”, the DEFI system wins over the CBDC system, which has centralized control from the state. However, the high degree of confidentiality in the DEFI system involves many risks, as it attracts fraudsters and violators of tax and AML legislation, which was discussed above as part of a comparative analysis based on the criterion of “transaction security”.

In modern conditions of universal striving for sustainable development, it is also important to note such features for comparison as energy consumption and environmental friendliness. Decentralized finance tends to operate on blockchain platforms, such as Ethereum, which utilize various consensus mechanisms. Many blockchains, for example those based on the Proof-of-Work (PoW) algorithm, consume significant amounts of energy [27]. The high energy consumption of the blockchain has a negative impact on the environment due to significant carbon emissions associated with the use of non-renewable energy sources for mining [6]. However, the transition to more energy efficient mechanisms such as Proof-of-Stake (PoS) reduces energy consumption. In the meantime, decentralization requires maintaining multiple nodes, which also increases the overall energy consumption of the system.

The metaverse can positively impact environmental sustainability by reducing CO₂ emissions through telepresence, reducing energy consumption and waste through augmented reality features. However, the use of Industry 5.0 technologies, AI training and cloud gaming will increase greenhouse gas emissions, and the growth of electronic waste will lead to soil and water pollution [4].

In turn, central bank digital currencies are being developed to minimize energy costs. They often work on existing banking technologies where there is no need for energy-intensive consensus mechanisms, making CBDC more energy efficient than DEFI. Because of its low

²¹ Decentralized Finance. Moscow: Bank of Russia, 2022. 51 p. URL: https://cbr.ru/Content/Document/File/141992/report_07112022.pdf (accessed on 22.06.2025).

energy consumption and increased centralization, CBDC systems are less harmful to the environment. Central banks often use energy-efficient technologies and can regulate the use of sustainable energy sources in developing and maintaining CBDC. Some experts are investigating the environmental risks of digital currency circulation, while considering the volume of electricity consumption and the possibility of switching to renewable energy sources [22]. Using centralized CBDC-based solutions can reduce energy costs and minimize the carbon footprint.

From the above, we can conclude that, according to the criteria of comparison “energy consumption and environmental friendliness”, CBDC surpasses DEFI due to its centralized architecture and the lack of need for energy-intensive consensus mechanisms. Despite its decentralization, DEFI is still less effective in terms of environmental sustainability, but the technology is gradually improving this situation.

CONCLUSIONS

According to the analysis, it can be noted that the choice between DEFI and CBDC depends on the following factors:

- The objectives of the state.
- The level of trust in financial institutions.
- Readiness for digital transformation.

From the perspective of the state’s objectives, a CBDC system is suitable for a country that wants to control the financial system and maintain the stability of its national economy. This type of system allows the government to retain control over money creation, payments, and market regulation, which can help prevent the emergence of shadow banking activities and reduce the risks associated with them. Additionally, it enables the implementation of tools for transaction monitoring, increasing transparency in the financial system, and contributing to the effective fight against money laundering and financing of terrorism. The choice of DEFI system is appropriate for a state that is interested in fostering innovation and reducing regulatory burden, as decentraliza-

tion reduces reliance on traditional financial institutions and enhances the accessibility of financial services to users. This system enables the creation of a competitive marketplace among financial service providers, promoting the growth of startups and innovative solutions, while also enhancing economic freedom and minimizing bureaucracy.

From the perspective of the level of trust in financial institutions, choosing a CBDC system would be appropriate if trust in traditional banks is low. In this situation, introducing a CBDC would allow the government to rebuild trust by enhancing the transparency of transactions and reducing the risks associated with the banking system. Additionally, central banks could respond more swiftly to crisis situations thanks to centralized control over the system. Choosing a DEFI-based system would be the right choice when a high level of distrust in government agencies and the central banks makes decentralization an attractive alternative. Users prefer independent platforms that protect their assets and privacy, and the possibility of circumventing government regulation and control is attractive to those who seek to avoid government interference in their economic activities.

From the perspective of readiness for digital transformation, a CBDC system would be appropriate for countries with a high level of digitalization among the population and infrastructure. The transition to CBDC could accelerate the development of the digital economy, reduce the costs of cash circulation and increase the speed of payments. At the same time, supporting government initiatives to digitize society and businesses can contribute to growth in investments in digital technology infrastructure. The DEFI system would be a suitable choice for countries with a lower level of digitalization and weaker infrastructure, as it can help gradually introduce decentralized finance, stimulating the development of new technologies and creating conditions for competition between traditional and new financial market participants. The lack of a strong attachment to the current banking system can facilitate the adoption of decen-

tralized platforms, allowing users to manage their assets more independently. This can be beneficial for countries that are just beginning to explore the possibilities of digital finance and want to take advantage of the benefits of decentralized systems.

Each option has its own set of advantages and disadvantages. Therefore, it is essential to consider all the factors before making a decision. Based on the analysis, we believe it makes sense formulating recommendations for the implementation of a specific system for organizing the finances of the state metaverse, taking into account the level of economic development and political stability of each country.

For countries with unstable economic or political situation, where it is essential to provide strict control over financial flows, maintain macroeconomic stability, reduce the risk of criminal activity, and comply with legislation, establishing a financial system based on a centralized digital currency (CBDC) in the metaverse looks like the most effective option. This approach would provide maximum protection for the economic interests of the state, increase the efficiency of tax collection, and avoid potential abuses associated with decentralized finance (DEFI). Furthermore, this solution would strengthen the role of the central bank and integrate the new currency with the existing financial mechanisms, significantly reducing risks to the country's financial sector.

For developed countries with strong economies and stable political systems, the use of any of these systems or their combination would be acceptable, depending on the goals pursued. These countries have the necessary resources and infrastructure to support any selected scenario, providing a high level of security and stability essential for effective management of the economic situation.

Emerging economies may prefer to implement DEFI technologies, as they enable the

rapid development of innovative solutions essential for economic growth.

Countries with economies in transition are currently undergoing a shift from a centralized economic system to a market-based economy. These countries may benefit from adopting a hybrid model that combines the elements of DEFI and CBDC. This approach could take advantage of decentralization and innovation, simultaneously providing government support and regulation.

Small island states or regions with small population could also effectively utilize both approaches simultaneously to create a hybrid system that combines the security and control of CBDC with the flexibility and innovation of DEFI.

In general, hybrid systems that combine decentralization and centralized supervision have the greatest potential to improve state metaverse management efficiency. Decentralized systems as a source of innovation and inclusion and centralized digital currencies as a means of managing and ensuring legal certainty complement each other in an architecture that is consistent with the nature of public sector metaverse finance. This architecture relies on immutable ledgers and blockchains, smart contracts, colored budget funds, decentralized identities, and legal oracles that effectively integrate transparency, compliance, and auditing into its structure and processes.

A comparison of DEFI and CBDC demonstrates that the correct formulation of the question is not an "either-or" choice, but rather a range of architectural combinations and areas of application on the one hand, and specific conditions of each country and its economic goals on the other hand. The main thing here is to consider the balance between centralization and decentralization, regulation and freedom, security and innovation.

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Formation of a Unified Digital Data System for Russia Within the Concept of a Digital Organizational Profile

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ABSTRACT

The relevance of this study is due to the digital transformation of public and corporate finance, which has led to the emergence of new methods and channels for government-business communication. This data-driven platform economy is characterized by a lack of end-to-end digitalization of government information systems and established approaches to presenting an organization's digital profile. Implementing the digital profile concept through government digital platforms will lead to the creation of a unified information space within the public financial management system. The object of this study is the development of a unified digital data system for Russia, based on the concept of a digital profile. The subject of this study is the system of financial and non-financial reporting information for strategic and systemically important Russian organizations, which forms the core of the digital profile. The aim of the study is to develop a terminology and conceptual framework for the formation of a digital profile of organizations in the field of corporate finance which will serve as the basis for a unified digital data system in Russia. The methodological framework for this study is based on an integrated approach that combines content analysis, comparative, factor, and cluster analysis of information about the activities of strategic and systemically significant Russian organizations. This information is derived from existing regulations, as well as actual financial and non-financial data about the activities of these organizations, which are publicly disclosed on specialized digital platforms. The scientific novelty of this work lies in the development of theoretical principles and conceptual approaches aimed at achieving Russia's sustainable development goals. These principles are designed to create a unified digital data system in the form of a digital profile for strategic and systemically important organizations, using platform solutions. The practical significance of this research lies in its potential for direct implementation of the proposed approaches into public and corporate financial management mechanisms.

Keywords: digital profile of an organization; unified digital data system; digital transformation; corporate financial management; corporate finance; strategic organizations; systemically important organizations; digital platforms; corporate reporting

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INTRODUCTION

The transformation of social, economic, and financial relations and the full-scale digitalization of various aspects of life have had a direct impact on traditional transformations and the search for new modes of communication in contemporary society. Information exchange at the level of government, business, and citizens has begun to take place in a digital environment through services and platforms acting as global aggregators and universal platforms for public and business interactions [1]. The ongoing changes are embedded in the national concept of public administration “The State as a platform” and launched during the national project “Digital Economy” (2019–2024).

One of the key directions in the development of this concept proposed within the framework of the new national project “Data Economy and Digital Transformation of the State” (2025–2030) is the creation of a unified information system for the accounting of data from economic entities based on a digital profile of an organization, which is crucial for different groups of users, but especially for the state.

The formation of a digital profile is particularly important for strategic and system-forming organizations in Russia, as they are the most significant clusters of economic entities in the national economy and financial and social spheres. The introduction of a digital platform for these organizations should become a key tool for data-driven decision support systems within the framework of digital public administration and the creation of national financial and non-financial management systems.

For these purposes, it is necessary to develop a system of terminology and conceptual approaches to the composition and structure of the digital profile of an organization, which forms the basis for the unified digital data system in Russia for strategic and system-forming organizations.

This has determined the purpose, objectives, and structure of this article.

MATERIALS AND METHODS

In the domestic legal context, the terms “digital profile”, “digital platform”, and “unified digital data system” have not yet been universally defined.

The issues of digital transformation of public administration, the development of digital platforms and a digital profile have been reflected in the works of such scientists as M.A. Abramova, N.N. Kunitsyna, E.I. Dyudikova [2]; I.O. Antropseva [3]; A.V. Babkin, P.A. Mikhailov [4]; E.R. Bezsmertnaya [5]; R.P. Bulyga, M.V. Melnik, I.V. Safonova, V.B. Gisin [6]; E.V. Vinogradova, T.A. Polyakova, A.V. Minbaleev [7]; I.Z. Geliskhanov, T.N. Yudina, A.V. Babkin [8]; N.L. Dzhapparova [9]; O.Y. Donetskova [10]; O.V. Efimova, M.A. Volkov, D.A. Koroleva [11]; O.V. Zhevnyak [12]; E.S. Zeleneva [13]; O.V. Rozhnova [14]; B.B. Slavin [15]; E.M. Styurin, N.E. Dmitrieva, L.H. Sinyatullina [16]; S.A. Suglobova, S.V. Muzalev [17]; E.V. Kirillina, D.V. Borisova, Zh.V. Strebkova, I.V. Shchukina [18]; G.V. Kolodnyaya [19]; G.N. Makhmudova, Z.A. Ashurov, B.S. Razakova [20]; K.M. Molchanova, N.V. Trushkina, O.K. Katerna [21]; L.O. Serdyukova, R.R.K. Bashirzade, A.V. Pakhomova [22]; N.S. Shchelkov [23]; K.V. Kharchenko [24]; A.H. Hindi Al-Ali, S.S. Sarhan Al-Ruazik [25]; N.G. Tsoi, K.G. Maltseva [26], C. Zhang [27].

In terms of content, the digital transformation of public administration, socio-economic and financial spheres, defined by the President of the Russian Federation as one of the national development goals of the Russian Federation,¹ is based on the conceptual idea of “The State as a platform”, expressed by the Center for Strategic Research² back in 2018 [28]. The model of digital transformation of public administration is an integrated system that includes six interrelated elements: orientation towards national goals, ecosystem approach (ecosystems of shared resources), platform economy (digital platforms and services), digital transformation of management, digital profile (digital twin) of the subject of economic relations, and individu-

¹ Decree of the President of the Russian Federation dated 21.07./2020 No. 474 “On the National Development Goals of the Russian Federation for the period up to 2030”, paragraph 1 (abrogated). Decree of the President of the Russian Federation dated 05.07.2024 No. 309 “On the National Development Goals of the Russian Federation for the period up to 2030 and for the future up to 2036”, paragraph 1.g

² The Center for Strategic Research Foundation is one of the oldest expert and analytical centers, which began its history in 1999 as a developer of strategies for the long — term development of the Russian economy.

alized management approach with emphasis on feedback.

During the national Digital Economy project, many state information resources were created using data from economic entities (data aggregator platforms), the main ones being: Federal Resource (Ministry of Economic Development, 2011); State Accounting Information Resource (GIR BO) (Ministry of Finance of Russia and the Federal Tax Service, 2020 “Digital analytical platform for the presentation of statistical data” (Rosstat, 2021); “Digital profile of the organization” (Bank of Russia and the Ministry of Finance, 2023). A modern large-scale initiative, acting as a successor to the concept of the digital economy, is the national project “Data Economics and Digital Transformation of the state” (implementation period — from 2025 to 2030). This national project consists of nine federal projects, four of which directly correspond to the subject of the research (federal projects “Digital platforms in social sectors”, “Digital Public Administration”, “Government Statistics” and “Artificial Intelligence”).

Within the framework of the new national project, during 2025–2027, it is planned to develop initiatives in the field of creating modern information resources for digital data of economic entities, including: a pilot project to create a Digital profile (the Bank of Russia and the Ministry of Finance); projects of the Digital Platform “Public Capital of Business” and the Sustainable Development Reporting Standard (the Ministry of Economic Development of Russia)³; the implementation of federal projects “State statistics” and “Artificial Intelligence”.

For example, a pilot project to create a Digital Profile of an organization by the Bank of Russia and the Ministry of Finance began its implementation in 2023 and has now entered its final stage. During this stage, scenarios for using the organization’s digital profile infrastructure version 1.12 were developed. At the end of 2024, the

project of the Digital Platform “Public Capital of Business Digital Platform” was launched. This platform was designed to assess the contribution of economic entities’ contribution to public welfare and national goals, as well as form a base of best practices for these contributions.

The federal project “State Statistics” provides for the further development of the Digital Analytical Platform for the presentation of Rosstat Statistical Data (hereinafter referred to as DAP SD), as well as the creation of platforms for federal and regional authorities, which will significantly accelerate the collection and processing of data (including reports from economic entities) and reduce the time for reviewing user requests. The key advantage of the Rosstat Data Center platform is its principle of operation, which ensures that it functions as an integral part of a unified digital ecosystem for public administration and the economy, rather than as a standalone system. These capabilities of the Rosstat Data Center, including methodological, technological, and organizational approaches to the functioning of the Digital Profile of the Bank of Russia and the Ministry of Finance, can be used as a basis for creating a platform for a unified digital data system for Russian organizations.

The authors’ main goal is to integrate financial and non-financial data from government information systems in order to ensure end-to-end interdepartmental digitalization of processes and create a unified system based on the digital profiles of legal entities and individuals.

The formation of a unified digital data system (hereinafter referred to as the UDDS) is a complex but necessary step in the digital transformation of the Russian economy and improving the efficiency of public administration (see *Fig. 1*).

One of the significant problems with the creation of the UDDS is that many agencies (the Federal Tax Service of Russia, the Federal Treasury, the Ministry of Labor and Social Relations, the Ministry of Economic Development, the Federal Financial Monitoring Service, the Federal Antimonopoly Service, the Ministry of Internal Affairs of Russia, Rosstat, etc.) have already implemented their own local information systems. These agencies have invested substantial re-

³ The draft decree of the Government of the Russian Federation “On the Standard of reporting on sustainable development and requirements for the system of verification of compliance of organizations with the standard of public capital of business” (prepared by the Ministry of Economic Development of Russia).

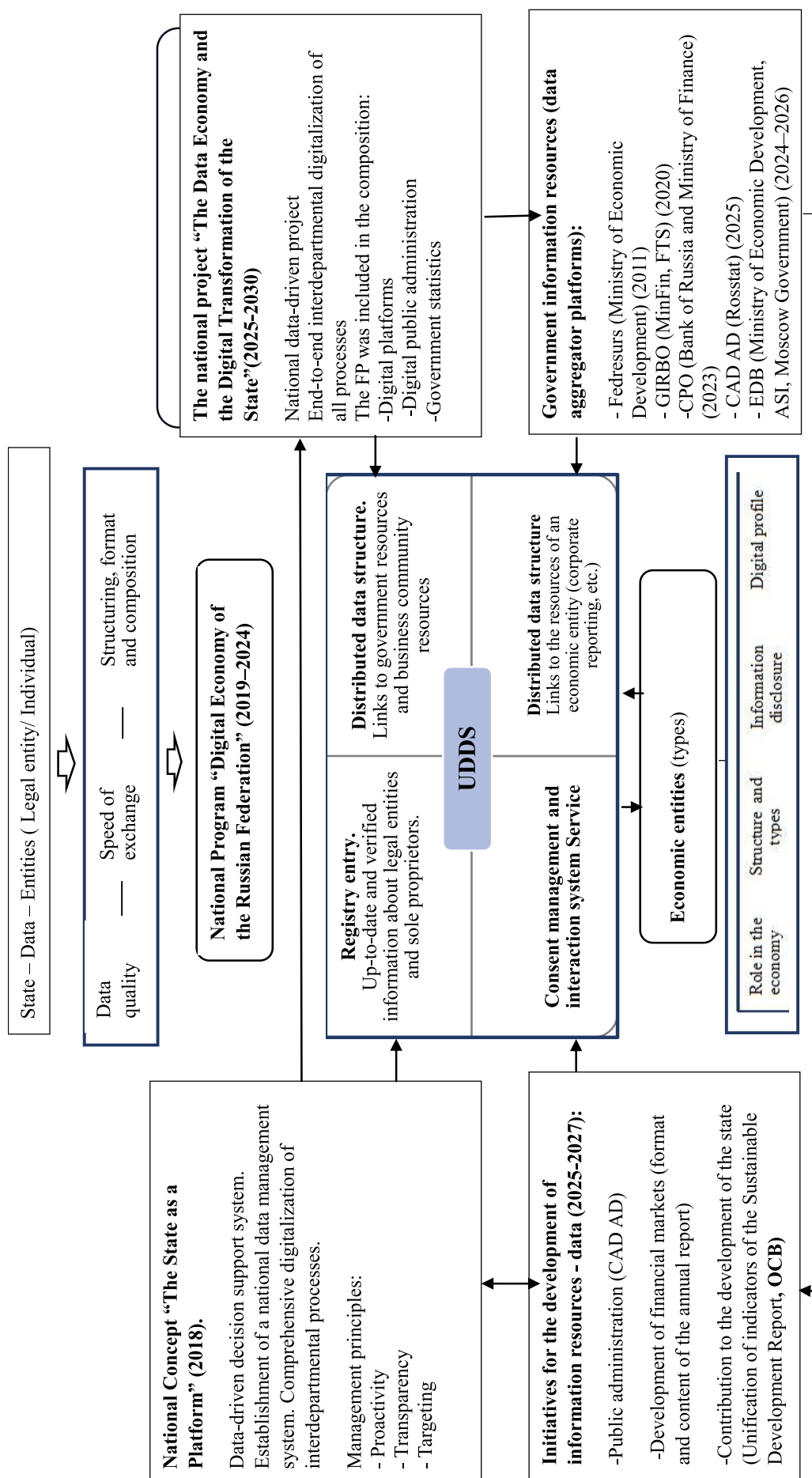


Fig. 1. The Formation of a Unified Digital Data System of Russia in the Concept of a Digital Profile of an Organization

Source: Compiled by the authors.

sources in developing these systems. As a result, organizations today are forced to create a huge number of different digital profiles: for departments, shareholders (corporate reporting and other performance information), citizens (as part of information disclosure), for clients and partners, etc. This departmental-oriented model of state platform management is costly and insufficiently effective in terms of a comprehensive assessment of the contribution of regulated and serviced entities to achieving national economic development goals.

To solve this problem, a clear and logical information support architecture should be developed, based on the creation of the UDDS, using the semantic communication capabilities of the systems. This nationwide big data infrastructure should be based on valid basic registers of government information systems and meet the needs of citizens, businesses, and government agencies

To conduct the research, the authors formulated the following hypothesis: the electronic communication system of economic entities (ECSD), created for the purpose of effective communication between the state and business through the use of state information systems (digital platforms), is formed as a digital profile of the organization. The core of this digital profile consists of financial and non-financial data from digital corporate reporting [29].

Economically significant organizations, classified as “strategic” and “systemically important” in accordance with the legislation of the Russian Federation, have been selected as objects for research. The problems addressed by the authors are related to these objects because in the domestic regulatory framework, the concepts of “strategic organizations” and “systemically important organizations” are present separately, at the level of registers of organizations, without defining their semantic content as special clusters of economic entities, in terms of assessing their contribution to achieving the national goals of socio-economic development in Russia [30, 31].

To verify the hypothesis put forward, the authors conducted the following:

1. Content analysis of the provisions of regulatory legal acts and special literature on the de-

velopment of a terminological cluster of concepts characterizing the process of creating a unified digital data system and the digital profile of an organization.

2. Comparative and cluster analysis of the composition, structure, and role of strategic and system-forming organizations in the economy.

3. Selective rapid study of the representation of 73 of 935 strategic organizations and 175 of 1.106 systemically important organizations in Russia among a wide range of users of report forms.

4. Detailed study of the extent and targeting of information disclosure in corporate reports of 13 strategic organizations and of 20 systemically significant organizations, among those where, according to a preliminary survey, the highest degree of public disclosure was revealed.

RESULTS AND DISCUSSION

Based on the results of the study, the authors' interpretation of the relationship of terms is proposed, the so-called terminological cluster, which characterizes the process of forming a unified data system based on the digital profile of an organization: “digital information ecosystem of an economic entity” — “digital profile of the organization” (from “digital identifier of a legal entity” to “digital twin of the organization”) — “unified digital system data” — “digital platform”.

The digital information ecosystem of an economic entity is an interconnected and adaptive set of components that supports the company's business processes, ensuring the organization's interaction in the system of economic relations in the region (country or the world) [32, 33]. The substantial basis of the information ecosystem is its digital profile, a system (database) of financial and non-financial data that ensures the process of organization interaction in the virtual environment of economic relations in a region (country, world).

Depending on the scale of economic interaction and the degree of reliability of disclosed data, a digital profile of an organization may range from a simplified version of a *digital identifier* for a legal entity to an ideal (hypothetical) image of its digital twin. At the same time, a digital identi-

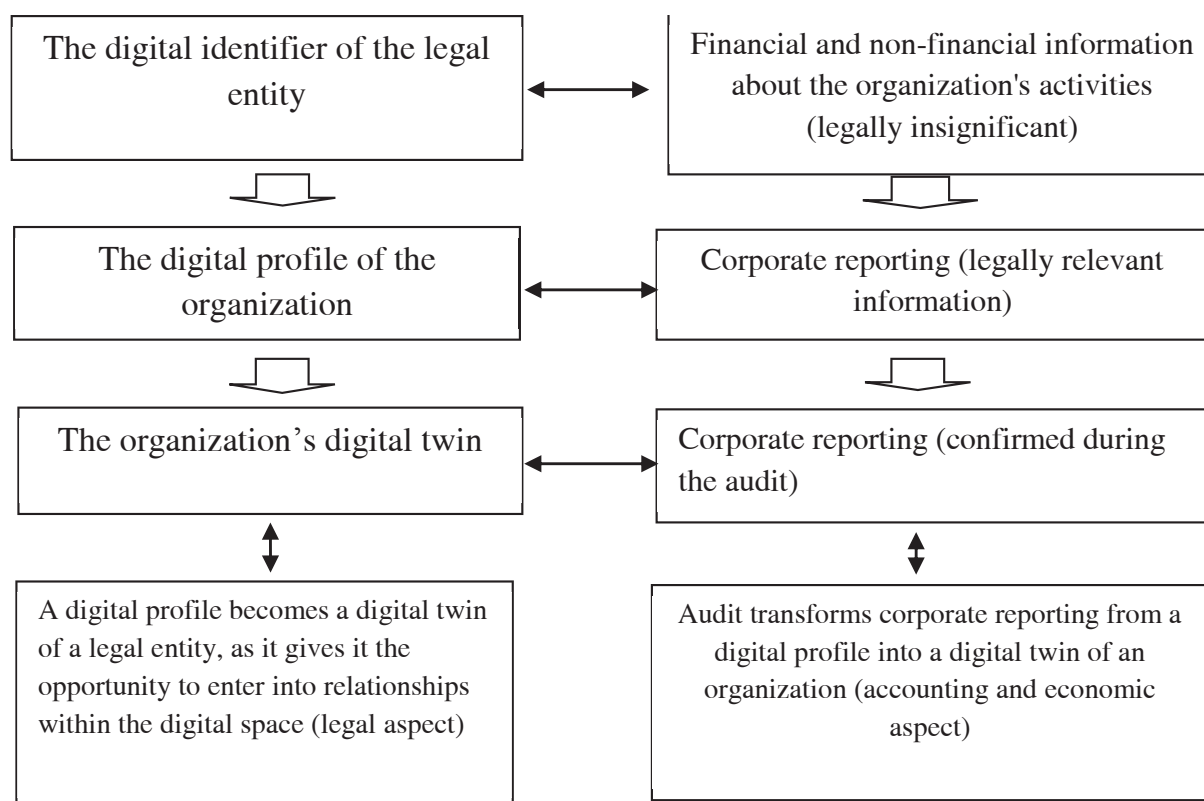


Fig. 2. An Essential Model of the “Digital Profile of an Organization” in the Paradigm of Corporate Reporting

Source: Compiled by the authors.

Table 1

The Structure of Strategic and Systemically Important Organizations of Russia According to the Criterion of Organizational and Legal Form

No.	Legal form of organization	Total SIO	SIO	General	STR	Total STR	TOTAL
1	PJSC	112	96	16	130	146	258
2	AO (CJSC, NPAO, etc.)	511	448	63	681	744	1255
3	LLC	421	419	2	13	15	436
4	Federal State Unitary Enterprises (FSUE)	24	7	17	3	20	44
5	Federal State-owned Enterprises (FKP)	7	3	4	0	4	11
7	Regional State unitary enterprises (GUPS, municipal unitary enterprises)	23	23	0	2	2	25
6	State-owned companies and corporations (GC)	2	2	0	0	0	2
8	Government agencies (FSBI, etc.)	2	2	0	0	0	2
9	Federal Autonomous Institutions (FAA)	0	0	0	4	4	4
10	Others (cooperatives, collective farms, public organizations, etc.)	4	4	0	0	0	4
	IN TOTAL	1106	1004	102	833	935	2041

Source: Compiled by the authors.

Note: Total SIO – the complete current list of systemically important organizations in Russia; SIO – systemically important organizations in Russia; General – Russian organizations classified as both systemically important and strategic; STR – strategic organizations in Russia; Total STR – the complete current list of strategic organizations in Russia.

fier is understood as a set of information confirming the legitimacy of a legal entity for performing certain legal or economic activities in the digital environment. A *digital twin*, on the other hand, is an ideal representation of a company's digital

footprint, based on the assumption that all parties involved in economic transactions receive the most comprehensive and reliable information about the company, both financial and non-financial.

Table 2

The Structure of Strategic and System-Forming Organizations of Russia According to the Criterion of Departmental Affiliation

No.	Subordination of organizations	Strategic		Systemically important		TOTAL	
		Quantity	%	Quantity	%	Quantity	%
1	Ministry of Industry and Trade	820	87.7	519	46.9	1.339	65.6
2	Ministry of Transport	23	2.5	155	14.0	178	8.7
3	Ministry of Energy	9	1.0	97	8.8	106	5.2
4	Ministry of Agriculture	2	0.2	93	8.4	95	4.7
5	Ministry of Communications and Mass Media	8	0.9	89	8.0	97	4.8
6	Ministry of Construction	4	0.4	82	7.4	86	4.2
7	Ministry of Culture	1	0.1	25	2.3	26	1.3
8	Ministry of Finance	7	0.7	4	0.4	11	0.5
9	Ministry of Sports	0	0.0	8	0.8	8	0.4
10	Ministry of Natural Resources and Environment	8	0.9	2	0.2	10	0.5
11	Ministry of Regional Development	1	0.1	0	0.0	1	0.0
12	Ministry of Defense	13	1.4	0	0.0	13	0.6
13	GC "Roscosmos"	22	2.4	20	1.8	42	2.1
14	GC "Rosatom"	17	1.0	12	1.1	29	1.4
	IN TOTAL	935	100.0	1.106	100.0	2.041	100.0

Source: Compiled by the authors.

Table 3

The Results of the Study on the Degree of Representation of the Reporting Forms of Strategic and Systemically Important Organizations in Russia among a Wide Range of Stakeholders

Code	The name of the indicator	Quantity
10	The total number of the Russian MTR, including:	2.041
11	Systemically important organizations	1.106
12	Strategic organizations	935
20	The number of Russian SSOs tested in the course of the study, including:	248
21	Systemically important organizations	175
22	Strategic organizations	73
30	The number of Russian SSOs that publish reports on their official website is among those verified during the study, including:	130
31	Systemically important organizations	100
32	Strategic organizations	30
40	Distribution of the number of studied SSOs in Russia, by type of published reports, total	130
	including by type of reporting:	
41	Accounting (financial) statements prepared according to the FSB	120
42	Financial statements prepared in accordance with IFRS	50
42	Consolidated financial statements	30
44	Securities Issuer's Report	47
45	Sustainable Development Report	16
46	Environmental Report	3
47	The full Annual report	58
48	The annual report in an abbreviated volume	41
49	Report on the implementation of the program of activities and cost estimates (revenues)	1

Source: Compiled by the authors.

All of the above means that, in essence, the “digital profile of an organization” as an extended “digital identifier of a legal entity”, being an integral part of the “information ecosystem of an economic entity”, ideally should strive exponentially to the “digital twin of the organization”.

The conducted research has shown that the use of the concept of digital profiles and digital twins of organizations will inevitably lead to the need to rethink the essence of corporate reporting. The essential model of the “digital profile of the organization” developed in the course of the research in the corporate reporting paradigm is shown in *Fig. 2*.

A set of digital profiles of organizations, formed in a certain way, will form the basis for creating a unified digital data system (UDDS) for a country or region. This system is considered to be a comprehensive database of financial and non-financial indicators about all aspects of the activities of economic entities, which form its economy, social sphere, and security.

The central place in the information ecosystem of an economic entity and the formation of a unified digital data system, based on the concept of the organization's digital profile, is occupied by a digital platform. A digital platform is generally understood as an information and communication system that allows organizations to exchange data within a single information environment and carry out communication functions among all participants.

In order to form conceptual approaches to the composition and structure of the digital profile of strategic and systemically important organizations in Russia, the authors conducted a comparative analysis of a cluster of strategic organizations. The results of this analysis allow us to draw the following conclusions.

In the content part of the digital profile of strategic and systemically important organizations in Russia, it is necessary to take into account the criterion of organizational and legal form when disclosing generalized information about the organization's structure, goals, and types and scope of activities in annual (comprehensive) reports of these organizations under

Table 4

The Degree and Targeting of Information Disclosure in the Corporate Reporting Forms of Strategic and Systemically Important Organizations in Russia

Code	Type SSO	AR	NFR	SR	FR		
					AFR	IFRS	CFR
100	TOTAL MTR of Russia, including:	33	33	33	33	14	14
101	Information not disclosed	12	21	33	7	0	0
102	Information is disclosed and posted on the website	14	12	0	16	11	11
103	Information is disclosed and posted on a digital platform.	7	0	0	10	3	3
110	Strategic organizations	13	13	13	13	2	2
111	The information is not disclosed	5	11	13	2	0	0
112	Information is disclosed and posted on the website	4	2	0	4	0	5
113	Information is disclosed and posted on a digital platform.	4	0	0	7	2	2
120	Strategic organizations	20	20	20	20	12	2
121	The information is not disclosed	7	10	20	5	0	0
122	Information is disclosed and posted on the website	10	10	0	12	11	6
123	Information is disclosed and posted on a digital platform.	3	0	0	3	1	1

Source: Compiled by the authors.

Note: AR – annual report and other similar reports on the activities of public sector organizations; NFR – non-financial reporting; SR – statistical reporting; FR – financial reporting; AFR – accounting (financial) reporting; IFRS – financial statements prepared in accordance with IFRS; CFR – consolidated financial statements.

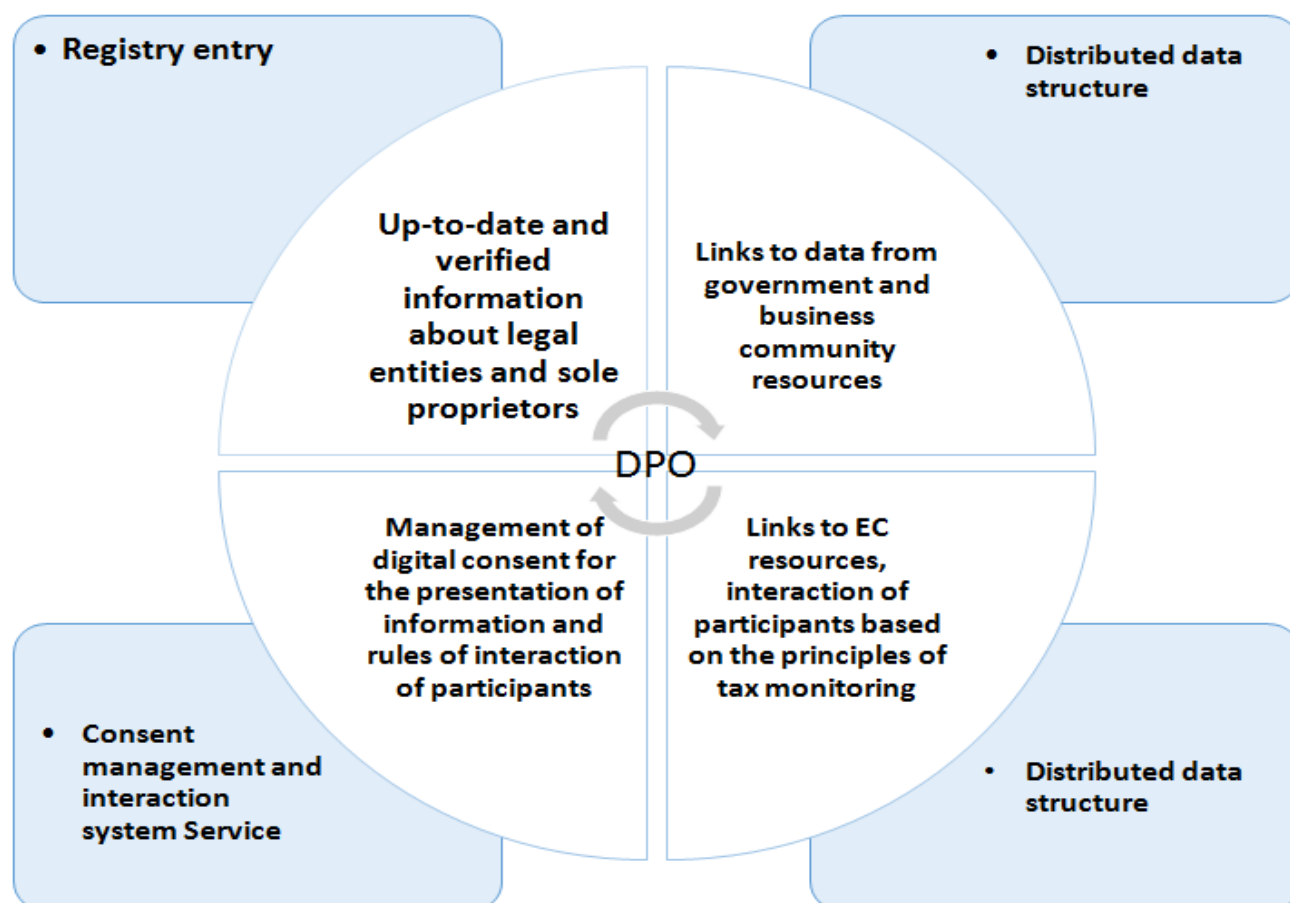


Fig. 3. The Structure of the Digital Profile of Strategic and Systemically Important Organizations in Russia

Source: Compiled by the authors.

current legislation of the Russian Federation (see *Table 1*).

To account for the influence of industry factors, the division of strategic and systemically important organizations into their departmental affiliations was used. (see *Table 2*).

The criterion of departmental affiliation should take into account information about the specifics of business processes, capital formation, and performance currently included in the non-financial and statistical reporting of these organizations when disclosing the content of the digital profile of strategic and systemically important organizations.

The theory proposed by M. Porter [34] is important for understanding the essence of the category “strategic and systemically important organizations”. Based on the cluster approach, in the system of strategic and system-forming organizations in Russia, it is necessary to identify

a special macro-industry cluster — enterprises of the military-industrial complex (MIC). In the context of sanctions and the global transformation of technological chains, defense industry enterprises are becoming critically important elements of the “external contour” of the economy, ensuring: technological sovereignty (import substitution of critical technologies); the country’s defense capability (development of the defense industry as part of the implementation of the state defense order); export potential (promotion of products to international markets, including the BRICS countries).

According to the results of the study of the degree of representation of data for a wide range of interested users in various forms of reports of strategic and system-forming organizations in Russia, the following results were obtained (see *Table 3*). The degree of publicity of reporting information in the segment of strategic organiza-

tions is lower compared to system-forming organizations due to the fact that organizations from non-public sectors of the economy are included in the strategic ones (Defense Industry, Ministry of Defense, etc.).

The following types of corporate reports were publicly available (i.e., accessible to anyone interested): accounting (financial) statements, International Financial Reporting Standards (IFRS) financial statements, non-financial reports, and comprehensive reports (annual reports, etc.). Statistical and tax reports can be considered private in corporate reporting, due to the confidential nature of the data and the specific way it is presented.

Thus, according to the rules in force in the Russian Federation, it is recommended to place statistical reports in the state information system “Digital Analytical Platform for Providing Statistical Data” (DAC SD) of Rosstat, access to which is personalized for users. Tax reporting, which is a set of documents reflecting information on the calculation and payment of taxes by an organization, is digitally submitted to the Federal Tax Service of Russia via telecommunications channels or is available as part of expanded information interaction with tax authorities (tax monitoring) by integrating the company’s information systems with AIS Tax-3.

The degree and targeting of information disclosure by reference groups of strategic and system-forming organizations of Russia in the context of types of corporate reporting obtained during the study allow us to draw the following conclusions (see *Table 4*).

Due to the confidential nature of the data, statistical reporting is the least disclosed type of corporate reporting among a wide range of stakeholders in strategic and system-forming organizations in Russia. There has been a relatively low level of public disclosure in relation to non-financial reporting, with only 36% of organizations in the sample disclosing special types of non-financial information on their websites. Additionally, the study found that none of the surveyed organizations posted non-financial reports on specialized information resources or digital platforms.

With regard to comprehensive reporting, there is a relatively high level of public disclosure. More than 60% of the organizations studied have made this type of corporate reporting publicly available.

The greatest degree and focus of information disclosure by strategic and systemically important organizations in Russia can be seen in relation to financial reporting forms.

At the same time, the main sources of information for the presentation of this type of corporate reporting for strategic and system-forming organizations in Russia include:

1) information resource of the Interfax agency (for publishing accounting (financial) statements; financial statements in accordance with IFRS; consolidated financial statements; annual report);

2) the state information resource of accounting (financial) statements (SIR FR). In the course of the conducted research, the basic structure of the digital profile of strategic and system-forming organizations has been developed, consisting of three parts (see *Fig. 3*).

The digital profile of Russia’s strategic and system-forming organizations should include information systematized in seven sections.:

1. General types of data and characteristics of the organization (legal entity).

2. Products and services.

3. Participation in government projects and programs.

4. Corporate Governance / Management Efficiency (KPI).

5. Innovation and Intellectual capital.

6. Disclosure of accounting information (by purpose):

6.1. Reporting forms (public/non-public, mandatory/non-mandatory).

6.2. Tax information.

6.3. Financial information.

6.4. Information on sustainable development.

6.5. Information on types of capital, risks, opportunities, and business processes.

7. Digital infrastructure solutions.

Each section of a company’s digital profile is a structured block of financial and non-financial

cial information relating to a specific aspect of its business. This information is subject to verification and must meet established standards and regulatory requirements.

The central substantive element of the organization's digital profile, which forms the core of the entire information ecosystem of an economic entity, is digital corporate reporting. It should synchronize and integrate with other components of the digital profile, logically complementing and confirming them, forming a "seamless information environment" [35].

The fundamental model of digital corporate reporting developed in the course of the study includes eight components:

"1) a system of principles-requirements for the formation and disclosure of accounting information;

2) structural elements (external and internal interface);

3) sources and methods for collecting and aggregating primary data;

4) the image and style of corporate reporting;

5) integration solutions for harmonization and connectivity of financial and non-financial indicators;

6) channels and access rights;

7) technological solutions;

8) control tools and mechanisms for ensuring data transparency" [36, p. 20].

The formation of corporate reporting of Russian organizations in the digital profile paradigm will allow:

1) take into account the specifics of the organizational and legal form of the organization;

2) to reveal the industry-specific features of their activities — the format currently called non-financial and statistical reporting;

3) satisfy information requests from key stakeholders:

a) the state, represented by: the relevant supervising ministry — the format of annual comprehensive and financial reporting; Rosstat — the format of statistical reporting; the Federal Tax Service of Russia — the format of tax reporting;

b) shareholders and investors — standard and special financial reporting formats;

c) companies — non-financial reporting formats.

CONCLUSIONS

The research conducted has shown that one of the most significant initiatives for the digital transformation of the Russian economy within the framework of the "State as a Platform" model and improving the efficiency of public administration within the framework of the national project "Data Economics and Digital Transformation of the State" is the creation of an integrated platform for a unified digital data system for strategic and systemically important organizations (UDDS SR/SIO). This is a crucial issue for a comprehensive assessment of their contribution to achieving national economic development goals.

The digital profiles of these organizations, which are based on financial and non-financial data from digital corporate reporting, will form the basis for creating this unified digital data system (UDDS SR/SIO).

The integrated nature of the platform means that it must have a federally distributed (decentralized) architecture. The UDDS SR/SIO integrated platform should act as a kind of "data exchange service bus" that will allow an organization to create a single digital profile, and all users of this information will receive the information they need from it. It should not contain the entire data set of economic entities. The platform itself should store information about data routes and access to them, as well as identification data and metadata about the organization's digital profile and verified information. If distributed ledger technologies are used, the platform can also perform transaction verification functions.

The proposed approach aims to preserve the current practices of departments and organizations when it comes to the exchange of electronic information. It also aims to significantly facilitate the work of employees within an economic entity by streamlining the process of preparing accounting data and reducing duplication. As a result, this should lead to a reduction in errors.

Furthermore, through the use of the integrated UDDS SR/SIO platform, different departments, with appropriate access permissions, will be able to access additional information about the organization's activities on their own. This will help them to make more informed decisions and improve their overall efficiency.

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Accounting and Reflection in the Company's Reporting of Investments in the Development of the Territory of Its Presence

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ABSTRACT

The recent trend is to increase companies' attention to the quality of life in their territory. The main reason for this is the need to attract and retain human resources. The territory of presence for companies is becoming an "asset" from investments in which a positive economic effect is expected. The purpose of the article is to show how the company's investment in the development of its territory is reflected in accounting and reporting and to justify the use of each option. The study was conducted based on regulatory documents that govern accounting and reporting, including international financial reporting standards, and non-financial reporting standards. From the standpoint of dynamic balance theory, it is possible to classify investments in the development of a territory as expenses of future periods or as assets of a company. However, it is difficult to reliably assess these assets and the issue of asset management is controversial. The article shows the rationale for the importance of separately accounting for investments in the development of territories considering their future economic importance. We suggest evaluating the effectiveness of investments in the development of the territory by analyzing the achievement of the company's most pressing goal – the retention and attraction of professional staff. In the accounting system of an enterprise, it is necessary to organize control over the effectiveness of investments in the development of the territory: to introduce an object of accounting supervision – "investments in the sustainable development of the territory" and to reflect this object as future expenses or as a non-current asset, depending on the expected period of benefits. Off-balance sheet accounting for the object is also possible. The reporting on geographical segments should reflect the costs of sustainable development of the territory of presence. The reporting on geographical segments should reflect the costs of sustainable development of the territory of presence. We propose to include information about business investments in sustainable development in comprehensive sources of information about the territory, as well as in the development of statistical accounting. On behalf of the territorial management authorities.

Keywords: investments in the territory; social investments; geographical segments; segment reporting; integrated reporting; financial reporting; investment accounting; sustainable development of the territory

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INTRODUCTION

A recent trend is the increased focus of companies on the quality of life in the areas where they operate. Companies no longer see the territory as just a location to place their assets or sell products. Instead, it has become an “asset” that can benefit the company. Until recently, the importance of investing in the development of the territory was primarily seen as “building the company’s image” [1, p. 168] or as a way to gain benefits and favorable treatment from the government [2, p. 435]. However, in today’s world, investing in local communities and making socially responsible investments is essential for a company’s long-term survival.

The main reason for companies to invest in the development of territories is the lack of skilled workers and the need to attract talent to their location. One of the key factors in a company’s competitiveness is the quality of its urban environment. Today, this largely determines the decision of where people choose to live and, therefore, where they choose to work.¹

At the Krasnoyarsk Economic Forum 2023, a discussion on “Business and Territories: A New Approach to Social Investment” focused on the role of large domestic companies in the development of regions due to the lack of skilled workers. The region and its development have become a factor in attracting and retaining talent for companies. Investments in regional development are not just one-time investments, but aim to fundamentally transform the region.²

A joint study by the Platform Center for Social Design (CSD) and the Center for Strategic Research, in collaboration with ESG Alliance, has shown that the quality of territorial development is a crucial factor in attracting employees.³

¹ Nornyi S. Territory of responsibility: Russian companies assume social functions. How and why a business develops its regions of presence. *Izvestia*. 2023. November 21. URL: <https://iz.ru/1608846/stanislav-nornyi/territoriia-otvetstvennosti-rossiiskie-kompanii-berut-na-sebia-sotsialnye-funkcii> (accessed on 10.04.2025).

² URL: <https://gnkk.ru/articles/territoriya-stanovitsya-aktivom/?ysclid=lwj383wyjd929836708> (accessed on 10.04.2025). (accessed on 10.04.2025).

³ Business and territories are the living environment as a factor of competition for staff. The Center for Strategic Research Foundation. 2023; March 01. URL: <https://www.csr.ru/ru/news/biznes-i-territorii-sreda-zhizni-kak-faktor-konkurentsii-za-personal/> (accessed on 10.04.2025).

This conclusion is supported by other studies as well.⁴ Companies also conduct their own analyses of the population’s satisfaction with living in a particular territory.

In October — December 2022, several corporations conducted a survey among the “Cities with Rosatom Presence” to assess the social well-being of the local population and their attitude towards the state-owned corporation.⁵ The study [3] found a positive relationship between corporate social responsibility and company value.

This leads to the conclusion that there is a group of investments on the territory that are aimed at obtaining future economic benefits.

Although it is true that some of the funds allocated for the development of a territory are charitable without the expectation of economic return, such voluntary donations should not be considered investments, as they do not aim to generate profits in the traditional sense. Investments, on the other hand, are defined by their goal of generating future profits. Therefore, we can agree that the primary difference between investments and charitable donations is the expectation of financial gain [4, 5].

A gradual qualitative shift in how companies view investments in their territories should lead to a redefinition of what investments in a territory constitute as an accounting object.

This article aims to explore how a company’s investment in its territory is reflected in accounting and reporting, and to justify the application of each approach. It tests the hypothesis that investments in a territory can be classified as an asset.

MATERIALS AND METHODS

The search for opportunities for accounting and reporting on investments in the territory was conducted based on regulatory documents, in-

⁴ Kapkov S. Personnel city: how a sustainable urban environment helps business. Online publication “forbes.ru”. 2021; November 17th. URL: <https://www.forbes.ru/forbeslife/446183-kadrovyy-gorod-kak-ustojcivaa-gorodskaa-sreda-pomogaet-biznesu> (accessed on 10.04.2025).

⁵ Pirogova E. Not just a job: how corporations develop their regions of presence. *RBC — Trends*. December 25, 2023. URL: <https://trends.rbc.ru/trends/green/cmr/653a70c49a794788212a0fdf?from=copy> (accessed on 10.04.2025).

ternational financial reporting standards, and other relevant standards. We also considered a look at investments from a dynamic balance perspective.

Accounting is a regulated activity, so let's take a look at options for accounting for investments that support the sustainable development of the territory, in accordance with relevant regulations.

The Federal Law "On Investment Activities in the Russian Federation in the Form of Capital Investments", dated February 25, 1999, No. 39-FZ, defines investments. The law defines entrepreneurial activity as the main area of investment and the main goal of making a profit. However, it also allows for other benefits from investments, such as social, environmental, or other positive outcomes. Therefore, these outcomes can be consistent with the definition of investment activities in this law.

The specified law defines investments made in the form of capital investments. Capital investments in Russia include various types of newly created or modernized property owned by individuals, state, municipalities, and other forms of legal entities. The definition of capital investments ensures the unambiguous application of this legislation to investments specifically in the property owned by an individual. For example, if a company invests in the construction of a kindergarten owned by the municipality, this is considered a capital investment under this law. Investments in fixed assets, such as buildings and equipment, are also included in the analytical report on "Investments as a Source of Economic Growth" [6]. Further in the article, we consider investments in the development of the territory as capital investments, as real, not financial investments.

RESULTS

There is no specific term for "investment" in accounting laws, but there is a related concept of capital investment. Federal Accounting Standard (FAS) 26/2020, "Capital Investments", does not apply to all investments. It only applies to investments where the organization has exclusive rights over the investment object.

This standard therefore does not cover investments in the social infrastructure of a territory or the construction of facilities that are transferred to the ownership of local governments.

The standard that governs the disclosure of information about an organization's territorial presence is Accounting Regulation "Segment Information" (AR 12/2010). Geographic regions can serve as the basis for segmentation. Segmentation involves separating information about part of an organization's operations, in this case, based on its location in a specific geographic area. A geographic territory is typically understood as a municipality or a constituent entity of the Russian Federation where a functional part of the organization operates. A geographic segment may be functionally associated with several administrative divisions, but this should not prevent it from being identified if it is essential for the reliability of reporting information. Quantitative indicators such as profit, assets, and liabilities are reported for each reporting segment. Of course, the costs associated with developing the territory will impact these indicators. However, the AR (Accounting Regulation) does not currently provide for a specific and separate allocation of funds for the sustainable development of the area. This could be achieved by introducing separate accounting and reporting of expenditures for sustainable development in the accounting policies, such as in the statement of financial performance.

Let's look at what investment options exist for the development of the territory, and what accounting options there may be for such investments.

1. The company invests in socially significant projects for the territory, which remain in its ownership. Therefore, the social facilities are non-current assets, and the current costs of their operation, including the depreciation of the facilities, are recorded in account 29 "Services and Farming", with subsequent writing off of expenses to account 91 "Other Income and Expenses". This accounting treatment is in line with current legislation, but it does not reflect the direction of costs towards future benefits.

2. The company invests in social facilities that are owned by local authorities, government agencies, or other individuals, but not by the company itself.

3. Funding of events, holidays in the territory, and other non-capital expenses by the company.

Items 2 and 3 are considered current expenses for the company and are recorded in account 91 "Other Income and Expenses". These expenses are shown in the company's accounting and reports at a given time. However, this accounting method does not reflect the expectation of future benefits from these investments. Therefore, we are exploring other ways to record investments in the development of the territory.

It may seem acceptable to define investments in the development of a territory as a contingent asset. According to the International Financial Reporting Standard (IFRS) 37, Provisions, Contingent Liabilities, and Contingent Assets, contingent assets typically arise from unexpected events that create the potential for economic benefits. In the case of investments, however, the company expects and plans for a positive outcome. Therefore, the category of contingent asset is not appropriate for the investment studied in the development of the territory.

In the dynamic theory of balance sheet, assets are understood as expenses incurred against future periods. When an asset on the balance sheet is a capitalized expense, there is a category of future period expenses (EFP). "Everything that is spent is spent — it's all a 'hole', but if it is filled with value, then these values can return in the form of income..." explains this category by Ya.V. Sokolov [7]. In dynamic balance sheet theory, an asset is interpreted as a set of company expenses that should bring income in future accounting periods. An asset shows directions for investing money to make a profit [8].

From the history of accounting, Gino Zappa, a representative of the classical Italian school (1879–1960), argued that an asset does not represent a company's funds but rather its re-

sources intended for profit. In the approach of Eigen Schmalenbach (1873–1955), there is a category of assets called "values that will become income".

In practical terms, it is not common to recognize investments in a territory's development as an expense in future periods. An analysis of the reports from twelve large companies showed that their expenses in future periods included:

- Expenses for repairing fixed assets.
- Insurance costs.
- Licenses and access rights, among others.

These findings are consistent with the idea that investments in a company's future should be recognized as assets rather than expenses. There are no expenses for investments in the development of the territory on this list. Nevertheless, we believe that due to the fact that investments in development of the area are expected to have a positive impact in the future, an investment in an asset, for example a gym for the municipality, can be recorded by the following accounting system:

Debit 76 Credit 51 — paid from the checking account to an outside party for the construction of the gym.

Debit 97 Credit 76 — expenses are attributed to the EFP (the object "Investment in the gym of the municipality").

Debit 91 Credit 97 — gradual inclusion in other expenses of the EFP as the useful life of the gym expires (or during the expected period of receiving benefits from this investment).

By including investments in the development of the territory in the controversial category of future expenses, we are, of course, strengthening the ongoing discussion [11–13] about EFP as an asset and an accounting object. However, this approach to reflecting investments in EFP is possible and can be justified by the need to keep in mind the information field of the purpose of investment, which is to achieve economic benefits.

Let's consider the option of recognizing investments in the development of the territory as non-current assets, rather than as EFP. Assets are economic resources that an organi-

zation controls as a result of its business activities, and which are expected to generate economic benefits in the future. These future economic benefits can be direct or indirect contributions to the organization's inflow of funds.

The Concept of Accounting in the Russian market economy defines assets as resources controlled by an organization that have the potential to generate future economic benefits. Similarly, the IFRS Conceptual Framework states that an asset is something that an organization has control over, as a result of past events, and that is expected to provide future economic benefits to the organization in the form of increased cash or cash equivalents.

In the case of investments in real estate, the criterion of control over the property is controversial. Nevertheless, the company's income-generating assets can be recognized as assets in accordance with International Financial Reporting Standards (IFRS). For the recognition of assets, "the legal affiliation of these funds becomes unimportant, since other people's property (for example, rented) can generate income" [9, p. 266]. The concept of IFRS has now been implemented in domestic standards. The AR(Accounting Regulation) 25/2018 "Lease Accounting" provides for showing in the balance sheet asset that set of funds (regardless of ownership rights), by managing which the company receives a reported profit [14].

The issue of controllability can be resolved through public-private partnership mechanisms, such as a concession agreement, public-private partnerships, or municipal-private partnerships. The accounting rules for these transactions are determined by the order of ownership transfer, as outlined in the agreement. According to information from the Ministry of Finance of the Russian Federation, No. PZ-2/2007, "On the specifics of accounting for concession agreements", concessionaires consider the costs of concession contract objects as investments in fixed assets, which are then transferred to intangible assets.

We believe that, due to the priority of content over form, lack of legal formalization of control should not prevent recognition of assets. If the

goal of investing in sustainable development of the territory is achieved, the social facility transferred to the area is a place for common use, used to provide social services to an unlimited number of people, a public good used precisely for purposes planned during investment (development of culture, sports, health care, education, and environmental protection).

A prerequisite for classifying an object as an asset on the balance sheet is receiving economic benefits from that object. Many studies have shown that socially responsible investment and the ESG approach to business have a positive impact on profitability, return on assets, and a company's market capitalization [3, 15–18]. Investments in the territory are expected to increase capitalization by achieving sustainable development goals, which can serve as a basis for including investment in the development of that territory in assets.

Obtaining economic benefits can be achieved by increasing productivity through attracting highly qualified specialists, avoiding environmental violations, preventing social unrest in the region and other qualitatively assessed factors. A methodology for assessing future economic benefits of investments is needed to recognize investments in a territory. This methodology should be adopted and disclosed in an enterprise's accounting policy.

Examples of such techniques exist. Scientists have developed methods for evaluating the effectiveness of social investments using correlation and regression analysis [19], based on the principle of alternative cost [20], and based on the cost – benefit analysis method [21].

In our opinion, the effectiveness of investments should be confirmed by achieving the goals that were set when making investment decisions. Let's return to the actual reason for the company's investments on the territory outlined at the beginning of the article – this is a shortage of personnel. Therefore, the effectiveness of investment in the development of the territory can be assessed by achieving the following indicators:

- The number of highly qualified and rare professions employed.

- Reduction of staff shortage and number of closed units.
- Decrease in staff turnover and retention of full-time employees.
- Number of employees who move from other regions or localities.
- Number who moved with their families.
- Increasing number of family dynasties at the enterprise.
- Number purchasing property in company's locality.
- The number of employees who continue their education in their field of work in the company.

It should be noted that the updated interpretation of the prudence principle favors recognizing investments in the development of a territory as an asset. The approach to the prudence principle (conservatism) has changed from a tendency towards greater recognition of losses than profits to recognition of assets and income with an equal degree of credence with liabilities and expenses [22–24].

Paragraph 2.16 of the Conceptual Framework for the Presentation of Financial Statements of IFRS states that “the application of prudence means that assets and income are not overestimated, and liabilities and expenses are not underestimated. Equally, the application of prudence does not allow underestimation of assets or income or overstatement of liabilities or expenses”. Therefore, if an object, in particular investments in the development of a territory, meets the requirements for recognizing an asset, then it should be reflected in accounting and reporting, since underestimation of assets is unacceptable.

DISCUSSION

These arguments for or against recognizing investments in the development of a territory as an asset are not clear-cut and allow us to make professional judgments both in favor of and against recognition of the asset.

As accountants, we have a tendency to want to reduce the diversity of economic life to accounting transactions and the equality they create on the balance sheet. This attempt to

fit developing economic life within the framework of accounting categories can also lead accounting into increasing intellectual darkness [25].

We believe it is crucial to ensure that information about investments made in the development of a territory is not lost in accounting and reporting processes. To achieve this, it is essential to introduce a measure of the significance of an object for both the company and the territory.

Various options for incorporating investments in the territory's development into the balance sheet were considered to demonstrate their theoretical and legal feasibility.

The view of the local community would be the most objective when assessing the direction of investments for the sustainable development of the territory. The author has investigated the possibilities of creating a comprehensive source of information about the territory (an integrated report on the territory) [26, 27]. Integrated territory reporting provides information about the resources of the territory and its interaction with stakeholders. It also reflects the investments of companies in the development of the territory through comprehensive information. The reports on the territory include information about the contribution of companies to its development. Companies, in turn, can refer to the territory's report in their own reports, creating a “hyperlink”. This helps to ensure neutrality and the truthful presentation of information in reports.

CONCLUSIONS

A qualitative change in businesses' attitudes towards investing in the development of their areas of presence leads to a shift in the way such investments are recognized as an accounting object.

The analysis presented in this article allows us to draw several conclusions about the possibilities of including information on investments in the territory where the organization operates in its accounting and reporting practices.

One of the options for disclosing information about investments in financial statements is

to allocate geographical segments. These segments must be specified in the accounting policies of the company, and each segment should keep separate records for expenses related to sustainable development.

Another option is to recognize investments in the development of a particular territory as future expenses. This method is suitable for expenses that are planned to produce benefits within a year or less.

The third option, which is suitable for long-term investments, involves considering investments in the development of the territory as non-current assets. At the same time, it is suggested to evaluate the effectiveness of these investments by analyzing the retention and recruitment of professional personnel.

It is necessary to maintain analytical records and document the factors that affect labor sufficiency indicators, calculate and analyze these indicators, and adopt a methodology for measuring the impact of investments on the local operation of the enterprise. Additionally, the methodology should be disclosed in the accounting policies.

On the part of the territorial authorities and in the development of statistical accounting, we propose including information about business investments in the sustainable development of the territory as an integrated source of information about the territory. The development of a territorial information system is presented through its comparison with business reports and their mutual verification and complementarity.

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The System of Objective Economic Laws of Credit

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ABSTRACT

The condition for the effective functioning of any economic mechanism is to consider objective economic laws when constructing it. At present, there are large-scale transformations taking place in the field of credit relations, and credit mechanisms are undergoing modernization at both the micro and macro levels. **The subject** of the research in the article is the objective laws of credit. **The purpose** of the work is to systematize the laws of credit and reveal the directions for their use. The main research **methods** are the dialectical method, the systematic approach, the methods of scientific abstraction, and induction and deduction. **The scientific novelty** consists in the formation of the author's concept for a system of objective economic credit laws. **The main results** of the study are: 1) In the system of laws of credit, there are three groups: laws of credit emergence, laws of credit functioning and laws of credit development. Within each group there are both basic and derivative laws. 2) The laws of credit emergence include the law of the necessity for credit and the law of ensuring the continuity of reproduction on the basis of credit. The laws of credit functioning include the law of repayment of credit and the law of the economic limit for credit. The laws of credit development comprise the law of complication of credit and the law of ensuring economic growth through the development of the institutional structure of credit relations. 3) The direction of using the laws of credit functioning is the organization of credit relations at the micro level (in the process of building a lending mechanism), and the direction of using the laws of credit emergence and development is the organization of credit relations at the macro level (in the process of building a mechanism to regulate the banking system and the financial market). **Keywords:** credit; theory of credit; objective economic law; pattern; system; credit mechanism; banking system

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INTRODUCTION

The study of objective laws that govern the functioning and development of economic relations is an important area of fundamental economic research. These laws were most actively studied in Russian economic literature during the Soviet period.

Nowadays, the issues of objective economic laws are rarely discussed in scientific publications and very little attention is given to them in educational materials. For many people, including those with an economic background, the idea of economic laws is only associated with regulatory legal documents, and when asked by popular neural networks to provide a list of economic laws, they display a list of federal economic regulations.

However, ignorance of economic laws and failure to take them into account can lead to negative socio-economic consequences. It is important to understand the stable cause-and-effect relationships that govern the functioning and development of economic systems in order to create effective economic mechanisms both at the micro and macro levels.

Knowledge of the laws of credit is particularly relevant at this time, as large-scale transformational processes are occurring in the lending sector. The structure of the credit market and credit system is changing, with new lending subjects, forms of credit relations, and credit technologies emerging. These new phenomena sometimes call into question the effectiveness of current lending mechanisms and the credit market organization. To better understand these changes, it is essential to revisit the study of the laws of credit and evaluate current processes through the lens of these laws' operation.

ANALYSIS OF RESEARCH ON THE LAWS OF CREDIT

Despite more than a century and a half of research, the issue of the laws of credit remains one of the underdeveloped areas of economics.

Although the problem of the laws of credit came to the attention of economists in the mid-19th century, many authors who touched on it limited themselves to simply stating the

existence of objective credit laws or formulating a few laws of credit without providing detailed justifications. Until the mid-20th century, there were only a handful of works that provided a more detailed explanation of the laws of credit. Some scholars did not aim to conduct a specific study of the laws of credit, but rather considered them as part of broader research. Even those authors who did set out to study the laws of credit sometimes limited themselves to briefly naming a particular law, without providing a detailed explanation of its content and objective cause-and-effect relationships.

In the second half of the 20th century, research into the laws of credit reached new heights, both in terms of quantity and quality. The most significant contribution to the understanding of these laws was made by O.I. Lavrushin, who conducted the first in-depth study of credit laws [1]. In general, over the more than a century and a half of research history, more than six dozen laws and patterns of credit have been formulated by various authors. We have previously conducted a detailed retrospective review of research on the laws of credit in the economic literature [2].

At the later stages of research, approaches to the systematization of the laws and patterns of credit began to emerge in scientific publications. J.P. Avdiyants was the first to do so, identifying three groups of the laws of credit: the laws of structure, the laws of operation, and the laws of credit evolution [3]. V.V. Ivanov, A.V. Kanaev, B.I. Sokolov and I.V. Toprover proposed a classification of the laws of credit into empirical and theoretical laws [4]. N.I. Valentseva considered it necessary to distinguish between the general laws governing the credit sphere, the specific laws of credit and the patterns of credit [5].

APPROACHES TO THE FORMATION OF A SYSTEM OF THE LAWS OF CREDIT

What should be the basis for building a system of the laws of credit? When solving this issue, it is necessary to proceed from the fact that economic laws reflect the deep interrelations in the essence of economic relations. The dialectical research method requires considering

the essence of all objects and phenomena not in statics, but in dynamics, in constant motion, the stages of which are formation (emergence), functioning, and development. Based on the above, it is legitimate to hypothesize that the system of the laws of credit should include the laws of the emergence, functioning and development of credit.

An analysis of the formulation of laws and patterns of credit¹ in the economic literature has shown that most of them can be attributed to one of three groups. *Table 1* provides a se-

¹ The patterns of credit were included in the scope of the study due to the fact that they, like laws of credit, are objective in nature, but reflect more complex relationships, since they are formed as a result of the action of a set of laws.

Table 1

Selective Grouping of the Laws of Credit Formulations in Economic Literature

The basis of the grouping	Formulations of the laws
The emergence of credit relations	
The need for a credit	The law of the objective necessity of credit [6] The law of credit emergence [7] The law of necessity of credit [8]
The role of a credit	The law of saving monetary reserves due to the participation of credit in the implementation of costs [9] The law of ensuring continuity and efficiency of reproduction on the basis of credit [9] The law of expansion of the material base of reproduction due to credit [3]
The functioning of credit relations	
The basis of the credit (repayment)	The law of repayment of funds [1, 7, 10] The law of repayment of a credit [3, 8] The law of repayment of a credit and the law of repayment of a loan [11]
Principles of lending	The law of preservation of the cost of credit facilities [1] The law of preservation of loaned value [3] The law of the temporary nature of the functioning of the loan [12] The law of urgency of a credit [3] The law of allocation and functioning of the interest on loan [3]
Credit limits	The law of the economic limit of lending [3, 10] The law of balance between resources released and redistributed on a return basis [12] The law of matching the size and structure of credit investments to the needs of economic turnover [13] The law of conformity of credits provided to the size and structure of banking resources [13] The golden rule of bank lending [4]
The development of credit relations	
Institutional structure	The law of development of credit relations [8] The pattern of development of credit relations infrastructure institutions and increased competition between them [14]
Forms and types of credit	The pattern of progressive development of credit [5, 15, 16] The pattern of credit concentration [5, 16] The pattern of expansion of forms and types of credit [14]

Source: Compiled by the author.

Table 2

The System of the Laws of Credit

Classification criteria	Laws of credit emergence	Laws of credit functioning	Laws of credit development
Basic laws	The law of necessity of credit	The law of repayment of credit <i>A special case:</i> • The law of preservation of loaned value • The law of the temporary nature of the functioning of credit	The law of complication of credit
Derivative laws	The law of ensuring the continuity of reproduction on the basis of credit	The law of the economic limit of credit <i>A special case:</i> • The law of balance between resources released and redistributed on the basis of repayment	The law of ensuring economic growth on the basis of the development of the institutional structure of credit relations

Source: Compiled by the author.

lective grouping of formulations based on their correspondence with the stages of credit relations' movement.

The set of formulations presented in *Table 1* does not constitute an integral system, as there is duplication within it, where the same relationships are described using different words. Additionally, upon closer examination, it becomes clear that not all of the listed relationships are of the same order. Some of them are, in fact, a consequence of more general laws, or a specific case of the manifestation of these general laws.

Therefore, when organizing the laws of credit, it is recommended to use two criteria:

1. According to the stage of the movement of credit relationships — the laws of emergence, functioning, and development.

2. According to the degree of complexity of the interrelationships reflected — basic and derivative laws/patterns.

Visually, the author's concept of a system of the laws of credit can be presented in the form of a matrix (*Table 2*).

Revealing the content of the laws of credit within the framework of the presented system requires answering three key questions:

1. Since economic laws reflect stable relationships in the essence of economic processes and phenomena, it's necessary to determine which

causal relationship each law of credit reveals in credit relations.

2. To understand objective economic laws, we need to understand their requirements for economic entities and the consequences of violating them.

3. From a practical standpoint, it's important to determine how the laws of credit can be used, as well as the methods and instruments for doing so.

THE LAWS OF CREDIT EMERGENCE

The basic law of emergence of credit is *the law of necessity of credit*. This law states that the formation of temporarily available funds for certain market entities and the temporary need for their attraction by others objectively necessitates the existence of credit relations.

The causal relationship reflected by this law is: "the emergence of needs for temporary attraction or temporary investment of funds — the emergence of credit".

In our opinion, *the law of ensuring the continuity of reproduction on the basis of credit* can be considered a derivative law of credit emergence. Its content is that credit creates an opportunity to ensure continuity in social reproduction by attracting borrowed funds to cover temporary financial needs that arise during the circulation of capital.

The causal relationship reflected by this law is: “the emergence of credit — the continuity of social reproduction”.

As can be seen from the above, there is a close relationship between these laws of emergence of credit — we can say that they “work in tandem”. The general requirement of these laws is the absence of artificial obstacles to the existence of credit relations. If there are factors hindering the functioning of credit, the needs of potential borrowers and creditors are not met, and the continuity of reproduction of economic entities and the economic potential of society are not fully realized, which ultimately hinders economic development. This scenario is illustrated, for example, by the implementation of a policy of credit restriction when an increase in the key rate leads to a reduction in lending and a decrease in production.

The main ways to apply the laws of credit emergence include creating a regulatory framework that does not hinder the existence of credit relations, as well as taking into account the significance of credit for economic growth in the implementation of economic policies, financial regulation, and monetary policy.

Islamic banking can serve as an example of an organizational and economic model that takes into consideration the requirements of the laws of credit emergence. The emergence of Islamic banks and their products that comply with Sharia regulations has contributed to credit development in these countries, and subsequently to their economic growth. According to Russian experts, introducing partnership financing into banking practices would help expand the range of financing options available to businesses [17].

THE LAWS OF CREDIT FUNCTIONING

The basic law of credit functioning is *the law of repayment of credit*, the content of which is that the repayment of borrowed funds, being the main essential feature of a loan, is a necessary condition for the functioning of credit relations (their reproduction). The causal relationship reflected in this law is: “repayment of credit — reproduction of credit relations”.

If the funds lent are not returned, the loan turns into its opposite (irrevocable financing), and the credit relations disappears. The repayment requirement acts as “Occam’s razor”, separating true credit relations from formal ones, which only superficially look like credit, but in fact are not of a credit nature. For example, an international loan granted for political reasons often does not imply repayment in the traditional sense and, in fact, is not a loan in the economic sense.

The main way to use the law of repayment of credit is to build a credit mechanism that ensures repayment of a loan. The rules for building such a mechanism are formalized in the system of principles of lending, and its toolkit includes methods for assessing and managing credit risk of a loan mechanism that ensures repayment of a loan.

Another important law of credit functioning is *the law of the economic limit of credit*, the content of which is that a necessary condition for ensuring repayment of borrowed funds is compliance with quantitative and qualitative credit limits in the lending process. The causal relationship reflected by this law is: “compliance with quantitative and qualitative credit limits — repayment of credit”.

If a loan has been issued for an improper purpose, to an uncreditworthy borrower, or in an amount exceeding the economically justified needs of the borrower or the capabilities of the lender (bank), it can jeopardize the repayment of credit. An example of such a violation is the massive issuance of subprime mortgage loans in the United States in the mid-2000s, which contributed to the global financial crisis of 2008–2009.

The main ways to use the law of the economic limit of credit are to determine acceptable credit facilities and comply with the principle of loan targeting, assess the borrower’s creditworthiness, establish credit risk standards and macroprudential limits for credit institutions by the regulator, etc.

The law of preservation of loaned value is a special case of the law of repayment of credit and consists in the fact that the loaned value must

return to the borrower, retaining not only its nominal, but also its real value (purchasing power). The causal relationship reflected by this law is: “the repayment of borrowed funds not only at face value, but at real value — the real repayment of credit”.

If the funds are returned only at face value, without taking into account their possible depreciation, the repayment is not fully secured (it is formal). The way to use this law of preservation of loaned value is to comply with the principle of interest payment when lending.

The law of the temporary nature of the functioning of credit is also a special case of the law of repayment of credit and consists in the fact that due to the temporary nature of the release of funds, a loan can only be granted for a certain period of time, which objectively determines the possibility of meeting only the temporary needs of borrowers with a loan. The causal relationship reflected by this law is: “the temporary nature of the needs satisfied by the loan — the issuance of a loan for a certain period of time — repayment of credit”.

If the loan is issued without a set repayment period, the likelihood of a violation of the repayment of the borrowed funds increases. The way to use the law of the temporary nature of the functioning of credit is to comply with the principle of establishing a return period when lending.

The law of balance between resources released and redistributed on the basis of repayment is a special case of the law of the economic limit of credit and consists in the fact that credit depends on the sources of its formation, and this objectively determines the balance between resources released and redistributed on the basis of repayment. The causal relationship reflected in this law is: “the correspondence of the volume and structure of credit resources to the volume and structure of loans issued — repayment of the credit”.

If the volume and structure of loans issued does not match the volume and structure of the lender’s (credit institution’s) resources, the repayment of credit may be impaired. The way to use the law of balance between resources

released and redistributed on the basis of repayment is to comply with the “golden rule of lending”.

THE LAWS OF CREDIT DEVELOPMENT

The basic law of credit development can be described as *the law of complication of credit*, the content of which is that the development of credit relations proceeds in the direction of complicating their institutional structure, successively passing through the stages of direct relations between lenders and borrowers, credit relations involving intermediaries, and regulated credit relations. At the same time, the old, simpler forms of credit relations do not disappear, but give way to a leading role to new, more complex forms. The causal relationship reflected by this law is: “contradictions of credit relations — the development of the institutional structure of credit relations and their forms from simple to more complex”.

In our opinion, *the law of ensuring economic growth on the basis of the development of the institutional structure of credit relations* can be considered a derivative law of credit development, the content of which is that improving the institutional structure of credit relations creates conditions for improving credit efficiency, and on this basis — for ensuring economic growth. The causal relationship reflected by this law is: “development of the institutional structure of credit relations — improvement of credit efficiency — economic growth”.

The general requirements of the laws of credit development are compliance with the objective vector of development of credit relations in society, the prevention of artificial prohibition of objectively necessary forms of credit relations. Deformations of the institutional structure of credit relations (its artificial simplification, the elimination of objectively necessary elements) lead to a decrease in the effectiveness of credit and to inhibit the development of the national economy.

An example of a violation of the laws of credit development is the distortion of credit relations in the Soviet economy. In the USSR, commercial credit was abolished and direct credit relations

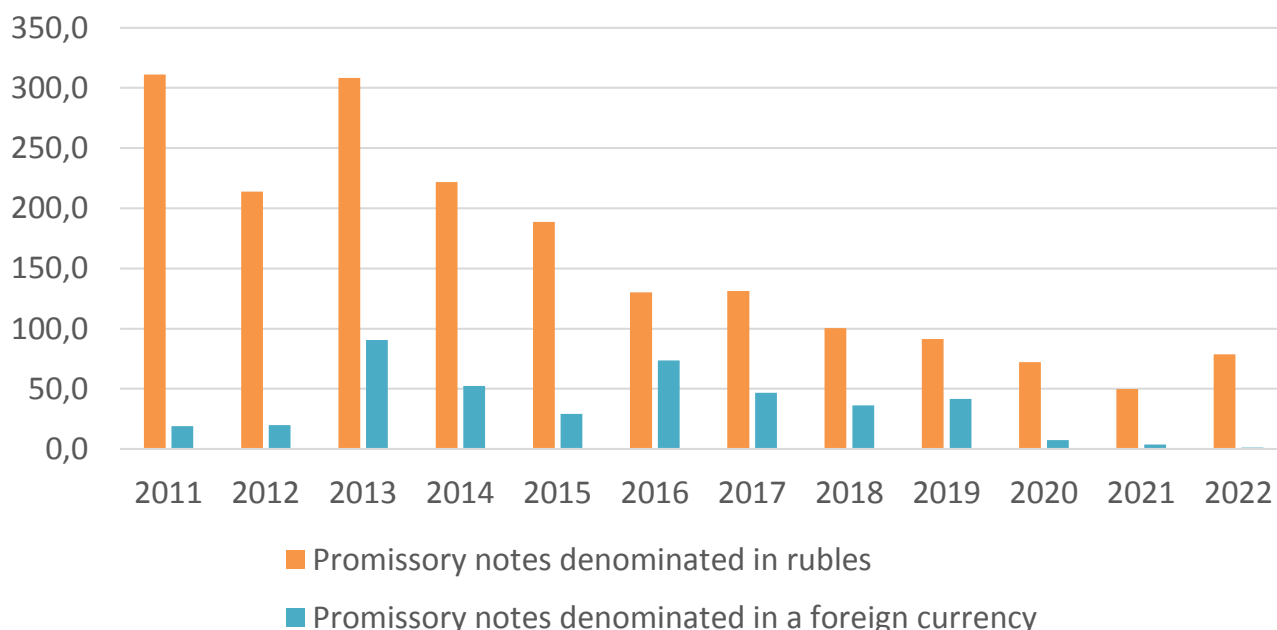


Fig. 1. The Amounts of Promissory Notes Recorded by Credit Institutions (in Billion Rubles)

Source: Compiled by the author based on data from the Federal State Statistics Service. URL: <https://rosstat.gov.ru/emiss> (accessed on 19.04.2026).

were restricted to civil credit only. Bank loans were issued to enterprises on a planned basis and credit relations with intermediaries were almost completely replaced by regulated credit relations. This led to a reduction in the role of credit and a lack of efficiency in the credit system.

To address these issues, it is necessary to implement new forms of credit relations and improve the structure of the credit system by institutionalizing them.

In various specific historical conditions, laws find their manifestation in *the patterns of credit development*. Actually, the law of complication of credit itself can be considered as a sequence of two fundamental patterns, the first of which is *the emergence of the institution of credit intermediaries and a single-tier banking system*, and the second is *the formation of centralized regulation of credit relations and a two-tier banking system*. At the same time, it would be wrong to assume that these are the only patterns of credit development.

In our opinion, one of the possible approaches to studying the patterns of credit development is to study the patterns of each of the three levels of credit relations — direct credit relations,

credit relations involving intermediaries and regulated credit relations.

The fact that earlier forms of relationships, while simpler, may fade into the background as new, more complex and advanced forms emerge, does not mean that their development has stopped.

In our opinion, the modern *patterns of development of direct credit relations* include the reduction of promissory note lending, the development of platform lending, and the development of lending in the system of decentralized finance.

Reduction of promissory note lending. For a long time, the main form of direct credit relations has been commercial credit carried out through promissory note lending. However, over the past 20–25 years, promissory notes have been steadily decreasing in countries with developed market economies. In Russia, in recent decades, there has also been a reduction in bill circulation. According to Federal State Statistics Service, the volume of ruble-denominated promissory notes registered by credit institutions in 2011–2022 decreased from 311.1 billion rubles to 78.8 billion rubles, i.e. almost 4 times (Fig. 1).

Development of platform lending. The emergence of platform lending in the 2000s can be

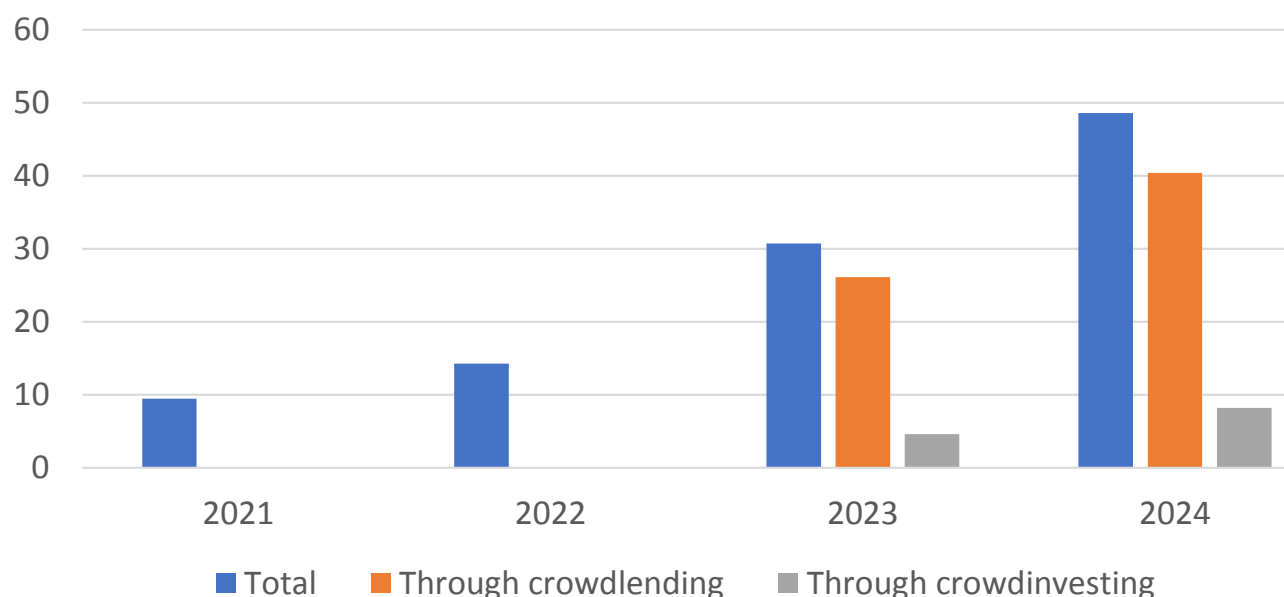


Fig. 2. The Amount of Funds Raised by Small and Medium-Sized Businesses with the Help of Investment Platform Operators (in Billion Rubles)

Source: Compiled by the author based on data from the Bank of Russia. URL: https://www.cbr.ru/analytics/develop/fin_avail (accessed on 19.04.2026).

considered a kind of “renaissance” of direct credit relations.² Its main type is crowdlending — lending by attracting funds from a large number of individuals, carried out on a digital platform, without the participation of a financial intermediary. Platform-based lending plays an important role in increasing financial accessibility by providing loans to small and medium-sized businesses. In Russia, the volume of funds raised by small and medium-sized businesses with the help of investment platform operators increased more than 4 times in 2021–2024 — from 9.5 to 48.6 billion rubles, and more than 80% of these funds were raised through crowdlending³ (Fig. 2).

*The development of lending in the system of decentralized finance.*⁴ Research by Russian econo-

mists shows that in 2019–2023, the growth rate of the sector of decentralized finance in the world exceeded the growth rate of the financial sector of the economy as a whole, including in terms of lending activities — by more than 4 times, and in terms of infrastructure development — by almost 20 times [18]. The advantages of decentralized finance are fast access and openness, increased trust, transaction autonomy, relatively high income generation, rapid implementation of innovations, and compliance with the principle of variability [19].

In our opinion, *patterns of development of credit relations involving intermediaries* include the development of non-bank credit intermediaries, reduction in the number of bank branches and the development of digital banks, integration of platform-based lending and decentralized finance services into the activities of credit institutions.

The development of non-bank credit intermediaries has been a significant trend in the 21st century, alongside traditional commercial banks. These non-bank entities, including fintech companies and big tech companies with their own lending platforms, have actively entered the lending market. For instance, K. V. Krnichansky

² We consider platform lending as a type of direct credit relations; thus, the relationship of this concept with the category of “credit” can be interpreted as a relationship between form and content.

³ The content of the concept of “crowdlending” is most consistent with the economic essence of the loan, since the entities providing their funds through crowdlending are creditors (unlike crowdinvesting, where the entities providing their funds are investors).

⁴ Strictly speaking, lending in the system of decentralized finance is a type of platform lending, however, due to the specifics of decentralized finance, it deserves independent consideration.

and E.S. Zeleneva discuss the natural evolution and expansion of fintech in their work on this topic [20].

Reduction in the number of bank branches and the development of digital banks. After the crisis of 2008–2009, developed countries began to close physical bank branches, and this trend accelerated during the COVID-19 pandemic in 2020–2021. In Russia, from 2019 to 2025, the number of branches and internal structural divisions of credit institutions decreased by 26.6%,⁵ from 30,492 to 22,366. These changes are due to the widespread use of internet banking and mobile banking, which reduces the need for customers to visit banks physically.

Integration of platform-based lending and decentralized finance services into the activities of credit institutions. According to analysts, the impact of decentralized finance on traditional financial intermediaries is likely to continue to expand [21]. A natural result of this is the inclusion of platform lending and elements of the decentralized finance ecosystem in banks' business models. One promising area of research is developing alternative lending channels [22].

The emergence of unregulated credit relations zones in the field of cryptocurrencies and decentralized finance can be considered a *pattern of development of regulated credit relations* under modern conditions. The development of cryptocurrencies has led to the formation of segments of the credit market outside the jurisdiction of central banks. This is not so much a relaxation of regulation by the central bank, but rather the emergence of an alternative system where the regulator objectively has no instruments of influence.

The future of the financial system is likely to be hybrid, with centralized and decentralized systems coexisting, competing, and converg-

ing [23]. Regulators will need to find a balance between promoting innovation and ensuring financial stability and consumer protection.

CONCLUSIONS

The analysis of the scientific discussion, the use of a dialectical method and a systematic approach to research allowed us to substantiate the author's concept of a system of objective economic laws of credit. According to this concept, there are three groups of laws in the system: laws of credit emergence, laws of credit functioning, and laws of credit development. Within each group, basic and derivative laws can be identified.

The laws of credit emergence include the law of necessity of credit (basic law) and the law of ensuring the continuity of reproduction on the basis of credit (derivative law). The laws of credit functioning include the law of repayment of credit (basic law) and the law of the economic limit of credit (derivative law). The laws of credit development include the law of complication of credit (basic law) and the law of ensuring economic growth on the basis of the development of the institutional structure of credit relations (derivative law).

The laws of credit functioning must be taken into account in the organization of credit relations at the micro level (in the process of building a lending mechanism) — when determining the principles of lending, developing methods for assessing and managing credit risk.

The effect of the laws of credit emergence and the laws of credit development must be taken into account in the organization of credit relations at the macro level (in the process of building a mechanism to regulate the banking system and the financial market) — when creating a legal framework and regulatory contour that does not interfere with the existence of credit relations, the institutionalization of new forms of credit relations.

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⁵ The Bank of Russia. URL: https://www.cbr.ru/statistics/bank_sector/review/ (accessed on 19.04.2026).

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Inflation and Monetary Policy: Analysis of the Impact of Inflation and Central Bank Policy on the National Economy

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ABSTRACT

The subject of the study is the inflationary processes and monetary policy of the Bank of Russia. The purpose is to analyze the impact of these factors on the state of the Russian economy. To achieve this goal, the following tasks have been set: to consider the theoretical aspects of the relationship between inflation, PREP and economic growth; to analyze the dynamics of inflation and the key tools of the PREP of the Bank of Russia for the period from 2010 to 2024; to conduct an econometric analysis of the impact of inflation and the key rate on GDP growth. The relevance of the topic arises from the importance of finding a balance between ensuring price stability and supporting economic growth within the framework of the policy of the Bank of Russia. The methods of comparative and statistical analysis and econometric modeling are used in this work. The dynamics of inflation, key rates, GDP growth rates and lending to the economy are analyzed from 2010 to August 2024. A regression model of the impact of inflation and the key rate on GDP growth was built. The results of the analysis showed that periods of accelerated inflation and a tightening of the monetary policy were accompanied by a slowdown in economic activity. An increase in annual inflation by 1 percentage point on average slows quarterly GDP growth by 0.096 percentage points, and an increase in the key rate by 1 percentage point reduces the GDP growth rate by 0.137 percentage points (other things being equal). The model explains 58% of the variation in the dependent variable. The coefficients are statistically significant. The conclusion is made regarding the need for the Bank of Russia to pursue a balanced PREP aimed at ensuring price stability without compromising economic growth. The scientific novelty of this study lies in the quantitative assessment of the effects of inflation and the key rate on economic dynamics in Russia based on current data. The prospects for further analysis are related to the use of alternative econometric methods and the study of monetary transmission channels of PREP.

Keywords: inflation; monetary policy; key rate; central bank; inflation targeting; economic growth; gross domestic product; lending; investment; transmission mechanism

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INTRODUCTION

Inflation and the monetary policy of central banks are two key factors that affect the state of a country's economy. Central banks use monetary policy (MP) to try to ensure price stability and create conditions for long-term economic growth. However, balancing these goals can be challenging.

High inflation can negatively affect purchasing power, savings, and investments, while deflation can also pose risks to the economy. Increasing the key interest rate to fight inflation may slow down lending and GDP growth, but easing monetary policy can stimulate business activity but also risk accelerating inflation.

Various theories and empirical studies have been conducted to analyze the relationship between inflation, monetary policy, and economic growth. Some economists, such as monetarists, believe that low and stable inflation promotes long-term growth. Others, like Keynesian economists, argue that moderate inflation can be an incentive for short-term economic activity and GDP growth [1, p. 245; 2].

The experience of developed and developing countries shows that central banks play a key role in ensuring macroeconomic stability. Monetary authorities use various instruments, such as the key rate, reserve standards, and open market operations to influence inflation and economic growth [3]. At the same time, the effectiveness of these instruments depends on the institutional conditions, the degree of development of financial markets, and the confidence of economic agents in the central bank's policies. [4, 5].

The relevance of this topic for Russia is due to the fact that, since 2015, the Bank of Russia has been implementing an inflation targeting regime, in which price stability is the priority goal. However, in practice, the regulator faces a difficult choice between controlling inflation and supporting economic growth, especially during times of crises and structural imbalances [6].

The purpose of this article is to investigate the impact of inflation and the monetary policies of the Bank of Russia on the Russian economy. In order to achieve this goal, we have set the following objectives:

1. To explore the theoretical aspects of the relationship between inflation, money supply, and economic growth.

2. To examine the dynamics of inflation, the key instruments of the Bank of Russia's monetary policy, and indicators of economic activity from 2010 to August 2024.

3. To perform an econometric analysis to determine the impact of inflation and key interest rates on GDP growth in Russia.

The object of the study is inflationary processes and monetary policy in the Russian Federation, and the subject is their impact on macroeconomic dynamics. The theoretical and methodological basis of the research consists of the works of Russian and foreign economists on monetary theory and policy, as well as econometric methods of time series analysis.

THEORETICAL ASPECTS OF THE RELATIONSHIP BETWEEN INFLATION, MONETARY POLICY AND ECONOMIC GROWTH

In economic theory, there are various approaches to analyzing the relationship between inflation, central bank monetary policy, and real GDP dynamics.

Monetarists (M. Friedman, E. Phelps, and others) believe that, in the long run, the economy tends towards a state of full employment and inflation is purely a monetary phenomenon determined by the rate of growth of the money supply. Friedman formulated the "k-percent rule", according to which the central bank should ensure predictable and proportional growth in the money supply commensurate with potential GDP [2].

Representatives of the new Keynesian school (J. Stiglitz, O. Blanchard, etc.) argue that in the short term, there is a trade-off between inflation and unemployment. They describe this relationship with the Phillips curve, which states that stimulating monetary policy can temporarily increase real GDP and employment, but at the cost of higher inflation. However, they do not deny the long-term neutrality of money, provided that economic agents' inflationary expectations are rational [1].

The modern neoclassical synthesis combines the ideas of monetarists and Keynesians, noting that MP affects real indicators in the short term due to price rigidity and the presence of information and institutional frictions. At the same time, in the long term, GDP growth rates are determined by fundamental factors on the aggregate supply side (technologies, factors of production, human capital, etc.) [7, p. 93]. Inflation mainly depends on the MP and inflation expectations.

Inflation targeting as a MP strategy that focuses on price stability has become prevalent in the world since the 1990s. Its theoretical foundation is the New Keynesian model, which assumes tight prices and imperfect information [8]. The central bank, with more complete information than the population, can stabilize inflation and inflation expectations. This, in turn, creates favorable conditions for sustainable economic growth [9].

Empirical studies in different countries generally confirm the existence of a non-linear relationship between inflation and long-term growth [3]. With low inflation (up to 3–5% per year) this relationship is insignificant or even positive. However, the acceleration of inflation in the range of 5–40% leads to a slowdown in growth. Hyperinflation of over 40% per year has devastating consequences for the economy. With deflation, the real debt burden and the risks of “debt deflation” grow [9].

Theory and practice show that central banks should avoid both excessively high inflation and deflation. Low and stable inflation (about 2–4% per year) is optimal for long-term growth [10, 11]. At the same time, MP should not create excessive volatility of interest rates and monetary aggregates, destabilizing the economy [12].

Inflationary expectations of economic agents play an important role in the transmission mechanism of monetary policy. If the population and businesses trust the central bank and its inflation targets, then expectations will be “anchored”, which makes it easier to control actual inflation [13]. On the contrary, surges in inflationary expectations can provoke a wage-price inflation spiral and require tighter monetary policy to suppress it.

To achieve this balance, the MP should be flexible enough, avoiding unnecessary strict rules. The inflation target should not be too low, so as to not suppress the adjustment of relative prices. The horizon for targeting should be long enough to absorb temporary shocks. The interest rate policy should be coordinated with other macroeconomic policies in order to eliminate non-monetary factors of inflation and increase market flexibility.

Modern theoretical models and empirical studies have shown that inflationary expectations play a crucial role in determining actual inflation rates and the effectiveness of monetary policy (MP). When economic agents, such as households, businesses, and investors, expect prices to rise, they may proactively increase their prices and wages, leading to increased consumption and reduced savings, which can contribute to inflation. In contrast, anchored inflation expectations allow central banks to implement a more flexible and accommodative monetary policy without the risk of spiraling inflation out of control.

To manage inflation expectations, central banks use a variety of tools, including “direct” (such as inflation targeting and forward guidance) and “indirect” (such as public relations and information policy) measures. By publishing inflation targets and communicating their intentions, central banks aim to convince economic actors of their ability to maintain price stability. Through press conferences, research publications, educational programs, and other channels, they explain the logic behind their actions and the impact they have on the economy to the general public.

The Bank of Russia has recently increased the transparency and frequency of its communications with markets and the general public. The central bank publishes not only forecasts for macroeconomic indicators but also its assessments of the balance of risks and justifications for decisions on the key interest rate. Regular press conferences and briefings are held for journalists and analysts. On the website of the Central Bank, detailed information is available about all aspects of monetary policy, from statistics to analytical reports. The Special Research and Forecasting

Department of the central bank produces thematic bulletins and reports that explain the theoretical foundations and practical implications of the bank's policy decisions.

In recent years, the Bank of Russia has made significant strides in improving the coherence and transparency of its monetary policy, as demonstrated by the increasing confidence of economic actors. However, there have been occasional episodes of inflation that deviated from the target path, which can be interpreted as a lack of stability in the monetary policy rate. These deviations were primarily due to non-monetary factors, such as changes in global economic conditions. To further enhance confidence in the central bank's policies, it is essential to refine its communication strategies and clearly explain the rationale behind its decisions.

Summarizing the theoretical concepts, the relationship between inflation, monetary policy (MP), and economic growth is complex and ambiguous. In the short term, there can be both positive and negative correlations between these variables, depending on the initial state of the economy, the phase of the business cycle, and the level of trust in the central bank.

All other things being equal, a more accommodative MP can boost GDP growth by expanding credit and aggregate demand, but it may also lead to some increase in inflation. On the other hand, a restrictive MP may temporarily slow economic activity, while strengthening price stability.

However, if we consider the relationship between inflation, monetary policy and economic growth in the long term, the picture changes somewhat. Moderate and stable inflation in combination with predictable monetary policies are important factors contributing to sustained economic growth. The fact is that under conditions of price stability, inflationary taxes on savings and investment are reduced, risks and costs of borrowed resources are lower, and excessive redistribution of wealth and income between economic agents is prevented. Low inflation makes it easier for companies and households to plan and make long-term decisions, increases confidence in the national currency and the financial system overall [14].

At the same time, excessive high inflation, especially if it is unpredictable, has a destructive effect on the economy. It distorts relative prices, leading to inefficient allocation of resources, shortening the planning and investment horizon, and provoking capital flight and currency crises. In conditions of rapid depreciation of money, economic agents prefer saving it in foreign currency and real assets (real estate, goods) instead of financing investment projects.

The negative effects of high and volatile inflation on economic growth are associated with a number of mechanisms and channels. Firstly, in conditions of rapid price growth, economic agents are forced to spend more resources on searching for information, frequent changes in price tags, menus, etc. (the so-called "menu costs"), as well as on adjusting contracts to new price realities (the so-called "costs of sand in the wheels"). This diverts resources from productive activities and reduces the overall efficiency of the economy.

Secondly, high inflation can lead to uneven price increases for different goods and services. This distorts the relative price proportions, making it difficult for consumers and investors to make rational choices. This can result in a sub-optimal allocation of resources, with excessive investments going to sectors with temporarily high returns, while basic industries and infrastructure are underfunded.

Thirdly, unexpected spikes in inflation can redistribute income and wealth. Creditors may lose out to debtors, and recipients of fixed income may see their wealth decrease. This can deepen inequality and undermine trust in government, as people may feel that they are losing out due to inflation.

In addition, high inflation devalues the savings of citizens and businesses in the national currency, stimulates capital flight, dollarization of the economy, speculative operations instead of long-term investment. With sufficiently high rates of depreciation of money, the so-called "inflation tax" (seigniorage) effect can occur, when the state actually confiscates part of the income and savings of economic agents through inflation.

In general, as many empirical studies have shown, high inflation is not so much a stimulus

as a hindrance to economic growth. The more volatile and unpredictable inflation is, the more negative its effects are. Therefore, maintaining price stability should be a top priority for central banks, even if this means making some short-term compromises in terms of economic output and employment.

Therefore, central banks should strive to keep inflation at a low and stable level, clearly explaining their goals, tools, and motives for decision-making to market participants and society as a whole. At the same time, it is important that the efforts of monetary authorities to ensure price stability do not lead to excessive restraint of aggregate demand and economic hypothermia.

Central banks should pursue a symmetric monetary policy, allowing inflation to fluctuate both up and down from the target level. The asymmetry in monetary policy means that the central bank reacts more strongly to risks of inflation exceeding the target than to risks of shortage. As a result, over a long period, actual inflation may fluctuate downward from the target. Although the Bank of Russia claims to have a symmetric strategy, some asymmetries may manifest themselves during times of increased uncertainty, due to concerns about rooting out inflationary expectations following episodes of high inflation.

At the same time, it can be argued that a stimulating policy is justified in a weak economic context to prevent deflationary risks. However, it is crucial to prevent the build-up of financial imbalances, as the positive effects of such a policy may be offset in the long run by its negative consequences.

Therefore, finding the optimal balance between short-term and long-term monetary policy objectives, between promoting growth and maintaining price stability, remains a pressing challenge for central banks. This requires a balanced and flexible approach that considers both structural and cyclical factors specific to each economy.

Ideally, MP should be countercyclical, smoothing out fluctuations in output around the potential level. During a recession, central banks should ease monetary policy to maintain aggregate demand. In an overheating economy, they should

tighten monetary policy to prevent imbalances from accumulating. At the same time, changes in the key interest rate should be gradual and predictable so as not to cause excessive volatility in financial markets.

The work of the central bank should be coordinated with other areas of state economic policy, including fiscal, structural and macroprudential policies. Lack of coordination between monetary and fiscal authorities can undermine efforts to ensure price and financial stability, as well as sustainable growth. Counterproductive competition between these authorities can also lead to negative consequences for the economy.

Insufficient budget discipline and the build-up of public debt limit the MP's ability to manage inflation and create risks of fiscal dominance. On the other hand, too rigid MP against the background of a conservative fiscal policy can lead to an excessive strengthening of the national currency and undermining the competitiveness of domestic producers.

In addition, the effectiveness of monetary policy largely depends on the development and stability of the banking system, as well as the depth and liquidity of financial markets. In countries with a bank-centered financial system, such as Russia, the main transmission channel for monetary policy is through the credit channel. This means that the central bank influences lending activity and interest rates in the economy mainly through its impact on the banking sector, including the volume and cost of funding, reserves and capital ratios, the spread between loan and deposit rates, and other factors [14].

Accordingly, the resilience of banks to shocks and their ability to increase lending to the real economy largely determine the effectiveness of monetary policy. If banks face problems with liquidity or asset quality, they may not be able to respond to mitigation measures by increasing credit as desired, preferring instead to reduce leverage, build up reserves, and hold risk-free assets.

In turn, non-financial companies have limited access to market-based capital raising tools, which makes them more dependent on bank loans. This means they are more vulnerable to fluctuations in interest rates and regulations, es-

pecially in countries with underdeveloped capital markets. The interest rate and credit channels of monetary transmission may be weaker there, while the foreign exchange channel may be stronger due to the high share of imports in the consumer basket and the tendency of economic agents to dollarize their savings and liabilities.

It follows that the efforts of central banks to increase the effectiveness of MP should be accompanied by measures to strengthen the stability of the banking system, develop non-bank financial intermediation and risk hedging instruments [15]. At the same time, it is important to avoid excessive growth of the debt burden in the economy and credit “overheating”, which can lead to a painful correction and recession.

Finally, an effective monetary policy is impossible without high confidence in the central bank among economic agents. Monetary authorities must be transparent and accountable for their actions, consistent in achieving stated goals, open to communication with market participants and the general public, and responsible for macroeconomic stability. The independence of central banks should be balanced with their responsibility for financial stability.

In recent years, the world’s leading central banks have significantly expanded their communication strategies and information policy tools, from publishing forecasts and forward guidance to holding press conferences and educational events [16]. The Bank of Russia also pays great attention to information transparency issues, regularly publishing reports on MP, the main directions of financial market development, conducting surveys of inflation expectations of the population and businesses, etc.

THE DYNAMICS OF INFLATION AND MONETARY POLICY OF THE BANK OF RUSSIA

Let’s analyze the dynamics of the main indicators of inflation, monetary policy and economic activity in Russia for the period from 2010 to 2025.

The trajectory of inflation during this period was heterogeneous (*Fig. 1*). In 2010–2013, the average growth in the consumer price index was 6–7% per year, which was higher than the Bank of

Russia’s targets of 4–5%. Spikes in inflation were observed during the crisis of 2014–2015 (11.4% and 12.9%, respectively) against the background of falling oil prices, capital outflows and the weakening of the ruble. Since 2016, annual inflation has entered the target range of the regulator, due to the transition to the inflation targeting and floating exchange rate regime [4]. In 2020, inflation accelerated to 4.9% driven by the pandemic crisis and the weakening of the ruble, and in 2021–2022. It increased to 8.4% and 11.9% against the background of a recovery in demand, rising global prices and import restrictions. In 2023, inflation gradually slowed to 7.4%, and in 2024 it returned to the Bank of Russia’s target level of 4%.

In response to the acceleration of inflation, the Bank of Russia tightened the MP, raising the key rate. Its trajectory generally followed the dynamics of inflation, but with some lag (*Fig. 1*). The sharpest increase in the rate occurred in December 2014 (immediately by 6.5 percentage points to 17%) to stabilize the foreign exchange market and inflation expectations [17]. In 2015–2020, as inflation slowed down, the key rate consistently decreased. However, from March 2021 to April 2022, the regulator raised it from a historical low of 4.25% to 20% to curb the surge in inflation. By the end of 2022, the rate was reduced to 7.5%. In 2023, against the background of slowing inflation, the Bank of Russia continued to ease the MP, reducing the key rate to 7% by the end of the year. In 2024, there was an increase in the key rate of the Bank of Russia, which may be due to a proactive response to inflationary risks in the context of a recovery in economic activity.

The dynamics of key macroeconomic indicators shows a close relationship between inflation, MP and economic activity (*Fig. 2*). During periods of accelerating inflation and tightening MP, real GDP growth rates tended to slow down, and vice versa. Particularly deep declines occurred in 2015 and 2020 (–2% and –2.7%, respectively), which coincided with increased inflation and a sharp tightening of the MP. In 2021–2022, despite the rate increase, GDP grew relatively quickly (by 4.7% and 2.1%) due to the effect of a low base in 2020 and budgetary support for demand in

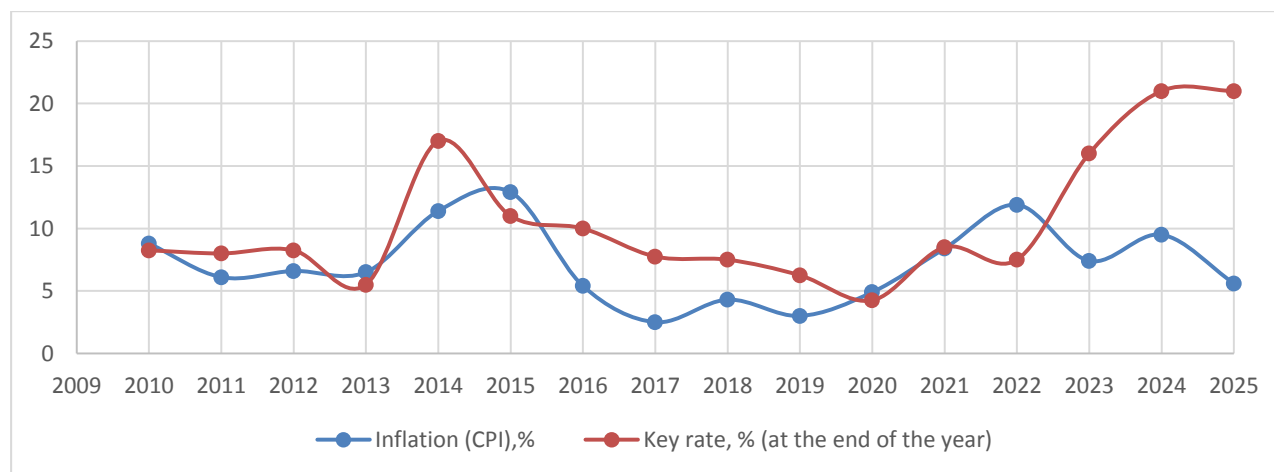


Fig. 1. The Dynamics of Inflation and the Key Rate of the Bank of Russia in 2010–2025, in %

Source: Bank of Russia. URL: <https://www.cbr.ru/statistics> (accessed on 08.07.2026).

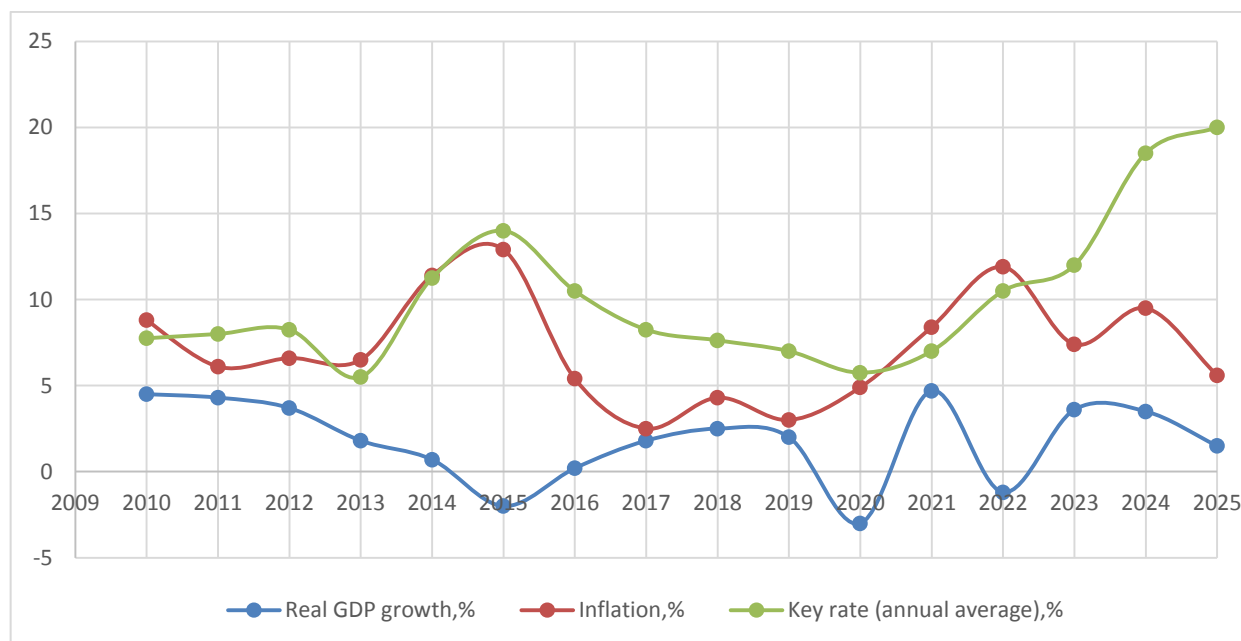


Fig. 2. The Dynamics of Real GDP, Inflation, and the Key Rate of the Bank of Russia, in %, Compared to the Previous Year

Source: Bank of Russia, Rosstat. URL: <https://rosstat.gov.ru/>, <https://www.cbr.ru/statistics> (accessed on 08.07.2026).

2023. GDP growth slowed to 0.8% amid tougher sanctions and economic restructuring. In 2024, GDP growth accelerated to 2.5% as the economy adapted to the new conditions, despite the tightening of the MP, expressed in an increase in the key rate of the Bank of Russia.*

An important transmission channel of MP is the dynamics of lending to the economy.

* The Bank of Russia. Statistics. URL: <https://www.cbr.ru/statistics/> (accessed on 08.07.2026).

When the MP is tightened, credit to the non-financial sector is reduced in real terms, which negatively affects investment activity and GDP growth [18]. For example, in 2015, the volume of loans decreased by 2.5%, while investments in fixed assets decreased by 10.5%. And in 2018–2019, credit growth accelerated to 10–11% in real terms, which supported the dynamics of investment and GDP (Figure 3). In 2020–2021, there was a slowdown in lending activity against the background of the pandemic and the tight-

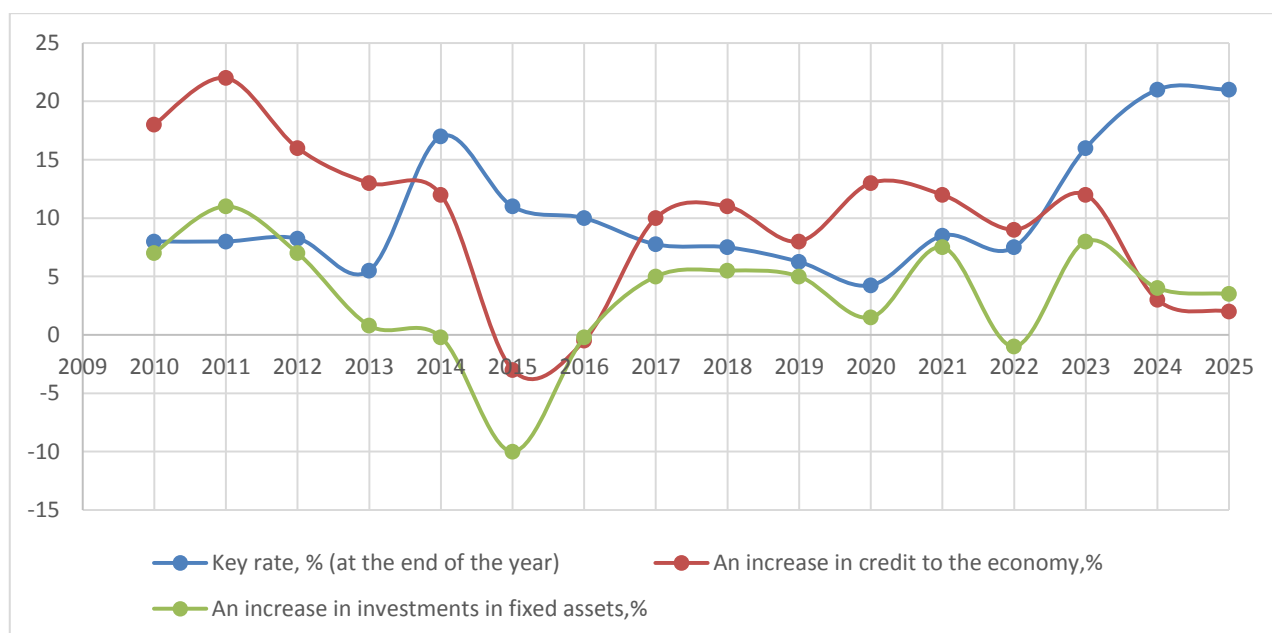


Fig. 3. The Dynamics of the Key Rate, Real Credit to the Economy and Fixed Capital Investment

Source: Bank of Russia, Rosstat. URL: <https://rosstat.gov.ru/>, <https://www.cbr.ru/statistics> (accessed on 08.07.2026).

ening of MP. However, in 2022 Credit growth resumed (by 12.6%), thanks to the regulator's measures to support lending under sanctions. In 2023–2025, there was a gradual normalization of credit dynamics as the economic situation stabilized, despite the tightening of the MP, which resulted in an increase in the key rate (Fig. 3).

In addition to the interest rate channel, the dynamics of loans and investments are influenced by the general level of economic uncertainty and risks. During periods of recession and tightening of monetary policy, banks can tighten non-price lending conditions, reduce limits and require more collateral [15]. This reduces the availability of borrowed resources, even if interest rates remain unchanged.

On the other hand, monetary policy can stimulate lending activity by increasing the money supply and reducing the cost of funding for banks. Through refinancing and asset purchases, the central bank enhances the liquidity of the banking system, thereby expanding opportunities for lending to the economy [16].

However, an overly lenient monetary policy (MP) can lead to excessive credit growth, debt burdens, and asset price inflation, posing risks to financial stability. Central banks should therefore

closely monitor debt indicators and, if necessary, use macroprudential policies to control them.

It's important to note that credit and investment dynamics are influenced not only by monetary factors, but also by other factors such as the overall business environment, institutional quality, property rights protection, etc. MP should therefore be accompanied by structural reforms aimed at improving the investment climate and boosting economic efficiency.

Another channel of MP's influence on economic activity is the exchange rate. In an open economy, an increase in interest rates by the central bank usually leads to a strengthening of the national currency, which reduces inflation by reducing the cost of imports. However, this can negatively affect the competitiveness of domestic producers and the dynamics of net exports, as well as lead to a weakening of the exchange rate, which can accelerate inflation. Conversely, a weaker exchange rate may support growth through import substitution and increased exports, although it can also have negative effects on domestic producers.

In Russia, the role of the currency exchange rate as a transmission channel is significant due to the country's high dependence on exports of raw materials and imports of technology. Fluctuations in oil prices and other Russian export prices

affect the inflow of foreign exchange earnings, business activity levels, budget revenues, and investor sentiment. As a result, the dynamics of the ruble's exchange rate, particularly during times of economic crisis, can significantly impact inflation and GDP growth.

The Bank of Russia has followed a policy of a floating exchange rate since 2014, without setting specific targets for the value of the ruble against other currencies. This allows the exchange rate to fluctuate freely in response to fundamental economic factors. This approach has helped to increase the flexibility and resilience of the Russian economy, making it less vulnerable to external shocks.

At the same time, the central bank reserves the right to intervene in the foreign exchange market if there are threats to financial stability. This means that it can buy or sell foreign currency to influence the exchange rate if necessary.

An important channel of the influence of monetary policy (MP) on economic growth is the dynamics of the exchange rate of the ruble. In the 2010s, there were several episodes of sharp weakening of the ruble, related to falling oil prices and capital outflows, which led to a surge in inflation and forced the Bank of Russia to tighten MP. In 2022, however, the introduction of currency restrictions and an influx of export earnings caused an excessive strengthening of the ruble in real terms, negatively affecting the price competitiveness of sectors of the Russian economy. The volatility of the ruble has decreased slightly in 2023 and 2024, but risks of new shocks remain, and the exchange rate factor continues to be a significant inflation risk and challenge for MP in a small open commodity-based economy like Russia.

In general, it can be stated that the nature of the relationship between inflation, monetary policy and economic dynamics in Russia largely depends on the phase of the business cycle, the external economic environment, and the effects of non-monetary factors. All other things being equal, episodes of accelerated inflation and tighter monetary policy by the Bank of Russia were associated with slower credit and investment activity as well as slower GDP growth. Conversely, periods of softer monetary policy and slower in-

flation were usually accompanied by faster credit growth, investment growth, and aggregate output growth. Next, we will conduct an econometric assessment of the strength and direction of the impact of monetary policy and the key rate set by the Central Bank of the Russian Federation on GDP growth in Russia.

ECONOMETRIC ANALYSIS OF THE IMPACT OF INFLATION AND THE KEY INTEREST RATE ON GDP GROWTH

To assess the quantitative impact of inflation and the Bank of Russia's key rate on GDP growth, we will conduct a regression analysis based on expanded quarterly data for the period 2010–2025. The dependent variable is the growth rate of real GDP compared to the corresponding quarter of the previous year.

(GDP_Gt), and the main explanatory variables are annual inflation. ($INFt$) and the average key rate for the quarter ($KEYRATEt$).

The specification of the evaluated equation has the form:

$$GDP_Gt = \alpha + \beta_1 * INFt + \beta_2 * KEYRATEt + \varepsilon_t.$$

The results of the least squares estimation (taking into account heteroscedasticity and autocorrelation of residuals) are shown in the *Table*.

The estimates show that an increase in annual inflation by 1 percentage point reduces quarterly GDP growth by 0.096 percentage points on average, and an increase in the key rate by 1 percentage point reduces GDP growth by 0.137 percentage points (all other things being equal). The model explains 58% of the variation in the dependent variable. The coefficient for $INFt$ is significant at the 5% level, and the coefficients for $KEYRATEt$ and constant are at the 1% level.

Various nonlinear model specifications were evaluated to determine the optimal levels of inflation and key interest rates in terms of maximizing GDP growth. Parameters were selected using numerical optimization methods, and the results show that all other things being equal, highest GDP growth rates are achieved with an inflation rate in the range 3–4% and a key rate of 5–6% per annum. Deviations of inflation, both up and down, from this range, especially growth

Table

Regression Model Estimation Results

Indicator	Ratio	St.error	P-value
Constant	0.172	(0.002)	***
INF _t	-0.096	(0.015)	**
KEYRATE _t	-0.137	(0.010)	***
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R ²	0.58		

Source: Compiled by the author.

Note: *** – the significance is at the level of 1%, ** – 5%.

above 8%, or falling to negative values, have a negative impact on output dynamics. A too low key rate (below 4%) poses risks to growth due to potential overheating of the economy and imbalances accumulation. In general, these quantitative estimates support the conclusions of theoretical analysis regarding the nonlinear relationship between inflation, the monetary policy rate, and growth, and emphasize the importance of keeping inflation and interest rates within an optimal range.

The estimates obtained are generally consistent with the results of other empirical studies on Russia, which have also revealed a negative relationship between inflation, monetary policy rigidity and economic growth. However, this model does not take into account the effects of other important factors, such as the dynamics of foreign trade, fiscal policy and institutional and structural characteristics of the economy. A more complete analysis would require the construction of multifactorial models.

In addition, the effects of inflation and monetary policy on economic growth can vary depending on the time horizon. Some researchers have noted that a tightening of monetary policy can lead to a temporary slowdown in business activity, but it also contributes to its eventual recovery by reducing inflation and inflation expectations. To estimate these long-term effects, researchers use distributed lag models, vector autoregressions, and other time series analysis techniques.

Another area for further research could be the analysis of the impact of inflation and monetary

policy on the sectoral composition of GDP and its changes over business cycles. The economic sectors are different in their sensitivity to fluctuations in interest rates and exchange rates. For example, the service sector and sectors that are oriented towards the domestic market are more affected by rising interest rates, while industries that export products are more influenced by the dynamics of the real exchange rate of the ruble. This creates conditions for an inter-sectoral redistribution of resources as a result of changes in monetary policy.

Finally, in a further analysis, it would be advisable to pay more attention to the study of coordination mechanisms between monetary policy and other areas of state economic policy, such as fiscal, macroprudential and structural policies. Empirical and theoretical studies have shown that MP efficiency can be significantly increased if it is accompanied by measures to strengthen fiscal discipline, limit systemic risks in the financial sector, improve the business climate and increase market flexibility. Conversely, pursuing a stimulatory fiscal policy or relaxing macroprudential regulations may undermine a central bank's ability to control inflation and ensure financial stability.

There has been a trend in Russia in recent years, to strengthen the coordination between the Ministry of Finance and the Bank of Russia's monetary and macroprudential policies. Both institutions have begun to work more closely together to achieve their inflation and exchange rate goals, aiming to smooth out the effects of fluctuations in oil prices and capital flows. Ad-

ditionally, risk management measures have been implemented in the retail lending sector and in certain markets, such as mortgages and unsecured loans.

However, progress in the structural area has been insufficient, as there are still challenges to diversify the economy, increase its competitiveness, and improve its efficiency.

In recent years, the so-called “fiscal rule” has become increasingly important in strengthening coordination between monetary and fiscal policies. This rule states that any additional oil and gas revenue received at a price above a certain threshold (currently set at \$40 per barrel at 2017 prices, with an annual inflation indexation of 2%) should not be used for current spending, but rather should be directed towards sovereign wealth funds and other long-term investments. Conversely, if prices fall below this threshold, the government should cover the resulting budget deficit by drawing on accumulated reserves rather than issuing government debt or printing money.

This design allows for a countercyclical fiscal policy and reduces the dependence of the domestic economy on fluctuations in the external environment. During times of favorable price movements, the budget rule helps prevent excessive government spending, aggregate demand, and the strengthening of the real exchange rate, making it easier for the central bank to control inflation. In times of crisis, the accumulated reserves allow the government to support the economy without putting excessive pressure on debt markets and interest rates, and without monetizing the deficit through the central bank.

The budget rule was first introduced in Russia in 2004 and has since been modified several times. During periods of crisis, it has been suspended. Currently, after a hiatus between 2015 and 2017, the rule has been reinstated since 2018. This has allowed for the accumulation of significant reserves (approximately 10% of GDP), which has helped mitigate the severity of the economic crisis caused by the pandemic and falling oil prices. This has also allowed the government to provide increased anti-crisis support to the economy without compromising the long-term stability of the budget or the Central Bank’s inflation targets.

Experts note that the availability of budgetary rules is an important factor that complements and enhances the effectiveness of inflation targeting, especially in economies that are heavily dependent on commodities. At the same time, for this policy to be successful, it is crucial that the rules be simple and transparent, ideally codified in law, and not subject to frequent changes by the authorities. If this is not the case, the confidence of economic actors in the policy may be undermined and the stabilizing effect may be diminished.

THE INTERACTION BETWEEN MONETARY POLICY AND BUDGET POLICY

The effectiveness of the monetary policy of the Central Bank of Russia largely depends on its coordination with the budget policy of the government. Inconsistencies between the actions of monetary and fiscal authorities can lead to conflict of goals and conflicting effects on inflation and economic growth.

Recently, Russia has implemented a “budget rule” designed to reduce the dependence of the domestic economy and exchange rate on oil and gas revenue volatility.

However, the effectiveness of budgetary rules has its limitations. Firstly, cutting off additional oil and gas revenue from budget spending constrains the potential growth of the economy, which requires large-scale investments in infrastructure and human capital. Secondly, an irrational budget expenditure structure with a low proportion of productive spending may lead to non-monetary inflation. Thirdly, the inflexibility of the rules limits the government’s ability to support the economy during crises, increasing the costs of the Central Bank’s stabilization policies.

Therefore, to increase the potential for balanced economic growth, it is necessary to fine-tune the entire system of macroeconomic policy, including both monetary and fiscal policies. This involves integrating fiscal mechanisms into the overall strategy of countercyclical regulation, making them more responsive to changing conditions and challenges.

It is important to ensure an increase in productive government spending, an improvement in the business environment, and an increase in

the efficiency of public sector operations, which will strengthen the structural foundations of low inflation. Aligning the budget with the medium-term policy targets is essential to achieving an optimal combination of policy measures and ensuring a stable and sustainable economic recovery.

CONCLUSIONS

The analysis revealed a close correlation between inflation, the monetary policy of the Central Bank of Russia, and the dynamics of real gross domestic product (GDP) from 2010 to 2024. In most instances, when inflation accelerated and the monetary policy tightened through an increase in the key interest rate, economic growth slowed down. Econometric models have confirmed the statistically significant negative impact of both inflation and the key interest rate on GDP growth.

The results obtained allow us to conclude that price stability should be a top priority for the Cen-

tral Bank of Russia to achieve sustainable long-term economic growth. However, MP (monetary policy) should not create excessive fluctuations in interest rates, exchange rates, and money supply, which could destabilize business activity.

It is important that monetary policy is coordinated with other macroeconomic policies, such as budgetary, structural, and macroprudential policies. Inflation targeting should also be accompanied by improvements in institutions and the investment climate [8].

To further analyze the relationship between inflation and economic growth, it would be beneficial to use alternative econometric methods, such as causality analysis, vector autoregressions, and Bayesian models. Additionally, it is important to investigate the impact of different monetary policy transmission channels and their effectiveness, depending on the stage of the business cycle and institutional environment.

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The Persistence of the Food Price Change in Response to Fiscal, Monetary, and Natural Factors' Shocks in Indonesia

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ABSTRACT

The **subject** of the study is the dynamics of food prices and their variations influenced by internal and external factors. This study assesses the impact of rainfall, fuel prices, and interest rates on food price fluctuations and analyzes the relative contributions of these variables. This study **aims** to determine the extent to which internal (intrinsic) factors and external (exogenous) factors contribute to variations of food prices, determine the relative dominance of each factor, and provide policy recommendations to stabilize food prices. This study uses a **method** of the Vector Error Correction Model with exogenous variables (VECMX) to analyze the dynamic relationship between endogenous variables (food inflation) and exogenous variables, such as interest rates, rainfall, and fuel prices. The **relevance** of this study is to provide insight into the factors that influence the dynamics of food prices, which can be used as a basis for formulating a policy of food price stabilization. The **results** showed that the persistence of changes in food prices is relatively high if it is affected by shocks from fiscal policy factors, monetary policy, and natural factors. The average food price change takes about 20–30 months to return to its natural value (new equilibrium) after receiving a shock. Most variations in food prices (more than 70%) are influenced by internal factors. After a certain period, the impact of fuel prices becomes more dominant than rainfall and the benchmark interest rate has the least effect.

Keywords: food price; rainfall; fuel price; interest rate; vector error correction; exogenous variables; internal factors; persistence

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INTRODUCTION

The world is being overshadowed by the economic slowdown and global uncertainty. The movement of world food commodity prices has become increasingly volatile over the past two decades. This situation can, of course, lead to inflation on the global scale, including in Indonesia. Factors such as natural disasters, uncertain weather and climate conditions, exchange rate volatility, shifts in supply and global demand (for example as a result of policy changes), can affect food price fluctuations [1, 2]. *Figure 1* shows the increase in the world food price index from 2002 to 2008, with a very intense market instability beginning in 2006. Significant increase in food prices occurred in 2007–2008, due to very high oil prices in this period. The surge in global food prices then occurred again in 2010–2011, one year after the global surge in 2007–2008 due to the La Nina phenomenon, which disrupted food production in many countries. The price of food commodities rose again in 2016–2017 and even a surge in global food prices returned in 2020–2022 when COVID-19 pandemic occurred.

One of the main reasons for the increase in food prices is cost push inflation. Cost-push inflation occurs when production the costs increase so as to encourage producers to increase the price of food products. One of the main factors that can cause an increase in food production costs is the availability of limited food agriculture supply [3]. Limited food supply can be caused by various factors including natural disasters, disruption of distribution, and rising agricultural input costs. Natural disasters such as drought, floods, storms or bad weather can damage crops and disrupt agricultural production, reduce the availability of food supply and encourage price increases. Disruptions in supply chains, such as transportation or distribution issues due to limited infrastructure, can hamper food movements from producers to consumers, causing scarcity and price increases. Increased energy costs can raise the cost of agricultural production, including transportation and operational costs, which can then encourage an increase in food prices. The increase in labor costs, whether due to a rise in wages or changes in labor regulations, can also lead to an increase in the cost of agricultural production and eventually an increase in food prices. The increase in fertilizer prices, pesticides, and seeds can also increase production costs, which can then be reflected in the increase in the selling price of food products [4].

Figure 2 shows that the consumer price index curve (CPI) for food is more volatile than the general CPI curve and the average of non-food CPI in the last three years. This can indicate that demand for food has been higher than demand for non-food items. If food demand increases faster than product and service demand in gen-

eral, the price of food may experience more pressure to rise, which can cause food inflation that is higher than general inflation. In addition, this indicates that food price fluctuations have a greater impact on general inflation, because the food sector has a greater weight in the calculation of general inflation than the non-food sector. Food inflation can be an important factor in determining changes in general inflation, because high food prices or significant price volatility can put a large pressure at the inflation rate in Indonesia. Based on *Fig. 2*, the consumer price index curve (CPI) for food is more fluctuating than the general CPI curve in the last three years. This can indicate that demand for food is higher than non-food. If food demand increases faster than product and service demand in general, the price of food may experience more pressure to rise, which could cause food inflation that is higher than general inflation. In addition, this indicates that food price fluctuations have a greater impact on general inflation, because the food sector has a greater weight in the calculation of general inflation than the non-food sector does.

Based on data from the Central Statistics Agency (BPS), the food, beverages and tobacco sectors, it have contributed the most to national inflation over the last four months of 2023 in a row. Specifically, in September, October, November, and December 2023, each amounting to 1.08 percent, 1.39 percent, 1.72 percent, and 1.60 percent. This significant contribution from the food sector shows that food commodities play a very important role in the dynamics of inflation in Indonesia. Among various food products, rice is the main commodity that has a big influence on national food prices. The price of rice, which is a product of rice, is one of the most sensitive factors in influencing inflation because rice is the staple food for most Indonesians. The price increase in food commodities will immediately have an impact on increasing the cost of living of the community and encouraging overall inflation. Therefore, the stability in food prices is the key to controlling inflation in Indonesia.

Food prices change is influenced by various factors, including climate shocks, fuel prices, and interest rates [5, 6]. These three factors interact with each other in influencing food supply and demand. Climate, especially rainfall, plays an important role in food production, particularly in agrarian countries like Indonesia. The agricultural sector is very dependent on weather patterns, and significant changes in rainfall both in the form of drought and flooding can interfere with the process of production and distribution of food. For example, a long drought can cause crop failure, while excessive rainfall can damage plants or inhibit harvest activity. This condition increases production costs and lowering food supply, which ultimately encourages an increase in food prices. In addition, rainfall shock can also worsen the vulner-

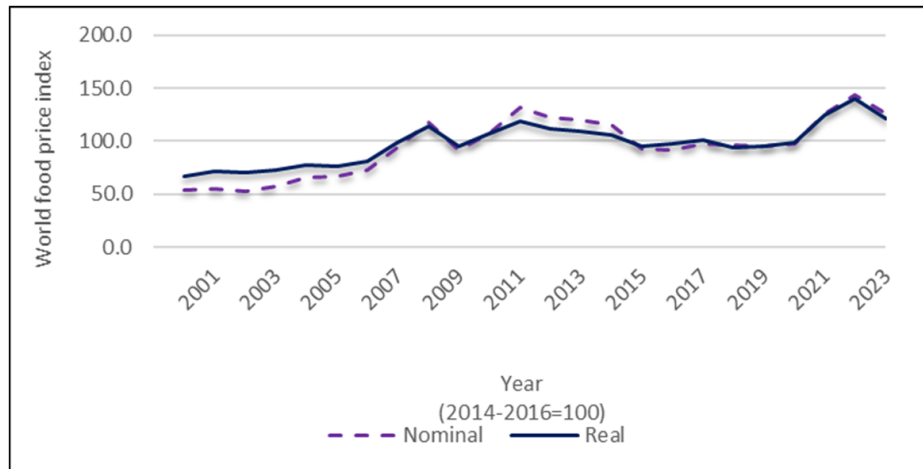


Fig. 1. World's Food Price Index 2000–2023

Source: FAO (2023), processed.

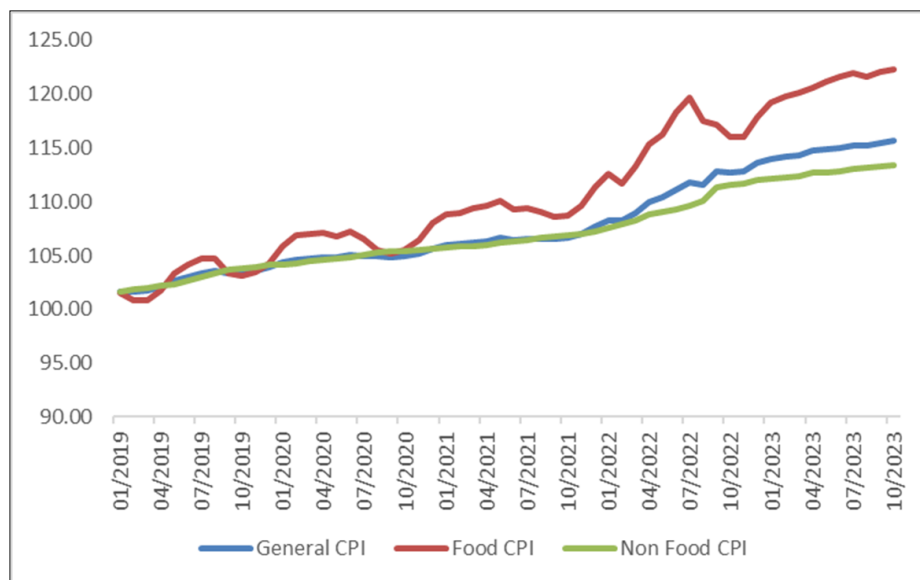


Fig. 2. Indonesia's General CPI, Non-Food CPI, and Food CPI

Source: BPS (2023), processed.

ability of food supply chains, especially in areas that are already geographically vulnerable. Global climate change further aggravates the volatility of rainfall, making the prediction of weather patterns more difficult. This adds to the challenges in maintaining food price stability and strengthening the urgency to understand the relationship between rainfall shock and food prices. The second factor is the price of fuel, which is one of the main factors that affect food prices, both directly and indirectly. In the agricultural sector, fuel is used to run agricultural machines, harvest transportation, and other logistics operations. When the price of fuel increases, the cost of food production and distribution also rises, this then translates into higher prices for consumers. In addition, the increase in fuel prices often triggers the domino effect on other commodity prices, including fertilizers and pesticides which also use fuel as production inputs.

This condition creates additional pressure on farmers, which in turn has an impact on the selling price of food products. Therefore, fluctuations in fuel prices become important variables that need to be considered in food price change analysis. The third factor is the interest rate which is a monetary policy tool used by the central bank to control inflation, including food inflation. When interest rates are raised, loan costs increase, which can reduce consumption and investment. However, in the context of food inflation, the influence of interest rates is not always direct. For example, high interest rates can hamper farmers' access to financing, thereby limiting their ability to increase production. As a result, the food supply can decrease, which has the potential to increase food prices. On the other hand, low interest rates can encourage food consumption and demand, which if not balanced by an increase in supply, can cause price surges.

Thus, the relationship between interest rates and food prices is complex that requires in-depth analysis to understand its dynamics.

Referring to the phenomenon of increasing the fluctuations of food, beverages, and tobacco prices in several provinces in Indonesia, this study begins with the question of how long the level of food price to return to the balance position after fluctuations due to shocks from fiscal policy, monetary policy, and natural factors. The persistent food price indicates that the food price symptoms are not only temporary but can persist for a longer period of time. The persistence of food price that measures the speed of price to return to the balance position after experiencing shocks into an indicator of prolonged fluctuations or not. The results of previous studies showed differences in the level of food inflation persistence. Several studies in Indonesia show that the level of food inflation persistence is still high compared to other types of inflation, such as persistence of non-food inflation, general inflation persistence, administered inflation persistence, and the persistence of core inflation [7, 8]. Several studies abroad also show that food inflation persistence always ranks the highest compared to the persistence of other group inflation, such as the research conducted by [9] which shows that the persistence of food inflation is higher than the persistence of headline inflation and the persistence of core inflation in Pakistan. The research conducted by [10] shows the result that food inflation persistence is always higher than the persistence of non-food inflation, general inflation and core inflation in India. This shows that food price fluctuations tend to have a longer or more sustainable impact in the economy compared to general price fluctuations or core price fluctuations. Unlike some of the studies above, research conducted by [11, 12] showed that the level of persistence of food inflation and volatile food in Indonesia was lower than the persistence of other group inflation. In other words, price changes in food groups tend to have more impacts while compared to other inflation groups such as core inflation or headline inflation.

LITERATURE REVIEW

Inflation persistence is the speed convergence of inflation to balance aftershocks, so it can be said that inflation persistence is a measure of the inflation rate to return to the balance position after shocking. Inflation persistence is a phenomenon when inflation does not directly return to its natural value in the event of a shock [13, 14]. The faster the inflation rate to return to the balance point, the lower the level of persistence of the inflation. Conversely, the longer the level of inflation to return to the balance point, the higher the level of persistence of the inflation. If inflation persistence is high, the response to inflation shocks is long-term and

difficult for the central bank to control. On the contrary, if the persistence of inflation in the country is low, the central bank can maintain the inflation rate in accordance with the target of inflation [15]. Inflation persistence is said to be high if the coefficient is close to 1. Previous research states that there are three types of inflation persistence, namely the positive serial correlation of inflation, the slow systematic monetary policy actions and the impact (its peak) to inflation, and the slow response of inflation to non-systematic policy actions [16]. Understanding of inflation persistence is very important to improve inflation forecasting capabilities, providing clarity on the dynamic effects of exogenous variable prices, providing information to improve monetary policy, and evaluate whether different monetary policy regimes will produce different levels of persistence [17].

A previous study by the univariate autoregressive approach states that the persistence of inflation in the food ingredients and the food group, beverages, cigarettes & tobacco in West Papua in the period from January 2013 to June 2017 was very persistent [18]. The time needed by inflation in the group of foodstuffs and food groups, drinks, cigarettes and tobacco to return to their natural values is about 16 months and 33 months respectively. Research by [19] using the univariate autoregressive approach concluded that Kediri had the lowest degree of persistence and average food inflation compared to the cities of Surabaya, Malang, and Jember during the 2013–2017 period. Surabaya and Jember are the cities that need the most attention to the food sector because of the degree of persistence and the average inflation rate was higher than the two other cities in East Java. The results of this study are supported by research [11] which states that commodities with high persistence values in Surabaya are dominated by volatile food and controlled-price commodities. While the cause of the high persistence of inflation in Surabaya is caused by a combination of backward-looking inflation expectations and is dominated by forward-looking inflation expectations. Research conducted by [7] found a high degree of persistence in behavior, especially in core inflation, administered inflation, and volatile food inflation, following the application of flexible Inflation Targeting Framework (ITF) policies in Indonesia. The time needed for inflation to return to balance is between 1 to 8 months for each group. These results indicate that it is important for authority in improving their policies. Structural improvements are needed through monetary policy based on inflation expectations, increased transparency of food prices, and synergies.

Some previous research results recommend the development of national food security policies that consider environmental, agriculture, monetary, and adminis-

tered prices factors to stabilize food prices. The results of research conducted by [20] and [21] concluded that there is a significant relationship between food prices and climate change. Other results of previous studies have shown that a decrease in crop production due to climate change has a greater impact on the increase in food prices compared to increasing plant production. Climate change tends to put negative pressure on the food system, especially when crop production is reduced. Studies that report a decrease in crop production due to climate change so that food prices increase, were stated by [22–30]. Conversely, studies that reported increases in crop production due to climate change so that food prices fall, concluded by [31, 32].

The increase in fuel prices can lead to an increase in the cost of the company's production in various economic sectors, especially those sectors that are very dependent on fuel such as the transportation, manufacturing and agriculture industries. Companies will reduce their production due to higher production costs. This leads to a shift in the aggregate supply curve to the left and causes a decrease in economic output. The impact of lower aggregate supply in facing the same level of demand is an increase in aggregate prices in the market. The results of the research conducted by [6] show a causal relationship with a long-term direction between oil prices (energy) and food prices. According to the supply-side theory, higher crude oil prices increase production costs and cause the supply curve to shift to the left, resulting in higher food prices. In line with the theory of the demand side, higher energy prices increase the demand for energy plants, which causes an increase in the area of land planted. Thus, the price of grain increases due to reduced production. However, [33] argues that oil prices have no significant influence on food prices in the European Union. This is evidenced by the high level of significance of the constant which shows that the model does not capture several variables or information. Previous research has also found no significant effect between the price of crude oil on the price of local rice in Indonesia [34]. This shows that Indonesian local food commodities are strongly influenced by domestic demand and supply factors. The price of rice in Indonesia is closely monitored by the government because the fluctuations in commodity prices can affect the welfare of the community.

The increase in agricultural credit interest rates will have an impact on increasing the cost of agricultural production and increasing food inflation. On the other hand, if there is a pressure, then interest rate increases are carried out to reduce consumption and reduce prices so that inflation can be controlled. Research by [35–37] shows a substantial correlation between interest rates and food prices. According to [35], interest rates and the price of agricultural commodities have a substantial cor-

relation each other and a U-shaped relationship between them. The researchers concluded that if the interest rates rise, then the price of food is likely to also rise. Research conducted by [38] has also found a positive relationship between inflation and interest rates. Unlike the results of this research, other research conducted by [39] found that interest rates had a negative and significant effect on inflation in Indonesia from January 2013 to November 2017. When interest rates rise by 1%, inflation drops by 0.21% in the short term. In the long run, when interest rates have risen by 1%, inflation dropped by 6.95%. A previous study also stated that an increase in 1% at the previous year's inflation rate caused this year's interest rate to fall by 0.07188% [40].

DATA AND METHODOLOGY

This section explains the data and methodologies used in this study for identification and quantification.

Data and Source

The data used are monthly time series data for the period from January 2018 to December 2023. Data of food inflation, fuel prices, interest rates, and rainfall variables were obtained from the Central Statistics Agency of Indonesia (BPS), the Bank of Indonesia (BI), and the Meteorology, Climatology, and Geophysics Agency (BMKG). All the variables were transformed into the form of natural logarithms to ensure the stability of variance and facilitate the interpretation of elasticity.

Data Analysis: The VARX/VECMX Model

This study uses the Vector Autoregressive with Exogenous Variables (VARX) model or the Vector Error Correction Model with Exogenous Variable (VECMX) to analyze the dynamic relationship between endogenous variables (food inflation) and exogenous variables (interest rates, rainfall, and fuel prices). Vector Autoregressive (VARs) are models by inserting exogenous variable vectors are called Vector Autoregressive with Exogenous variables (VARXs) [41]. The VARX model modeling short-term relationships through variable differentiated and long-term relationships through ECT. All variables remain included as endogenous variables to ensure that the two-way relationship between these variables is handled correctly. Variables such as *IR*, *FP*, and *CR* are included as endogenous variables in the VARX/VECMX model to prevent endogeneity. This is done because these variables have the possibility of a two-way relationship with the *CPI*. The VARX/VECMX model requires that all variables that influence each other to be included as endogenous variables. Prevent bias from omitted variable bias and reversal causality. Ensure the validity of the parameter estimation in the model. Thus, the model used will be more accurate and can provide

a more precise interpretation of the relationship between the CPI , IR , FP , and CR . The general form of VARX (p, q) by inserting exogenous variables as follows.

$$\begin{aligned}CPI_t &= \mu + \sum_{i=1}^p \alpha_i \cdot CPI_{t-i} + \sum_{j=1}^q \beta_j \cdot IR_{t-j} + \sum_{j=1}^q \gamma_j \cdot CR_{t-j} + \sum_{j=1}^q \delta_j \cdot FP_{t-j} + \epsilon_t, \\IR_t &= \mu + \sum_{i=1}^p \alpha_i \cdot IR_{t-i} + \sum_{j=1}^q \beta_j \cdot CPI_{t-j} + \sum_{j=1}^q \gamma_j \cdot CR_{t-j} + \sum_{j=1}^q \delta_j \cdot FP_{t-j} + \epsilon_t, \\CR_t &= \mu + \sum_{i=1}^p \alpha_i \cdot CR_{t-i} + \sum_{j=1}^q \beta_j \cdot CPI_{t-j} + \sum_{j=1}^q \gamma_j \cdot IR_{t-j} + \sum_{j=1}^q \delta_j \cdot FP_{t-j} + \epsilon_t, \\FP_t &= \mu + \sum_{i=1}^p \alpha_i \cdot FP_{t-i} + \sum_{j=1}^q \beta_j \cdot CPI_{t-j} + \sum_{j=1}^q \gamma_j \cdot IR_{t-j} + \sum_{j=1}^q \delta_j \cdot CR_{t-j} + \epsilon_t.\end{aligned}$$

If the cointegration exists, then a Vector Error Correction Model with Exogenous Variables (VECMX), can be estimated, which combines levels and differences. This can be done instead of using a VARX model in levels. The VECMX (p, q) regression equation is given by:

$$\begin{aligned}\Delta CPI_t &= v + \rho \cdot ECT_{t-1} + \sum_{i=1}^p \theta_i \cdot \Delta CPI_{t-i} + \sum_{j=1}^q \phi_j \cdot \Delta IR_{t-j} + \sum_{j=1}^q \varphi_j \cdot \Delta CR_{t-j} + \sum_{j=1}^q \Psi_j \cdot \Delta FP_{t-j} + \epsilon_t, \\\Delta IR_t &= v + \rho \cdot ECT_{t-1} + \sum_{i=1}^p \theta_i \cdot \Delta IR_{t-i} + \sum_{j=1}^q \phi_j \cdot \Delta CPI_{t-j} + \sum_{j=1}^q \varphi_j \cdot \Delta CR_{t-j} + \sum_{j=1}^q \Psi_j \cdot \Delta FP_{t-j} + \epsilon_t, \\\Delta CR_t &= v + \rho \cdot ECT_{t-1} + \sum_{i=1}^p \theta_i \cdot \Delta CR_{t-i} + \sum_{j=1}^q \phi_j \cdot \Delta CPI_{t-j} + \sum_{j=1}^q \varphi_j \cdot \Delta IR_{t-j} + \sum_{j=1}^q \Psi_j \cdot \Delta FP_{t-j} + \epsilon_t, \\\Delta FP_t &= v + \rho \cdot ECT_{t-1} + \sum_{i=1}^p \theta_i \cdot \Delta FP_{t-i} + \sum_{j=1}^q \phi_j \cdot \Delta CPI_{t-j} + \sum_{j=1}^q \varphi_j \cdot \Delta IR_{t-j} + \sum_{j=1}^q \Psi_j \cdot \Delta CR_{t-j} + \epsilon_t.\end{aligned}$$

where CPI_t is food inflation vector; IR_t is interest rate vector; CR_t is climate-rainfall vector; FP_t is fuel price vector; α_i is parameter matrix sized $p \times p$ for each $i = 1, 2, \dots, p$; v and μ are vectors of constants; $\beta_j, \gamma_j, \delta_j, \phi_j, \varphi_j$ and Ψ_j are parameter matrix sized $q \times q$ for each $j = 1, 2, \dots, q$; ρ is speed of adjustment; ECT_{t-1} (Error Correction Term) is the lagged value of the residuals obtained from cointegrating regression of the endogenous variable on the regressors. It contains long-run information derived from the long-run cointegrating relationships; ϵ_t and ϵ_t are residual vectors.

The persistence of food inflation illustrates how long the influence of shocks or changes on certain factors on food inflation lasted over time. These models make it possible to include exogenous variables, namely fiscal policy (fuel price), monetary policy (interest rates), and natural factors (climate-rainfall) that can affect inflation directly or indirectly. VARX/VECMX can help identify how the response of inflation to shocks or changes in these exogenous variables develops within a certain period of time, which can be interpreted as a form of persistence. The stages carried out when estimating data with VARX/VECMX including stationary data test (unit root test), determination of the optimum lag (lag length criterion), VAR stability test, causality test, cointegration test, VARX/VECMX estimation, analysis of Impulse Response Function (IRF), and Forecast Error Variance Decomposition (FEVD).

In the range of data (72 months) in Indonesia experienced a large crisis during the pandemic in the first months of 2020. The crisis is estimated to have had a significant impact, causing break points on the data chart. Structural break testing in this study uses the Chow Test. If the results are significant, then a dummy variable is added to express the event of the crisis due to the pandemic.

EMPIRICAL RESULTS

Descriptive Statistics

Descriptive analysis in this study aims to provide a general picture of the characteristics of the main variable data used. These variables include benchmark interest rate (IR), fuel price index (FP), rain climate indicator (CR), and consumer price index for food (CPI). Table 1 presents basic descriptive statistics for each variable, including average, median, maximum and minimum values, standard deviations, and distribution sizes such as skewness,

Table 1

Descriptive Statistics

Measure	IR	FP	CR	CPI
Mean	4.727431	124.9926	7.995919	109.3491
Median	4.75	103.665	8.123431	108.27
Maximum	6	211.92	13.8172	125.1
Minimum	3.5	62.76	1.327283	97.85416
Std. Dev.	0.9766928	46.37254	2.860279	7.674339
Skewness	-0.0229727	0.7256736	-0.252708	0.3962325
Kurtosis	1.400127	1.963012	2.491046	1.972901
Shapiro-Wilk	2.515	5.020	0.078	3.006
Shapiro-Francia	2.152	4.547	-0.269	2.585
Observations	72	72	72	72

Source: Authors' estimation derived from research data.

Note: IR – Interest Rate, FP – Fuel Price Index, CR – Climate-Rainfall, CPI – Food Consumer Price Index.

kurtosis, and normality tests using the Shapiro-Wilk and Shapiro-Francia tests. In addition, the number of observations for each variable is also included to ensure adequate data representation. The results of this analysis will be the basis for understanding the patterns and nature of the data before conducting further analysis.

The average benchmark interest rate is 4.73%, indicating that interest rates in the entire observation period were relatively stable around this value. The median which is almost the same as the mean (4.75%) shows that the distribution of interest rate data tended to be symmetrical without a significant outlier. Relatively low standard deviation (around 0.98%) shows that interest rate data is not very volatile and tends to gather around the average. Interest rate data is not normally distributed, but the skewness and kurtosis are low, so it can be assumed that the data is quite close to the normal distribution for most analysis. Meanwhile, the median of the fuel price index, which is lower than the mean shows that the distribution of data has a positive slope (positive skewness). A high standard deviation (around 46.37) shows that the fuel price index data varies greatly. This distribution tends to be leptokurtic and has a positive slope. In descriptive statistics of CR, the average rainfall climate indicator is 7.996, which may represent the average amount of rainfall in certain units (mm per month). Relatively low standard deviation (around 2.86) shows that rainfall data tends to be not too fluctuating. This distribution tends to be leptokurtic and has a negative slope. Finally,

in the descriptive of CPI statistics, the median of the consumer price index for food is lower than its mean. The maximum value is 125.1, while the minimum value is 97.85416. This range shows variations that are in the consumer price index for food. The Shapiro-Wilk and Shapiro-Francia tests show that the data in general are not normally distributed. Therefore, the data should be transformed into the natural logarithm form.

Unit Root Test

Stationary data test (unit root test) is needed to determine the form of the VARX/VECMX model that will be used in the study. The existence of non-stationary variables in the VARX/VECMX system is important to observe because it can increase the possibility of cointegration relationship. This study uses an Augmented Dickey-Fuller (ADF) test because the ADF test is a popular method for testing stationary but it has weaknesses such as excessive sensitivity. The advantage of the ADF test is that it can overcome the problem of autocorrelation and correlation serials, provide critical values for significant testing, and is flexible because it can handle trends, intercepts, or a combination of both [42, 43].

The ADF value presented in Table 2 is significant at the difference level, indicating that the variables become stationary after the first difference. The PP value is also significant at the first difference level, the results that are consistent with the ADF test. This confirms that the variables are stationary after the first differencing.

Table 2

Unit Root Test

Variable	Ln IR	Ln FP	Ln CR	Ln CPI
Level				
ADF	-0.309	-0.868	-3.263**	0.400
PP	-0.896	-0.912	-3.571 ***	0.174
First Difference				
ADF	-4.557***	-6.668***	-8.648***	-5.566***
PP	-4.615***	-6.692***	-8.643***	-5.543***

Source: Authors' estimation derived from research data.

Note: $p < 0.01$ ***; $p < 0.05$ **; $p < 0.1$ *. IR – Interest Rate, FP – Fuel Price Index, CR – Climate-Rainfall, CPI – Food Consumer Price Index.

Determination of Optimal Lag

Another important thing in the estimation of the VARX/VECMX model is the determination of the optimal lag in the model system. An optimal lag is needed in order to capture the effect of each variable on other variables in the model system. The optimal lag is determined by observing the smallest Final Prediction Error Criterion (FPE), the Akaike Information Criteria (AIC), the Schwarz Criterion (SC), and the Hannan-Quinn Information Criterion (HQ).

Based on the results of the lag length analysis criteria as shown in Table 3, lag order 2 is optimal for the model. The model will include two lags for each variable in the system. Using the optimal lag order, the model will be more stable, efficient, and easily interpreted for further analysis, such as IRF and Variance Decomposition.

VAR Stability Test

In this section, the VAR model stability testing steps will be discussed, the interpretation of the stability test results, and the implication of the reliability of the model in explaining the dynamics of the interaction between food prices, rainfall, fuel prices, and benchmark interest rates. This test is also the basis to ensure that the conclusions drawn from the FEVD and IRF analysis have strong statistical validity.

Table 4 above lists the modulus values of the roots of these characteristics. The polynomial in the food price model ranges from 0.795302 to 0.975790. These results show that all the modulus values of the root of the characteristic polynomial are less than one, therefore, the model can be said to be stable.

The Granger Casualty Test

The next stage is the Granger causality test. The Granger causality test is a statistical method used to determine if an exogenous variable can predict changes in the endogenous variable better than only using the lag values from the endogenous variable only. If the exogenous variable has additional information that is useful in predicting endogenous, it is said that exogenous “Granger causes” endogenous, so do the opposite.

Table 5 shows that all pairs of variables (CPI–IR, CPI–FP and CPI–CR) show bilateral causality (bidirectional), meaning that each variable affects each other in the VAR model. The benchmark interest rate can be used by the central bank to control inflation, while food inflation can be an important factor in monetary policy. The price of fuel is also very influential on food inflation, and

Table 3

Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	HQ	SC
0	137.8963	NA	1.78e-07	-4.190202	-3.915733	-4.082438
1	440.6375	546.8873	1.72e-11	-13.43992	-12.61651*	-13.11663
2	465.0777	40.99658*	1.32e-11*	-13.71218	-12.33984	-13.17337*
3	476.6765	17.95943	1.55e-11	-13.57021	-11.64893	-12.81587
4	490.7748	20.01042	1.71e-11	-13.50886	-11.03864	-12.53899
5	507.0190	20.96031	1.80e-11	-13.51674	-10.49758	-12.33134
6	521.0649	16.31138	2.10e-11	-13.45371	-9.885611	-12.05278
7	545.8632	25.59819	1.81e-11	-13.73752	-9.620487	-12.12107
8	567.3910	19.44447	1.83e-11	-13.91584	-9.249866	-12.08386
9	586.2184	14.57609	2.17e-11	-14.00705	-8.792135	-11.95954

Source: Authors' estimation derived from research data.

Note: Sign * indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: the Akaike information criterion; SC: the Schwarz information criterion; HQ: the Hannan-Quinn information criterion.

Table 4

VAR Stability Test

Root	Modulus
0.975790	0.975790
0.838806	0.838806
0.780557-0.152432i	0.795302
0.780557 + 0.152432i	0.795302

Source: Authors' estimation derived from research data.

vice versa. This is relevant because logistics costs and food production are influenced by fuel prices. Likewise, rainfall can affect agricultural production and food inflation. Food inflation can also affect consumption patterns which then affects other economic activity.

Structural Break Test

Data series used in the 72-month span of time may be possible for the influence of the extreme macroeconomic policy or conditions in that time span. As explained in the previous section, the cyclical influence of extreme macroeconomic policies or conditions during that time is a crisis due to the Covid-19 pandemic which began in the first month of 2020.

Structural break testing using the Chow test showed a shock period that significantly affected the first month of 2020 (2020M01) with a significance level of 1% indicated by the probability value of 0.0000 and a F statistical value of 63.47. This means that the zero hypothesis decreases and there is a structural break in that period. Thus, the dummy variable is used in this study as a representation of the influence of the COVID-19 pandemic (*D_CVD*) crisis. Value 0 is given in the 2018M01–2019M12 period, and the value 1 is assigned for the period from 2020M01 to 2023M12.

Cointegration Test

This study uses Johansen's cointegration test to check whether the variables have a long-term relationship [44]. The Johansen test has two types of testing namely trace test and the maximum eigenvalue test. The Trace test is a test to measure the total number of cointegration relationships. Maximum eigenvalue test is a test used to measure the relationship of the cointegration individually. Both of these tests are almost equally strong, but in some situations, the trace test is stronger (more accurate). Therefore, it is recommended to use both of these two tests together to get more reliable results. However, if the condition is possible, the trace test can be used [45]. The final decision regarding the number of cointegration relationships is usually based on trace statistics, because this test is stronger in detecting overall cointegration relationships.

Based on the trace and maximum test of the *Table 6*, the "None" hypothesis is not rejected, meaning that there is at least one cointegration relationship. The null hypothesis (at most 1) is also rejected, meaning that there are more than one cointegration. The null hypothesis (at most 2) is rejected, meaning that there are more than two cointegration relationships. The null hypothesis (at most 3) is accepted, meaning that there are 3 cointegration relationships. Johansen's cointegration test results show cointegration relationship between variables in the model, so the VECMX model is more appropriate because it can capture long-term relationships through the mechanism of error correction.

VECMX Estimation

This section discusses VECMX estimates to analyze long-term and short-term relationships between variables, as well as error correction mechanisms that return

Granger Casuality Test

Granger Casuality	Chi2	Prob>Chi2	Direction of Causality
CPI does not Granger cause IR	7.166	0.0074	Unidirectional
IR does not Granger cause CPI	0.97	0.325	
CPI does not Granger cause FP	2.164	0.1413	Unidirectional (sig. level 10%)
FP does not Granger cause CPI	3.37	0.067	
CPI does not Granger cause CR	8.44	0.0037	Bidirectional
CR does not Granger cause CPI	4.02	0.045	

Source: Authors' estimation derived from research data.

Note: *IR*-Interest Rate, *FP*-Fuel Price Index, *CR*-Climate-Rainfall, the *CPI*-Food Consumer Price Index.

Table 5

Table 6

Johansen Tests for Cointegration

Hypothesized No. of CE(s)	Eigen value	Trace		Maximum Eigenvalue	
		Statistics	0.05 CV	Statistics	0.05 CV
None*	0.293031	53.02828	40.17493	23.92698	24.15921
At most 1*	0.198809	29.10130	24.27596	15.29425	17.79730
At most 2*	0.158315	13.80704	12.32090	11.89214	11.22480
At most 3	0.027371	1.914900	4.129906	1.914900	4.129906

Source: Authors' estimation derived from research data.

the system to balance. This approach is relevant to understand the dynamic interactions between food prices, rainfall, fuel prices, and benchmark interest rates.

Table 7 shows the estimated results of the VECMX of $D(LN_CPI)$ which divides the effect into two main parts namely short-run and long-run. In the short term, an increase in food prices in the previous one month (CPI_{t-1}) significantly affects food price this month (CPI_t). While interest rates (IR), fuel prices (FP), and rainfall (CR) do not have a significant impact in the short term. In the long run, statistically significant increase in interest rate is related to a decrease in food prices. This finding is in line with [46], who found that Bank Indonesia's interest rate has a significant negative effect on inflation in the long run, suggesting that monetary policy instruments remain effective in curbing price pressures in Indonesia even though their transmission may not be immediate. This result is also consistent with the work of [47], who applied a Vector Error Correction Model to inflation, the BI rate, and deposit interest rates in Indonesia and found that changes in the BI rate significantly influence inflation fluctuations, confirming the long-term linkage between monetary policy instruments and price dynamics as observed in this study.

Impulse Response Function (IRF)

Impulse Response Function (IRF) analysis is used to see the response of food inflation to a standard deviation of interest rates, rainfall, and fuel prices, as well as to measure the persistence of these impacts. By using IRF, we can find out the amount of food price index response to a standard deviation, the duration and persistence of the impact of the shock, and the policy implications that can be designed for mitigation of negative impacts [48].

Figure 3 shows a dynamic response from the price of food (LN_CPI) to the food price shock (LN_CPI) itself.

In period 1, when there was a standard shock 1 deviation with food prices, the direct food prices increased by 0.00689 units. In the third period, the response decreased and then returned to rise in the 10th period. In the 10th period and so on, the response slowly increased until it reached a new equilibrium at 0.0088. This shows that changes in food prices have a direct and persistent effect on themselves. Food prices tend to increase stable stable and reach a new balance after around 20–30 months after-shock from themselves.

The upper right graph shows the dynamic response of the price of food (LN_CPI) to a 1 standard deviation shock in rainfall (LN_CR). The initial response to rainfall was 0. After several periods, the response increases gradually until the fourth period. The response reached its peak around the fourth period of 0.003651, then it slowly decreased. This shows that rainfall has a positive but indirect impact on food prices. The effect is visible after several periods. A shock in rainfall can lead to temporary imbalances (for example, floods that damage agricultural land), so that food prices to rise. Food prices tend to be stable and reach new equilibrium after around 25–30 months after rainfall.

The lower left graph shows the dynamic response of food prices (LN_CPI) to shocks of 1 standard deviation at BBM Prices (LN_FP), the initial response to the price of food to the price of fuel prices is 0.000000. This can be caused by lag (delay) in the transmission mechanism from fuel prices to food prices. In the second period and so on, the response increased slowly until it reached a new equilibrium of 0.0038. Food Prices (LN_CPI) go to new equilibrium after around 20–30 periods after the shock to fuel prices (LN_FP).

The lower right graph shows the dynamic response of the price of food (LN_CPI) to a shock of 1 standard deviation in the BI benchmark interest rate (LN_IR). In the initial period, the response of food prices to the

Table 7

VECMX Estimation

Variables	Short-Term		
	Coefficient	Std. Err	t-Statistics
CointEq1	-0.004217	0.00462	-0.91212
CointEq2	0.002813	0.00280	1.00447
CointEq3	0.000679	0.00469	0.14490
D(LN_CPI(-1))	0.335103**	-0.13231	2.53267
D(LN_CPI(-2))	-0.104254	-0.13907	-0.74963
D(LN_IR(-1))	-0.002301	-0.02965	-0.07761
D(LN_IR(-2))	0.006724	-0.02897	0.23210
D(LN_FP(-1))	0.010189	-0.01155	0.88194
D(LN_FP(-2))	0.013748	-0.01122	1.22481
D(LN_CR(-1))	0.002805	-0.00293	0.95717
D(LN_CR(-2))	0.002889	-0.00307	0.94164
Variables	Long-Term		
	Coefficient	Std. Err	t-Statistics
LN_IR(-1)	-2.782677***	0.13622	-20.4274

Source: Authors' estimation derived from research data.

Note: $p < 0.01$ ***; $p < 0.05$ **; $p < 0.1$ *. IR – Interest Rate, FP – Fuel Price Index, CR – Climate-Rainfall, CPI – Food Consumer Price Index.

benchmark interest rate shock was 0.000000. Then increased until the sixth period. The peak response occurs in the sixth period, where the response increased to 0.00197. After that, the response decreased slowly until it reached the new equilibrium at 0.0009. Food Prices (LN_CPI) lead to a new equilibrium after around 20–30 post-shock period interest rates (LN_IR). This is consistent with the view of [49], who noted that aggressive interest rate hikes by central banks can take a considerable time before their full effect on inflation materializes, and in some cases may even generate unintended pressures on prices through their impact on the broader financial system.

The average food price change takes about 20–30 months to return to its natural value (new equilibrium) after receiving a shock from rainfall variable fuel oil prices, and the benchmark interest rate. This shows

high persistence, which is in line with several studies of food inflation in developing countries [7, 11, 19].

The study period (2018–2023) includes the COVID-19 pandemic, which can cause data to be distorted due to non-standard shock such as lockdown and other changes. Therefore, this research also examines the strength of the results (robustness) by dividing the period into two sub-periods: “Before COVID-19” and “After COVID-19”.

In both periods as shown in Fig. 4, it appears that the effect of the rainfall shock reaches a relative peak around the period 5–6, then fades slowly but remains persistent until the end of the period. Food prices tend to be stable and reach a new balance after about 10–30 months post-shock. The pattern of interest in shock interest rates is relatively consistent in both periods. However, the magnitude of the response is higher after

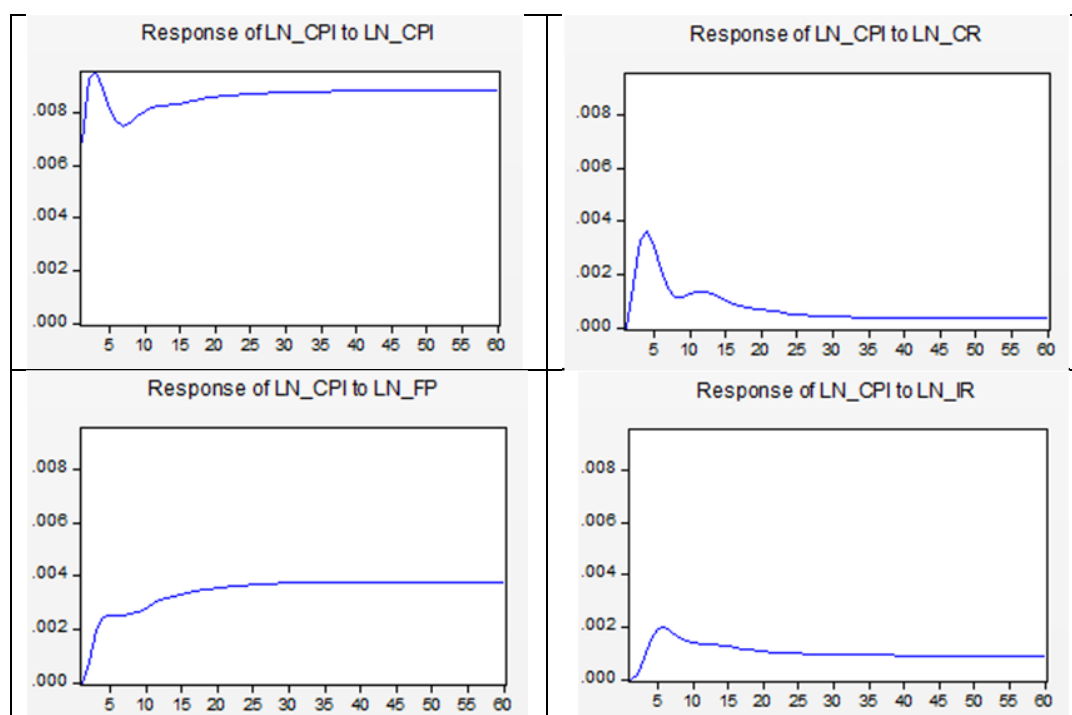


Fig. 3. Response of Food CPI to Rainfall, Fuel Prices, and Interest Rates

Source: Compiled by the authors.

COVID-19, which may be caused by extensive monetary policy during the pandemic.

Forecast Error Variance Decomposition (FEVD)

Forecast Error Variance Decomposition is used to understand how much each exogenous variable contributes to variations (fluctuations) in endogenous variables (LN_CPI) over time. Variance Decomposition of the LN_CPI variable (food prices) uses the Cholesky factor in this study.

Figure 5 shows that, at the beginning of the period, all variations in food prices (100%) were caused only by themselves (LN_CPI). No influence from rainfall, fuel prices, or interest rates was observed, because shocks from other variables had not had time to affect food prices. After running for several periods, the contribution of food prices began to decline slowly. This shows the more variation in food prices caused by external factors. Over time, the contribution from fuel prices increased, although the price of food still dominated variations in food prices. In the 60th period, the price of food still dominated the variation in the prices of the food itself, with a contribution of around 83.91%. Fuel price is the most important external factor, with a contribution of around 13.58% of the total. Whereas rainfall and benchmark interest rates contribute contributions of around 1.19% and 1.31% respectively. This means that internal factors such as fluctuations in demand, production, and other

market factors, play a dominant role in determining variations in food prices.

Variance decomposition graphics also show that food price variance is gradually influenced by exogenous variables (LN_CR , LN_FP , and LN_IR) over time. Initially, the impact of rainfall was higher than the fuel prices. However, after a few periods, the impact of the fuel price is higher than the rainfall, until the period so on. This is reinforced by the results of the robustness test by dividing the period into before COVID-19 period and after COVID-19 period.

As reported in Fig. 6, changes in the dominance of rainfall (LN_CR) over BBM Prices (LN_FP) reflect the dynamics of the influence of exogenous variables on food prices. Initially, rainfall had a greater impact as it has a direct relationship with food production, and agriculture is highly dependent on weather conditions. Rainfall shocks, such as floods or droughts, can cause direct disruptions to food supply, which then have an impact on prices. However, over time, the impact of fuel prices becomes more dominant because they have a cumulative impact that gets stronger over time. The increase in fuel prices leads to increased production costs, such as the use of fuel for agricultural equipment, distribution costs (transportation of goods), and other operational costs. While the benchmark interest rate has an impact on lower food prices than rainfall and fuel price, because of its relationship with the price of food (LN_CPI) is not directly. The benchmark

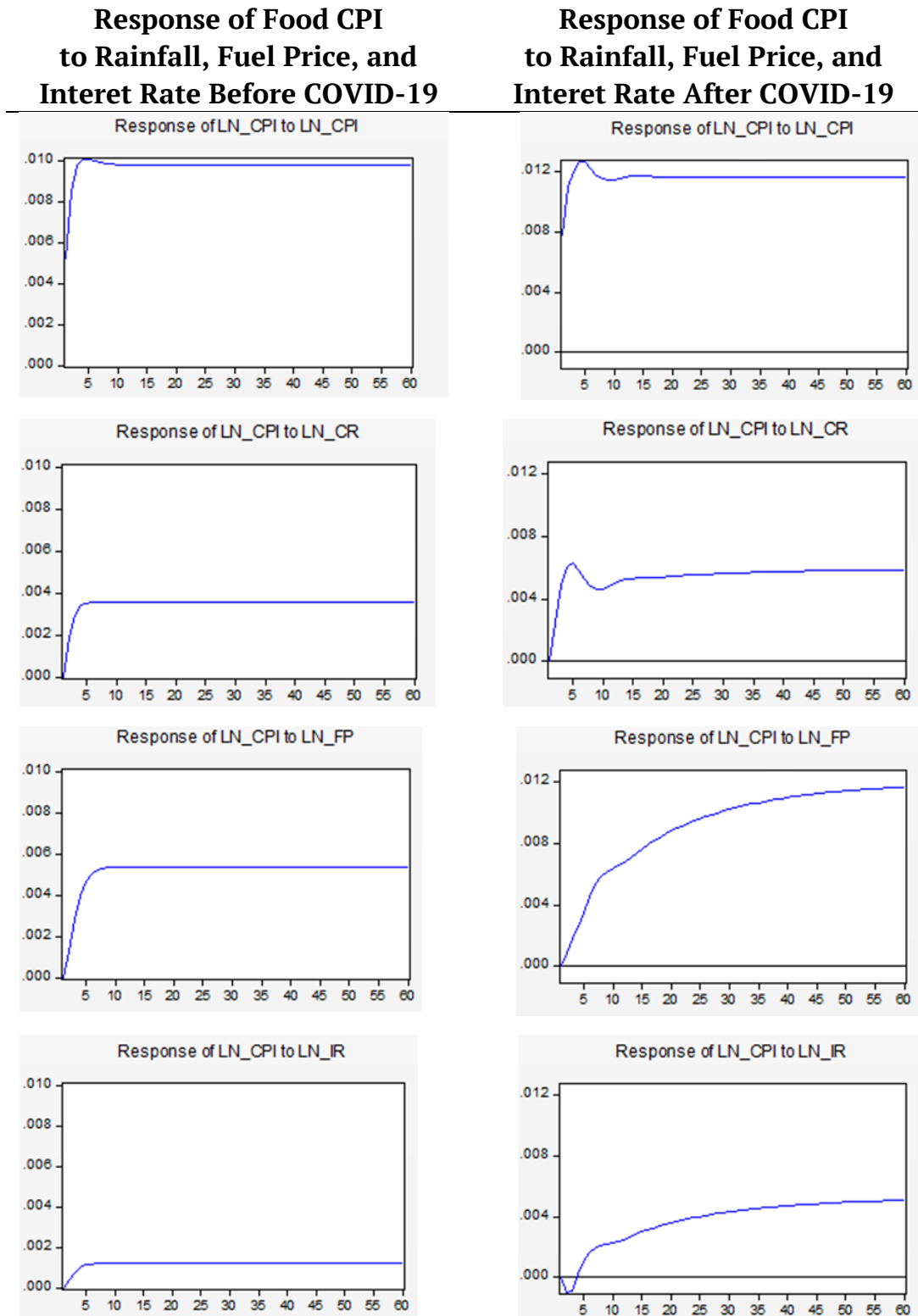


Fig. 4. Robustness Test of the Response of Food CPI to Rainfall, Fuel Price, and Interest Rate

Source: Compiled by the authors.

interest rate is more often used to control inflation as a whole and maintain macroeconomic stability. The impact on food prices is only a small part of the broader impact on the entire economy. This supports

[50]' argument, who emphasized that the effectiveness of macroeconomic policy tools such as the key interest rate in influencing price dynamics is distributed unevenly across economic sectors. Structural and sectoral

factors often play a more dominant role in influencing prices than monetary instruments alone. This uneven distribution of policy effectiveness is particularly evident in the food sector, where structural dynamics heavily outweigh monetary influences.

Most of the variations in food prices (LN_CPI) are intrinsic or internal because they are influenced by factors such as food production, consumer demand, distribution and logistics, government policy, food reserves, and agricultural technology. These intrinsic variables have a direct relationship with the food supply chain and play a dominant role in determining food prices compared to exogenous factors such as rainfall, fuel prices, or interest rates. Agricultural technology used, seed quality, fertilizer use, and land management can all affect the supply of food. The level of efficiency in the production processes, such as irrigation, mechanization, and pest control, also affects production costs and food prices. Transportation infrastructure, such as roads, ports and terminals, affects the distribution of food products on the market. If the distribution is disrupted, the price of food in certain areas may surge. The cost of storing and managing food stocks (for example, refrigerated warehouses for perishable products) also affects prices. If this cost is high, food prices tend to rise. Increased population and income of the community often increase demand for high quality food (for example, meat, fish, or processed products), which can affect the price of these commodities. Subsidies for farmers, such as fertilizer or seed subsidies, can reduce production costs and, in turn, stabilize food prices. This highlights the critical role of government intervention. Previous studies

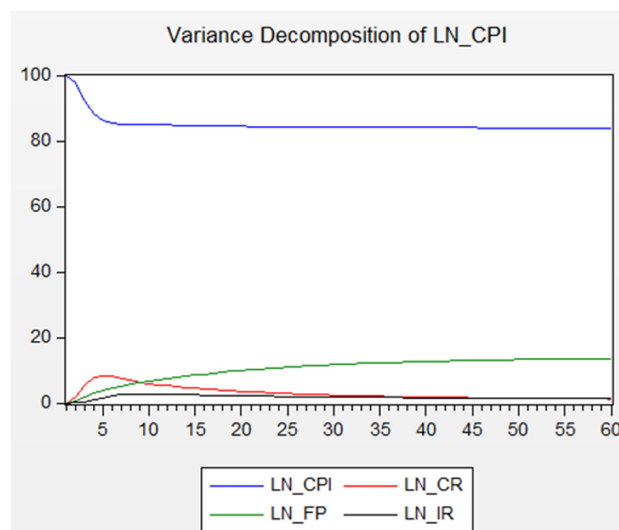


Fig. 5. Variance Decomposition of Food CPI

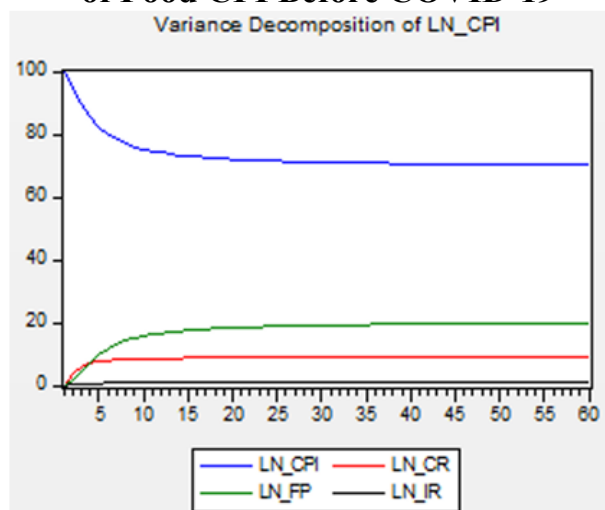
Source: Compiled by the authors.

have demonstrated that food price inflation in Indonesia exhibits significant persistence in response to fiscal, monetary, and natural shocks, and that policy interventions such as the National Food Inflation Control Movement (GNPIP) play an important role [51]. Technological development, such as good agricultural process, modern irrigation, and other technologies can increase productivity and reduce production costs. The incentive for importing or exporting food can also affect domestic prices.

CONCLUSION

This study discusses an in-depth insight into the dynamics of food inflation and the factors that in-

Variance Decomposition of Food CPI Before COVID-19



Variance Decomposition of Food CPI After COVID-19

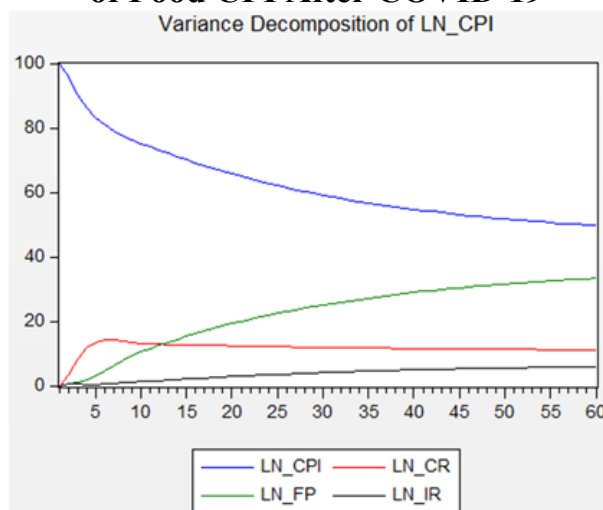


Fig. 6. Robustness Test of Variance Decomposition of Food CPI

Source: Compiled by the authors.

fluence it. All variables dynamically influence each other. Based on the results of the IRF analysis, some important conclusions can be drawn about the relationship between the exogenous variables and food prices. The average food price change takes about 20–30 months to return to its natural value (new equilibrium) after receiving shocks from the rainfall variable, the price of fuel oil, and the benchmark interest rate. This shows that the persistence of changes in food prices is relatively high when it is affected by shocks from fiscal policy factors, monetary policy, and natural factors.

Food prices are very responsive to their own internal shocks, both in the short and long term. This can be caused by factors such as inflation expectations, vulnerable supply chains, or market uncertainty. An increase in food prices during the initial period (period 1–2) can strengthen inflation expectations among consumers and producers. These expectations can cause a higher price spiral if not controlled. Because food prices have the characteristics of persistence, price stabilization policies, such as subsidies or price control, need to be applied quickly to prevent prolonged shock impacts. The policy should also consider the long-term effects of price shocks, because the impact is not entirely lost.

Fuel price shocks have a significant but gradual impact on food prices. The response of food prices to fuel price shocks is marked by initial delays, gradual surges, and stabilization in the long run. An increase in fuel prices can affect food prices through supply chains, such as increased transportation and production costs. Therefore, mitigation policies, such as fuel subsidies or alternative energy development, can help reduce the negative impact of shocks on food prices. In the early days after shocks, interventions such as food assistance or price stabilization can help maintain market stability and protect consumers from significant price surges. A long-term focus should be given to improving the efficiency of the food supply chains, diversification of energy sources, and the development of logistics infrastructure.

Rainfall shocks have a significant impact on food prices, but temporarily. The response of food prices to rainfall shocks is characterized by initial delays, gradual surges, and long-term stabilization. Therefore, it is necessary to develop the right mitigation and adaptation strategies to reduce the vulnerability of the food sector to extreme weather fluctuations. Mitigation policies, such as the development of strong irrigation infrastructure to protect against floods or the diversification of food sources, can help reduce the negative impact of rainfall shocks. In the early days after shocks, interventions such as distribution

of food aid or providing subsidies can help maintain price stability and protect consumers from significant price increases. Long-term planning: Because the impact of shocks is temporary, long-term focus should be given to increasing food security and adapting to climate change.

The IRF results also show that interest rate policies take time before they have an impact on food prices. Therefore, policy makers need to take this adjustment into account when designing monetary policy. Although the increase in interest rates initially decreases food prices (short-term effects), the long-term impact actually increases them. This needs to be taken into consideration to maintain price stability.

Based on Variance Decomposition graph analysis, although there are influences from exogenous variables such as rainfall, fuel prices, and benchmark interest rates, most of the variations in food prices (LN_CPI) are determined by internal factors such as food production, consumer demand, distribution, government policy, and agricultural technology. Exogenous variables have a gradual and limited impact, with fuel prices being more dominant than rainfall after a certain period. Therefore, the policy strategies must focus on strengthening internal factors to stabilize food prices and reduce vulnerability to external fluctuations. Policies ought to prioritize increased agricultural productivity, distribution efficiency, and management of food reserves in order to reduce the volatility of food prices. Interventions such as fuel subsidies for the agricultural sector, the development of irrigation technology, improving good agricultural processes and diversification of energy sources can help reduce the negative impacts from exogenous variables. In addition, strict regulations on price speculation and market monopoly can help maintain food price stability. Based on variance decomposition graph analysis, although there are influences from exogenous variables such as rainfall, fuel prices, and benchmark interest rates, most of the variations in food prices (LN_CPI) are determined by internal factors such as food production, consumer demand, distribution, government policy, and agricultural technology. Exogenous variables have a gradual and limited impact. Fuel prices are more dominant than rainfall after a certain period, so the policy strategy should focus on strengthening internal factors to stabilize food prices and reduce vulnerability to external fluctuations. Policies must prioritize increasing agricultural productivity, distribution efficiency, and management of food reserves to reduce the volatility of food prices. Interventions such as fuel subsidies for the agricultural sector, the development of irrigation technology, increasing good agricultural process and diversification of energy sources can help

reduce the negative impacts of exogenous variables. Additionally, strict regulations against price speculation and market monopoly can help maintain stable food prices.

This study has several limitations, one of which is the use of precipitation as the only climate factor analyzed, without considering other climate variables such as temperature, drought, or other extreme

events. This restriction is made taking into consideration the main focus of research, which is on the pattern of rainfall and its impact on prices. Therefore, it is recommended that further research can take additional climatic factors into account, such as daily average temperature, drought index, or the frequency of extreme events (for example, floods or a prolonged drought).

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T. Irawan — development of the concept of the article, formation of tables and figures, critical analysis of literature.

F. Syarifuddin — description of the results and the formation of conclusions of the study.

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Herding Bias and Investment Decision Making – a Systematic Literature Review

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ABSTRACT

The issue of herding bias and investment decision-making has been extremely important in recent times to understand the irrationality of investors. This study comprehensively analyzes the literature on herding bias and investment decision-making to understand the various dimensions of herding biases and their impact on the decision-making of investors. A systematic literature review of relevant research papers from leading databases was conducted to determine the current research trends, develop a nomological network by identifying the variables used as antecedents, mediators, moderators, and outcomes, and highlight the most popular theories referred in studies. The findings of this study reveal behavioural biases, herding bias, investment decision-making as the main thematic domains. Further, the study also found a dearth of literature, especially relating to collectivist and individualistic societies, and concluded that future studies should also contemplate different psychological and social aspects, such as trading behaviour and investor patterns while studying the impact of herding bias on decision-making of investors.

Keywords: behavioural biases; herding; herding bias; investment; investment decision making; systematic literature review

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INTRODUCTION

The term ‘herding’ describes people’s propensity to mimic the rational and irrational judgments of others. In general, it has been seen in the existing strand of literature that the terms “herding” or “herd behavior” in economics and finance, refer to the process by which economic agents imitate other’s actions and/or base their judgments on those of others [1, 2]. The article [3] postulated a relationship in which the availability of information and herd behaviour are interconnected. They discovered that investors are more likely to follow the choices made by individuals or groups when information is ambiguous. Thus, investor herding behaviour is the main reason for financial bubbles. Investment decisions refer to the decisions made by individuals or firms to invest capital to gain a better return on investment. The study [4] argues that investors choose to forgo short-term gains to receive larger returns.

A precise set of goals must be achieved for each investment. Practically speaking, there are various goals for investing, including choosing risk and return as well as protection from inflation, growth, and liquidity risks [5, 6]. Decisions about investments are not always logical. Studies have connected behavioural biases to how people make investing decisions [7–10]. Hence, it is extremely important to understand investors’ herding behaviour as it could hamper their decisions on the choices of investments made. When examining investor behaviour, it is important to minimize herding biases in order to enhance investor rationality, leading to improved investment returns [11, 12]. And thus, it is imperative to comprehend the fundamental elements of herding bias and their influence on investors’ decision-making through a systematic literature review which is the first of its kind. The need for this study is essential as it has been observed that Investors are often blamed when they operate their business in herds [13, 14]. This brings instability during the time of crisis [15]. Therefore, it is crucial to decipher their herding behaviour on the investment decision making.

LITERATURE REVIEW

Behavioural bias refers to irrational thoughts and actions that might unintentionally affect the way decisions are made [16, 17]. The term “behavioural biases” in investment decision-making refers to the irrationality that results from the interaction of heuristic biases, cognitive illusions, framing effects and the herd mentality of investors [18–20]. Three behavioural biases exist: overconfidence, the disposition effect, and herding. The research defined overconfidence bias as a tendency where people have an unjustified faith in their instinctive abilities and judgments [21, 22]. It has been claimed by researchers that overconfident people, due to their

innate tendency, become extremely confident about their cognitive ability while undermining the prevailing risks in investments [23]. The study examined the disposition effect and created a framework based on several components (such as mental accounting, self-control, regret aversion, and tax consideration) [24, 25]. The prospect theory has been cited in the majority of empirical investigations as an explanation for the disposition effect [26].

The term ‘herding’ describes people’s tendency to copy the rational and not so rational judgments from others [27]. Therefore, investor herd behaviour is the main reason for the financial hurdles. Previous research find that managers of US pension funds are not affected by the herd behaviour and have little influence on stock prices when trading major equities by [28]. Institutional investors’ trading behaviour is influenced by their prior trading position [29]. They also discovered that herding behaviour in big stocks became less aggressive over time. Previous researchers argued that investors decide to forgo short-term gains to receive larger returns [30, 31].

According to traditional finance, individual investors are logical actors who choose investments to maximize profits while minimizing investment risk by determining the inherent share prices value [32]. However, behavioural finance contends that various psychological biases heavily impact a person’s financial choices. In behavioural finance, psychological biases are used in identifying and assessing of investment options available to the investors [33, 34]. This frequently explains both the market and the individual’s divergence from conventional financial theory. Investor behavioural biases would persist even when their investing judgments follow a rational decision-making procedure [35].

There are a number of factors which influence day-to-day investment decisions of individuals, which includes social interaction, motivation, inclination, and enthusiasm [36]. Investors do so through financial goals, periodicals, and accessible funding [37]. Investors’ lack of confidence and technical expertise in their ability to make wise decisions cause them to act in a biased manner [38, 39]. The rational decision-making of individuals is impacted by behavioural biases, such as heuristics, herd mentality, cognitive illusions and the framing effect. Due to time constraints, high costs, and a lack of knowledge and interest, individual investors have fewer opportunities to examine stocks [40].

Previous researchers defined herding as the process of thoughts or actions of members of a group (the herd) through a variety of interactions rather than through centralized coordination [41]. Past researchers argued that herding happens when individuals intentionally replicate other investors’ actions [42]. The authors mention two types of herding: “spurious” herding, in which

investors make decisions based on comparable sets of fundamental data, and “intentional” herding, in which investors actively seek to imitate other investors’ actions [43, 44]. The former could result in a successful outcome, whilst the latter could not. Intentional herding can also lead to excessive volatility, fragile markets and systemic risk. It is highlighted that although the “lemming-like” behaviour of investors is frequently blamed in the popular media of financial markets, it is still very difficult to conclude that herding occurs in actual financial markets for a variety of reasons using field data. Previous researchers developed a methodology that helps to estimate herd behaviour in financial markets and claimed that herding arises due to the uncertainty of information events in the market [45]. Additionally, investors with a herd mindset tend to follow the herd, believing that the decisions made by the majority of investors are always correct [46, 47]. When it comes to buying and selling stocks, a herding investor makes judgments based on what the crowd does, rather than following rationality.

Studies by [48, 49] have pioneered theoretical work on herd behaviour, where agents with access to private information make decisions in turn. The authors found that once a number of agents have reached the similar conclusion, all subsequent agents abandon their own data and replicate the actions of their predecessors. Investors can respond to the introduction of fundamental information. Market participants can deduce information from the actions of previous participants. Analysts can conform to safeguard their reputations. Institutional investors can conform for reasons linked to compensation. Investors can exhibit irrational behaviour. And herd behaviours can arise from psychological and/or social norms [50, 51].

METHODS

This study includes a thorough evaluation of research papers published between 1995 and 2024 on herding bias and investing in decision-making. The review included only research papers published in reputed international peer-reviewed journals between 1995 and 2024. Other sources such as books, conference papers, working papers, and doctoral dissertations were excluded from the review because the year 1990s attracted significant attention in terms of investment behaviour. Further screening of the articles was done using the abstract analysis, which merely helped us in meeting our criteria. It is therefore imperative to understand previous research in peer-reviewed journals. However, some prestigious journals, such as the *Journal of Economic Psychology*, the *Journal of Behavioral and Experimental Economics*, and the *Journal of Behavioral and Experimental Finance* were also excluded because, after the

abstract screening, they did not meet the scope of our study. The objective of this study is to focus on herding bias and investors’ decision-making. Therefore all the studies that typically emphasize these two concepts have been taken into consideration. The eligibility of research papers was examined through their titles and abstracts. Although there is already extensive literature published on herd bias and the decision-making of investors, very few studies have investigated the relationship between herding bias and the decision-making of investors. Therefore, 52 papers that focused on herding bias and investors’ decision-making were selected for this study.

The articles were searched using leading databases, such as Web of Science, Scopus, EBSCO, and Google Scholar. Keywords, such as “behavioural biases,” “herding,” “herding bias,” “investment,” “investment decision making,” “herding bias and investment decision making,” and “herding and herding bias” are used to find relevant research papers. Some top-rated journals in this field, such as *The Journal of Finance*, *Review of Behavioural Finance*, *Financial Analyst Journal*, *European Financial Management*, and *International Review of Financial Analysis*, are also searched. Furthermore, the references of some of the most prominent research papers were also utilized to find other sources, which were then evaluated to determine their applicability to the study. *Figure 1* depicts a flowchart of the selection of articles considered for review.

RESULTS AND DISCUSSION

Trends of Publications

The main focus of the study is to identify current research trends that examine the relationship between herd bias and investor decision-making. In this section, the study attempts to categorize articles by year, region, theme, journal, discipline, and category.

Year-wise Research Publications

Figure 2 shows the number of studies carried out every five years between 1995 and 2024. The highest number of studies was conducted in the period from 2016 to 2020. However, during the period of 2021–2022, there was a decline in the number of studies. The reason for this could be the COVID-19 pandemic, in which many organizations did not have an effective decision-making mechanism to forecast any strategy for a longer tenure in terms of investment. The period 2023–2024 has gained momentum again because of the upsurge in the number of investors during these years. Investors tend to be affected by many behavioural biases, particularly herding bias. An increasing number of studies on this topic is useful for understanding individuals’ investment decisions.

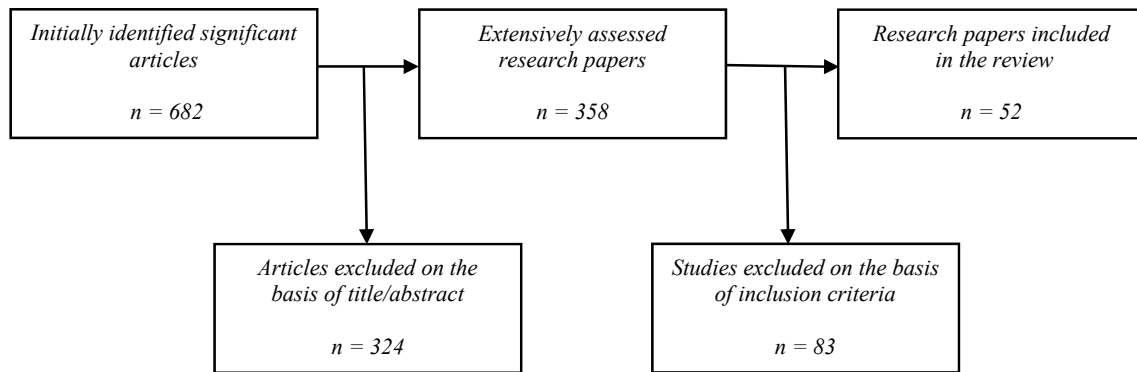


Fig. 1. Flowchart Showing the Selection of Articles

Source: Compiled by the authors.

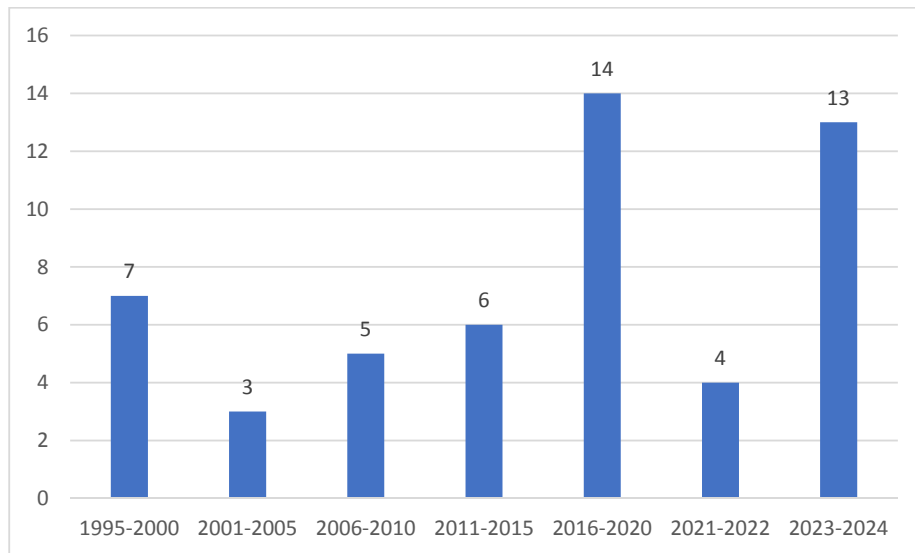


Fig. 2. Year-wise Studies

Source: Compiled by the authors.

Region-wise Studies

Figure 3 shows the number of studies conducted in various regions of the world from 1995 to 2024. It is thought-provoking to find out that the studies on herd bias and investors' decision-making are being conducted on continents like Asia, North America, and Europe. The majority of studies (42.31%) were conducted in Asia, followed by North America (26.92%), and only (11.54%) of the research was carried out in Europe. The probable reason for having the maximum number of studies on the Asian continent is that, going forward, Asian countries will become a hub for financial investment opportunities. Increased economic growth and urbanization in these regions offer significant potential for growth and profits for investors willing to take risks associated with investment decisions. Additionally, Asia has the highest middle-class population that is actively interested in financial investments [52].

Figure 4 shows the different themes employed by researchers between 1995 and 2024. The fields of herding and herding bias have been the primary focus of research. It is interesting to note that from 2017 to 2020 a layer of complexity was added to the herding bias problem by incorporating investment decision-making. As a result, from 2021 to 2024 a combination of factors was highlighted, including behavioural biases and focusing on herd bias and investors' decision-making. To gain the necessary understanding of the constructs across several domains, themes were developed to evaluate the constructs in various time frames systematically. Identifying themes in the data enables us to ascertain the areas that may arise from the lack of the existing literature.

Journal-wise Publications

As presented in Table 1, research papers on the issues in this study were published by a wide range of journals. For example, the American Business Review published 7.69% of articles. The Review of Behavioural Finance published

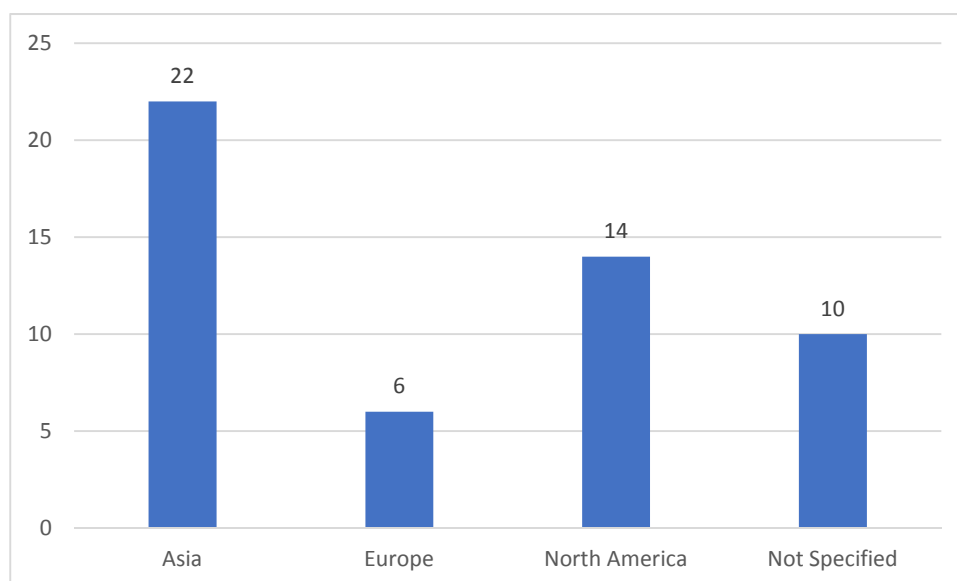


Fig. 3. Region-wise Studies

Source: Compiled by the authors.

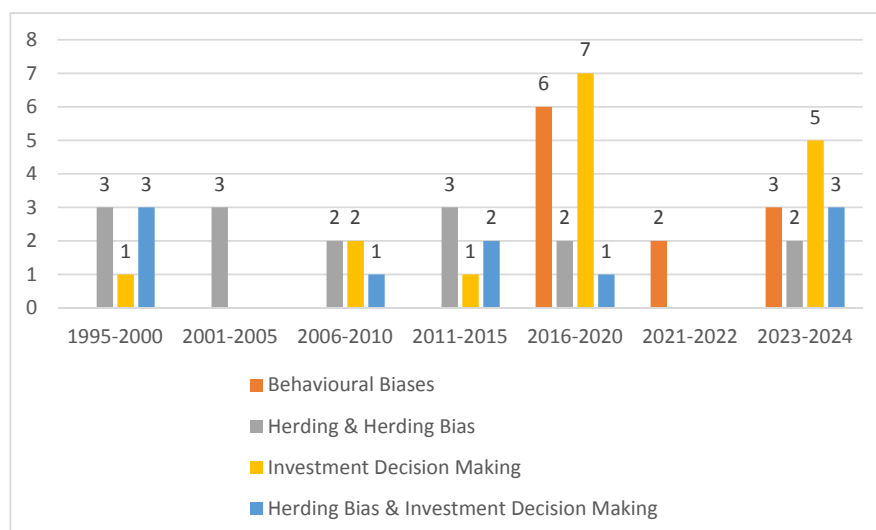


Fig. 4. Theme-wise studies

Source: Compiled by the authors.

5.77% of articles, and Qualitative Research in Financial Markets published 5.77% of the research papers.

Discipline and Category-wise Distribution

An analysis of these 52 research papers reveals that 27% of the research studies were from the finance discipline, 19% were from the economics discipline, 12% were from the accounting, and 6% were from the business management subject area. Regarding the category of journals, it was found that 8% of research papers were published in A* category journals, 25% were in A category, 17.31% were in B category, 10% were in C category, and 17.31% were Scopus-indexed. The publication of these papers in very high-category

research journals indicates the relevance of the research topic. *Table 2* provides a breakdown of the subject-wise publications in this field.

Most Cited Publications

Table 3 shows the most cited publications on herding bias and investment decision-making. The highest number of citations, with 2323 times cited, has been achieved by the article “Herding and Feedback Trading by Institutional and Individual Investors.” Meanwhile, the research paper “Herding in Financial Markets: A Systematic Literature Review” followed quite a distance with 322 citations overall. Lastly, the research paper titled “Estimating a Structural Model of Herd

Table 1

Publications by Source Title

Journal	Number of Research Studies	Percentage
The American Economic Review	4	7.69
The Review of Behavioral Finance	3	5.77
The Qualitative Research in Financial Markets	3	5.77
The Journal of Finance	2	3.85
The International Journal of Housing Markets and Analysis	2	3.85

Source: Compiled by the authors.

Behaviour in Financial Markets” has slightly lower citations of 192. Many other research papers are also followed with similar number of citations.

Country-wise Studies

Figure 5 shows the majority of the countries where research papers on herding bias and investment decision making have been published. India dominates the sample with more than 5 publications, namely 8 research papers, with a percentage of 15.38%. The UK and Pakistan also published 5 research papers in this field, with 9.61% each.

Nomological Network of Herding Bias and Decision-Making of Investors

This SLR highlights numerous variables used as antecedents, determinants, mediators, and moderators. These variables were grouped into three categories: behavioural biases, decision-making of investors, and herd bias. The theme of herding behaviour witnessed several changes in the herd and herding bias in different contexts, such as financial markets, laboratory markets, online experiments, investment newsletters, and institutional and individual investors. The literature on investors' irrational behaviour shows that investment differs among individuals and occurs in different contexts. Many studies show investment satisfaction, attitude, and corporate reputation as mediating variables to measure the indirect effects of antecedents and the outcomes and risk aversion as moderating variables to find the strengths or weaknesses of the constructs for the same. Various behavioural biases, such as anchoring, representativeness, herding, and availability biases, have been used as antecedents to reinvestment decisions in different domains and contexts. Antecedents for investment decisions include market sentiment, past

Table 2

Publications by Subject Area

Subject Area	TP	Percentage
Finance	14	26.92
Economics	10	19.23
Accounts	6	11.53
Business Management	3	5.76

Source: Compiled by the authors.

Table 3

Top 5 Most Cited Publications

Title	Citation
Herding and Feedback Trading by Institutional and Individual Investors	2323
Herding in financial markets: A Systematic literature Review	322
Estimating a Structural Model of Herd Behaviour in Financial Markets	192
Elucidating investors rationality and behavioural biases in Indian stock market	72
Can herding improve investment decisions?	43

Source: Compiled by the authors.

behaviour, and overconfidence, which cause changes in office investments, mutual funds and stocks, as well as the intention to invest in the holistic analysis of the relationships between the constructs.

Figure 6 depicts the mediator-moderator framework for herd bias and the decision-making of investors. It has been revealed that there are very few mediators and moderators are used in quantitative empirical research papers to establish the impact of herd bias on the decision-making of investors. Researchers have identified different dimensions of herding bias and the decision-making of investors. It is imperative to comprehend that various factors that mediate this relationship have been used in researchers' interpretation. Factors such as investment satisfaction, judgment/valuation, attitude, corporate reputation, risk perception, risk tolerance, investor behaviour, market anomalies, and market sentiment have all been used as mediators in studies at different time phases. Concerning the dimensions mentioned above, researchers also argued about different moderators, including risk aversion, financial literacy, investment decision-making, social media, and national culture. Studies like those by [53] have used market efficiency as a moderator, which in turn added a valuable perspective to the literature by

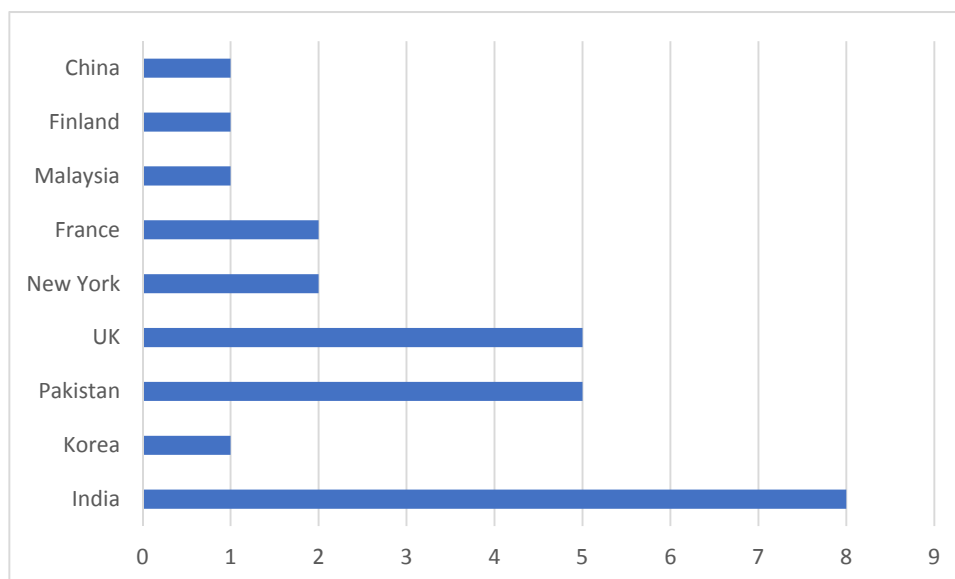


Fig. 5. Country-wise Publications

Source: Compiled by the authors.

highlighting the role of different behavioural aspects, with the effect on the decision-making of investors in particular. Similarly, the study by [54] emphasizes that herd behaviour has a negative impact on the efficiency of the market and the performance of investment. Researchers such as [55] use risk aversion in their studies to determine its effect on herding behaviour and investment decision-making. All the above-mentioned dimensions add valuable insights to the discourse by highlighting the relationships in the existing literature.

Theories Used in Herd Bias and Investment Decision-Making Studies

The most significant models and theories used in the research of herding bias and investment decision-making. In the field of traditional finance, theory development had been based on rationality [56]. Traditional financial pioneers promote reason in decision-making by justifying choices based on the information at hand [29]. Traditional financial theories, such as the Arbitrage Pricing Process, the Capital Asset Pricing Model, and the Options Pricing theory Merton have dominated the minds of financial analysts to provide answers to investment-related questions. These ideas support and advance the traditional idea that investors are rational when making decisions about investment, assuming that they make rational decisions.

The most prominent theories in the area of behavioural finance are the *prospect theory*, which works in accordance with expectancy utility theory to explain decision-making in uncertain situations. By fusing the psychological and behavioural components of economic and financial decision-making, prospect theory has

brought about a fundamental shift in traditional finance by introducing it to the newly growing field of behavioural finance. Due to a lack of acceptable justification for a variety of investors' irrational behaviours, the traditional ideas of the efficient market hypothesis and anticipated utility theory have been replaced by behavioural finance.

The foundations of behavioural finance were laid by Kahneman and Tversky's introduction of *prospect theory* in 1979. The three main heuristics on which this theory is based are accessible, representative, and anchored. The study by included the gambler's fallacy bias and overconfidence bias in their list of heuristic biases. In addition, numerous behavioural economists have introduced the concept of loss aversion disposition effect and mental accounting, which helped to advance the field of behavioural finance. And hence, behavioural biases have become a significant area of research in behavioural finance.

Another prominent theory used in the area of behavioural finance is the theory of *bounded rationality*, which extends the assumption of prospect theory to the extent that it is carried out in defence of bounded rationalism. As a result, investors frequently oversimplify their decision-making processes and are vulnerable to behavioural heuristics that may result in systemic errors and good investment choices, but do not maximize options. Due to intrinsic risk perception asymmetries in the value function of investors, judgements regarding investments may be made more intuitively and based on past performance rather than on logical analysis and objective factors.

Previous research has also focused on the utilization of resources to gain a competitive advantage. A type of strategic management, known as resource-based theory,

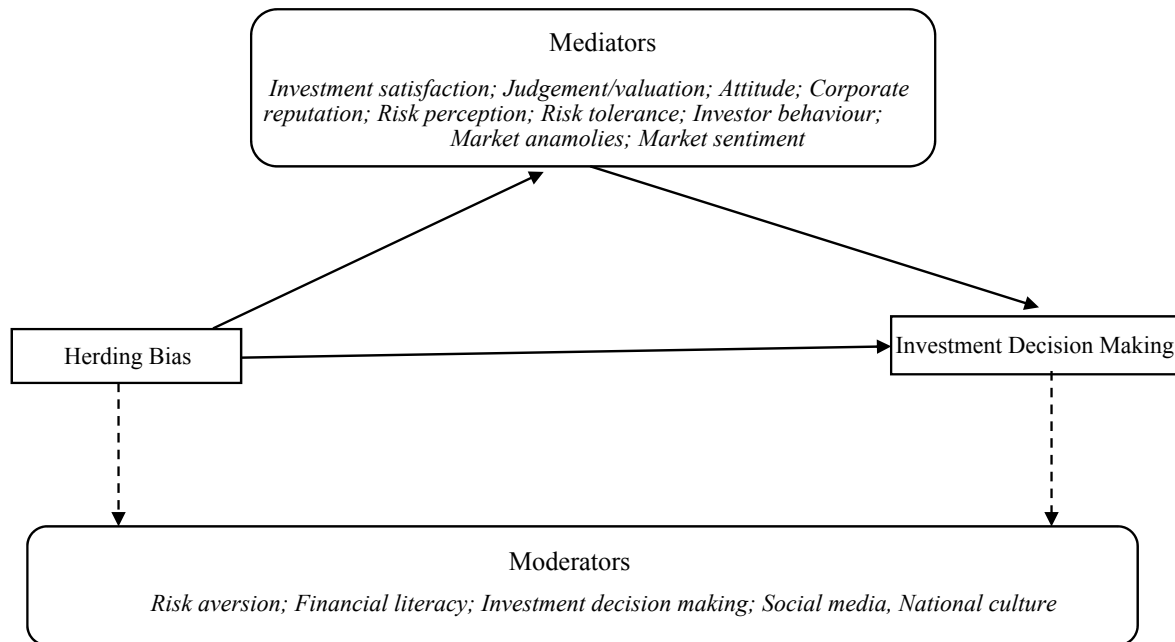


Fig. 6. Mediator-Moderator Framework

Source: Compiled by the authors.

focuses on the internal strengths and limitations of the company. From this perspective, a firm's immovable and diverse resources play a significant role in developing a competitive advantage [58]. Resource-based theory states that a corporation is equivalent to the diverse array of resources it holds. Resources are assets that are attached semi-permanently to a company, both tangible and intangible. Networks acquire the resources owned by other businesses to gain a competitive edge. This implies that investment in resources and competencies may not always be evaluated from the perspective of an individual firm without adapting to complementary inter-firm resources.

According to the *efficient-market hypothesis*, a classical version of finance theory states that investors make logical decisions regarding the financial items they want to invest in. However, "the theory of behavioural finance" contends that an investor's decision to purchase a financial instrument is influenced by their psychological, sociological, and emotional preparedness.

Expected utility is based on the hypothesis that the most advantageous option will be selected. This is established based on the theory of perspectives. Compared to other less likely outcomes, even if the value of the first is lower, there is still a preference for secure rewards. It should be remembered that because the experience of loss is a component of human subjectivity, it cannot be measured. Even though several factors contribute to this, including family influences, investment objectives, risk factors, guilt, justifications, fear, and agony. Therefore, loss aversion incorporates the feelings and aspirations of people with which investment decisions are made using

logical justifications.

CONCLUSION

This work contributes to several theoretical insights into herd bias and decision-making of investors in the literature. After synthesizing the chosen research papers, the study found that most of the work was conducted between 2016 and 2020. Most studies have been conducted in Asia. Further, Prospect theory is commonly used in studies of herd biases and investor decision-making. This research also analyses herd bias and investment decision-making theories in understanding theoretical foundations of the construct. The study also reveals that these theories originate from economics, statistics, and finance. Furthermore, financial theories dominate this field. This research paper also highlights several research gaps in the literature review. The study found that most empirical research on herding bias and investment decision-making domain is cross-sectional in design, providing a very limited view in comparison to other attitudinal and behavioural outcomes. Second, the absence of cross-cultural studies on this topic was another notable gap. As most investigations have been conducted using secondary data from different stock exchanges, they may have problems with generalizability. It would be fascinating to observe whether investors from various parts of the world respond to different biased behaviours while investing. Therefore, cross-cultural research should be conducted to determine whether results obtained from various samples are similar.

Third, this review of the literature has revealed that

there has been a lack of qualitative research. The concepts of herd bias and decision-making of investors are highly individualized. An accurate picture of the bias towards certain investments by many respondents cannot be obtained using a predefined scale. Only open-ended inquiries allow responders to express their concept of transcendence. Therefore, future research should employ qualitative methods, such as ethnography, thematic analysis, and grounded theory. Fourth, the review identified very few studies that used mixed-methods research; with respondents limited by predetermined options in closed-ended inquiries. Future researchers could combine quantitative and qualitative methods to triangulate data and determine if they produce similar results.

This study's gap analysis can be very helpful in the advancement of herd bias and decision-making of investors. In addition to the gaps listed above, this study also recommends additional research on herding biases and decision-making of investors in context of cultural aspects of investment and herding behaviour, which can be observed in the form of the transformation of society from collective to individualistic, and the search for changes in the patterns of investment due to enhanced diversification in technological media. A promising research direction needs to examine perceived collectivism vs. individualism values using Hofstede's cultural model. Notably, the study further asserts, that since collectivist societies predominate in the Eastern world, behavioural biases will be inextricably linked to principles of empathy, compassion, and respect when making investments. However, investment decisions in Western countries are more independent. The study also aims to propose additional cross-cultural comparison studies to provide empirical support for this gap.

This study concludes that even though the area of research has grown vividly over the past twenty-five years, gaps are still persistent in the field of herding bias and decision-making of investors. Dimensions, such as behavioural biases, herding behaviour, and investment decisions are becoming more relevant in the current environmental landscape. It is essential to understand these biases when making investment

decisions to ensure efficiency and effectiveness. By synthesizing the extensive literature on herding bias and decision-making on investors, this research significantly adds to the field. It will aid future researchers in understanding the current state of the field and identifying areas that need further investigation.

This literature review provides various scopes for future research. First, future studies focus on emerging stock markets because of the increased expansion of emerging economies. Potential, institutional, and individual investors prefer to invest in the share market, offering a wealth of opportunities for further research. Second, empirical research, which is based on primary data, needs to be prioritized to examine investor behaviour when making investment decisions. Third, in addition to stocks, multi-asset, and bonds can also be considered when examining herding bias. Finally, studies focusing on home bias and herding behaviour should be conducted to make sound investment decisions. It is also possible to conduct research by combining many investment classes, including institutional (mutual funds, hedge funds), individuals, financial advisors, pension funds, etc.), in order to determine the variation in their behaviours and how behavioural biases affect their ability to make good financial decisions.

The study would be highly beneficial for financial firms where investors regularly monitor the stock markets. It would help them to advance their understanding before making a decision, as herding bias can lead to irrational investments where traders follow the crowd.

This study has several limitations. First, the review was limited to papers written and published in English. Second, even though every attempt was made to include as many publications as possible in the literature review, some studies might have been left out because databases such as ScienceDirect and ProQuest were not used. Third, there could be scope for the involvement of qualitative studies on herding bias and investment. Finally, future researchers could expand on this work by conducting mixed-methods studies.

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Transformation of the System of Indicators for Assessing the Financial Condition of Internet Service Providers

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ABSTRACT

The article is devoted to the urgent problem of diagnosing the financial health of Internet service providers (ISPs) in a dynamically developing digital economy. The main attention is paid to the development of specialized analytical tools that take into account the unique industry features of the ISP industry, such as the high capital investment required for infrastructure projects, the rapid technological obsolescence, the specific nature of cash flow generation and the significant proportion of intangible assets. The purpose of the research is to develop a specialized analytical toolkit that provides accurate diagnosis of the financial condition of telecommunications companies in an environment characterized by high capital intensity, rapid technological change, and regulatory challenges. This toolkit aims to overcome the limitations of traditional methods, such as coefficient analysis and Altman models. The paper uses a systematic approach that combines comparative analysis of international practices (the USA, the EU, China) with Russian realities, quantitative methods of financial analysis (modified coefficients of liquidity, profitability). It also uses qualitative methods like stress testing. Additionally, the paper incorporates elements of predictive modeling using Big Data technologies. The main results of the study include: the development of eight key financial indicators that have been adapted to the specific needs of the industry. We have also proposed a three-tiered assessment system, which includes strategic, tactical and operational levels. Moreover, we have provided a rationale for a combined approach that integrates DCF analysis, AI analytics and regular stress testing. The results obtained are of great practical importance for financial managers in telecommunications companies. They allow for a more accurate assessment of investment risks and the sustainability of business models that optimize debt burden and investment management. Regulators can use the proposed methodology to monitor the stability of the industry. Investors can also use it to make informed decisions. The theoretical value of the work lies in the development of a new methodology for financial analysis of high-tech industries that takes into account their unique characteristics. The research conducted has shown that by adapting traditional methods to the specific needs of these industries, it is possible to improve the accuracy of financial diagnostics by 20–30%, which is critically important in a market high volatility such as the telecommunications industry.

Keywords: financial policy; financial condition; valuation methodology; structure of capital and property; communication equipment; information and Internet services; corporate finance and management; Internet service providers; telecommunications; assessment methodology; digital economy; industry specifics

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INTRODUCTION

The telecommunications sector plays a key role in improving financial policy in the digital economy, providing an infrastructural framework for the transformation of business, public services and social interactions. According to World Bank research,¹ investments in the telecommunications industry directly correlate with the GDP growth of countries, accelerating the introduction of innovations (artificial intelligence; AI), Internet of things (IoT), and cloud computing (CC). The Russian authors [1–5] emphasize that under the conditions of sanctions pressure, the development of domestic Internet service providers is becoming critical for technological sovereignty. The share of the telecommunications sector in Russia's GDP exceeds 3.5% (according to the Ministry of Digital Development²), and the growth rate of the broadband market is 7–9% annually.

The aim of this research is to create analytical tools for evaluating the financial performance of internet services, considering industry-specific characteristics, regional regulatory aspects, technological advancements in communication equipment, and macroeconomic variables. In the context of digital transformation, internet service providers are essential for the sustainable growth of both regional and national economies [6]. However, high capital intensity, technological dynamics and regulatory challenges require the use of specialized methods to assess their corporate financial condition and management.

The research methodology and tools include a systematic analysis of scientific literature, a comparative study of international and domestic approaches to assessing the financial condition of internet services, the use of quantitative and qualitative analysis methods, as well as the development and adaptation of

specialized financial models to take into account industry-specific factors, technological trends, and macroeconomic conditions in order to create comprehensive tools for assessing the sustainability and competitiveness of telecommunications companies.

The financial condition of Internet service providers is a key condition for the development of telecommunications infrastructure, as it determines the ability of companies to finance capital-intensive projects (deployment of 5G networks, fiber-optic lines) and maintain the quality of services. As noted by N.V. Bukhov and S.A. Aliyev [7], in conditions of high market volatility, providers with stable financial indicators demonstrate greater efficiency in attracting investments and implementing government digitalization programs.

A study by Yu.M. Beketnova [8] confirms that in countries with a high proportion of financially stable operators, the rate of implementation of innovative technologies is 1.5–2 times higher. In Russia, according to the Ministry of Digital Development,³ 60% of infrastructure projects in the regions are implemented by companies with a financial stability coefficient above 0.7.

Traditional methods of financial analysis demonstrate limited effectiveness in evaluating Internet service providers due to the unique characteristics of the industry. As noted by T.A. Kuzovkova and Yu.S. Terekhova [3], standard liquidity and profitability ratios do not take into account key industry factors:

- A high proportion of intangible assets.
- The specifics of capital expenditures.
- Cyclical investments in infrastructure.
- Features of the formation of cash flows.

A study by McKinsey & Company⁴ shows that applying traditional Altman models to telecom

¹ World Bank. World Development Report 2024: Digital Dividends. Washington, DC: World Bank Group; 2024. URL: <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

² The Ministry of Digital Development of Russia. Report on the state of the Russian telecommunications market in 2023. Moscow; 2024. URL: <https://digital.gov.ru> <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

³ The Ministry of Digital Development of Russia. Report on the state of the Russian telecommunications market in 2023. Moscow; 2024. URL: <https://digital.gov.ru> <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

⁴ McKinsey & Company. Rethinking Financial Analysis for Telecom Operators. New York: McKinsey & Company; 2023. 38 p. URL: <https://www.mckinsey.com/industries/telecommunications>; <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

companies gives an error margin of 25–30% in predicting bankruptcies. This confirms the need to develop specialized assessment methods.

The issues of assessing the financial condition of companies have been widely studied in the economic literature [8–10], however, their applicability to Internet service providers requires significant adaptation due to industry specifics.

Traditional approaches to financial condition assessment (coefficient analysis, Altman,⁵ Springate, Zmievsky, Taffler, and Grover models [11]) have been developed for industrial enterprises and demonstrate limited effectiveness in analyzing telecommunications companies. The main disadvantages:

1. They do not take into account the high capital intensity and long payback periods of infrastructure projects.
2. They ignore the specifics of the income of Internet service providers.
3. They are not adapted to the valuation of intangible assets (brand, customer base, licenses).

Foreign authors [12, 13] propose modified models, including: industry KPIs, analysis of regulatory risks and government support, scenario modeling at various levels of investment in 5G (the fifth generation of wireless cellular technology) and IoT.

Russian scientists are focusing on the impact of sanctions on financial stability, the need to consider subsidies and government digitalization programs, as well as the development of stress tests for industrial companies.

Despite a significant amount of work, there are still some unresolved issues: the lack of a unified methodology that combines financial and non-financial indicators, and the insufficient study of Russian realities, such as the role of the public sector and currency risks.

To develop analytical tools for assessing the financial condition of Internet service providers, it is necessary to solve a number of tasks:

1. To identify key financial indicators characterizing the activities of Internet service providers.
2. To carry out a comparative analysis of methods for assessing the financial condition of Internet service providers in the USA, EU, China and Russia, highlighting key differences in approaches to regulation, investment and risk management.
3. Identify the limitations of traditional financial indicators (liquidity ratios, Altman models) in relation to the specifics of the telecommunications industry.
4. Develop modified indicators, including: the capital expenditure ratio (CLE), adapted to the long payback period of the infrastructure; the economic sustainability index (ERI), integrating cyber risks and regulatory changes.

THE MAIN PART

One of the main indicators of a company's competitiveness is its financial situation. Equally important are its financial activities and the final results of its work, which are of interest not only to its management, but also to shareholders, creditors, investors, suppliers and other business partners.

Table 1 presents a comparative analysis of the concepts of the financial condition of Internet service providers in the USA, The EU, China and Russia, based on current research and regulatory documents.

The analysis of *Table 1* allowed us to draw the following main conclusions regarding the concept and content of features of the financial situation of internet service providers in different countries:

1. The USA and the EU focus on competition and innovation, while the EU also includes social criteria.
2. China sees internet service providers as an instrument of government policy, with strict financial control.
3. Russia emphasizes sustainability in the face of sanctions, combining market mechanisms and government regulation.

High-tech industries, including the telecommunications sector, are characterized

⁵ Altman EI. Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. *J Finance*. 1968;23(4):589–609. URL: <https://www.jstor.org/stable/2978933> <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

Table 1

**Transformation of the Financial Performance System
of Internet Service Providers: Regional Differences**

Country	The concept	Features	Entity	Principles
The USA	Financial condition as the ability to invest in innovation	– High competition – Private investments – FCC regulation	Ensuring profitability in the development of 5G infrastructure and broadband access	– Market self-regulation – Competition support – Focus on ROI
The EU [14]	The balance between commercial sustainability and accessibility of services	– Strict regulation – State support for digitalization – High QoS standards	Compliance with EU directives (e.g. Digital Agenda 2030)	– Unification of standards – Social responsibility – Consideration of ESG factors
China [15]	Financial status as part of the government's digital strategy	– Dominance of the public sector – Centralized planning – Active investments in 5G	Integration of telecom companies into national projects (for example, Digital China)	– Priority of state policy – Long-term planning – Debt load monitoring
Russia [6]	Financial situation in the context of sanctions and import substitution	– High dependence on government support – Sanctions restrictions – Regulation of Roskomnadzor	Ensuring technological sovereignty while maintaining profitability	– Import substitution – Localization of infrastructure – Consideration of sanctions risks

Source: Compiled by the author based on: [6, 14–16]; Federal Communications Commission (FCC). 2023 Broadband Deployment Report. Washington; 2023. URL: <https://www.fcc.gov> <https://www.worldbank.org/en/publication/wdr2024>; European Commission. Digital Economy and Society Index (DESI) 2023. Brussels; 2023. URL: <https://digital-strategy.ec.europa.eu> <https://www.worldbank.org/en/publication/wdr2024>. Ministry of Industry and Information Technology (MIIT). China's 5G Development Report 2023. Beijing; 2023. URL: <http://www.miit.gov.cn> (accessed on 10.05.2025).

by unique features of financial and economic activity that fundamentally distinguish them from traditional sectors of the economy. As noted by M.A. Plakhotnikova, Yu.V. Vertakova and D.V. Mukhortov [16], the key distinguishing features are: high capital intensity, short cycles of technology renewal, and cost structure features (see Figure).

The financial condition of Internet service providers (Table 2) is a key indicator of their competitiveness and sustainability in the context of high capital intensity of the industry and dynamic technological development. As noted by N.V. Bukhov and S.A. Aliyev [7], the stability of Internet service providers directly

affects the quality of services, investment attractiveness and the ability to innovate. In the context of the digitalization of the economy, the reliability of providers is becoming critically important to ensure the smooth operation of business, public services and social communications.

The financial condition assessment involves analyzing all aspects of a company's financial statements, including the balance sheet, income statement, statement of changes in equity, and cash flow statement. These reports provide a comprehensive view of the company's financial health. Internet service providers, like any other company, can use this information

High capital intensity	• Significant investments in infrastructure (5G, fiber-optic networks) • The share of fixed assets in assets reaches 50–70% • Long payback period of projects (5–7 years)
Short technology update cycles	• The need for modernization every 3–5 years • Rapid obsolescence of equipment • Fixed R&D costs
Cost structure features	• The predominance of fixed costs over variables • High share of depreciation in the cost • Significant operational costs for network support

Fig. The Specifics of High-tech Industries

Source: Compiled based on [2, 16].

to evaluate their profitability, efficiency, and adaptability to market changes.

Assessing the financial health of internet service providers requires a comprehensive approach that considers their unique industry characteristics, such as high capital intensity, reliance on technological cycles, and regulatory risks. The key elements of this analysis are presented in *Table 3*.

The most significant parameters, such as liquidity and profitability (9–10/10), are the basic indicators for survival in a highly competitive environment. Cash flows determine the possibility of investing in 5G/6G, but the high level of capital expenditures of internet service providers requires strict control over free cash flows and debt burden. Average revenue per user from internet service providers is a key indicator for revenue forecasting, especially in the B2C segment. For a comprehensive assessment, it is recommended to combine coefficient analysis with stress tests, such as scenarios of rising central bank rates or stricter data protection regulations.

In the context of the digital transformation of the economy, internet service providers play a key role in ensuring sustainable development of regions and national economies. However, high capital intensity, technological dynamism and regulatory challenges necessitate the use of specialized tools to assess their financial standing. The paper provides a comparative analysis of contemporary assessment methods

(*Table 4*), highlighting their advantages and drawbacks, as well as offering recommendations for selecting optimal approaches, considering industry-specific factors.

A comprehensive analysis of the five key methods for assessing the financial health of internet service providers should take into account the following:

1. The specific industry of the telecommunications sector.
2. The regulatory environment in different regions.
3. Technological developments (5G/6G, IoT, cloud services).
4. Macroeconomic factors that influence the industry.

By considering these factors, a more accurate assessment of the financial stability and viability of internet service providers can be made.

Each method requires a multi-level assessment system based on a number of parameters, including accuracy, predictive ability, and adaptability to market changes.

The optimal methodology for assessing the financial condition of Internet service providers requires a combined approach, where:

1. Coefficient analysis (score 7/10 in accuracy) serves as a basic tool for operational monitoring, due to its simplicity and speed, but is insufficient for strategic decisions due to its static nature.

Table 2

**Analysis of the Role and Importance of the Financial Condition
of Internet Service Providers in Various Countries**

Country	Features	Role	Meaning
The USA	High competition, dominance of major players (Comcast, AT&T, Verizon)	Ensuring infrastructure sustainability, supporting innovation (5G, IoT)	It is critically important for the digital economy, cybersecurity and the telecom market
The EU [14]	Regulation at the EC level (GDPR, Net Neutrality), high market fragmentation	Support for competition, accessibility of services for the public and businesses	It affects digital sovereignty, the development of Smart Cities and ESG standards
China [15]	State Control (China Telecom, China Unicom), focus on 5G and Huawei	A tool for implementing the Digital China strategy and technological leadership	A key element of national security and the export of telecom services
Russia [6]	Sanctions pressure, import substitution, growing demand for local services	Ensuring sustainability in isolation, supporting IT infrastructure	It is important for the digitalization of public services, cybersecurity and economic stability

Source: Compiled by the author based on: [6, 14]; Federal Communications Commission (FCC). 2023 Broadband Deployment Report. Washington; 2023. URL: <https://www.fcc.gov> <https://www.worldbank.org/en/publication/wdr2024>; European Commission. Digital Economy and Society Index (DESI) 2023. Brussels; 2023. URL: <https://digital-strategy.ec.europa.eu> <https://www.worldbank.org/en/publication/wdr2024>; Ministry of Industry and Information Technology (MIIT). China's 5G Development Report 2023. Beijing; 2023. URL: <http://www.miit.gov.cn> <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

2. DCF analysis (9/10) provides high predictive value for long-term evaluation, but is dependent on the volatility of macroeconomic parameters.

3. Rating models (8/10) are useful for cross-market comparisons, but are limited by formalized agency criteria.

4. Big Data and AI (9/10) maximize forecast accuracy and adaptability, but require significant investments in infrastructure.

5. Stress testing (8/10) is critically important for risk management, but its effectiveness depends on realistic scenarios.

For a comprehensive assessment, it would be advisable to combine the following methods: DCF (strategic level), AI analytics (tactical level), and coefficient analysis (operational level). These methods should be supplemented by regular stress testing to verify the stability of the business model in conditions of uncertainty.

Table 5 provides a comparative analysis of methods for assessing the financial condition of internet service providers.

From *Table 5*, it follows that the choice of optimal tools should be based on specific analysis tasks. Coefficient analysis (simplicity and speed) is ideal for operational control. DCF/FCF analysis (long-term cost accounting) is indispensable for strategic decisions. Rating models (standardized approach) are useful for cross-market comparisons. Big Data and AI analysis (high forecast accuracy) is effective for deep analytics, but it requires significant resources. Stress testing (vulnerability detection) is crucial for risk management.

At the same time, maximum efficiency can be achieved by combining different methods, considering their complementarity and the specific needs of the telecommunications industry.

An analysis of the Russian practice of using financial condition assessment methods [2–5]

Table 3

**Rating of Parameters for Assessing the Financial Condition
of Internet Service Providers (10-point System)**

Rating	Analysis Parameters	Goal	Specificity	Justification
9/10	Liquidity	Assessment of the ability to cover short-term liabilities	High infrastructure operating costs can reduce liquidity	It is critical to maintain the smooth operation of the network and payments to suppliers
9/10	Profitability	Determining the profitability of a business model	The decrease due to competition is offset by B2B services (clouds, VPN)	Shows the effectiveness of cost management and pricing
9/10	Cash flows	Assessment of the ability to generate cash flow for development	Negative cash flow from new players	A key indicator for dividends and network modernization
8/10	Financial stability	Debt burden and debt dependence analysis	Capital intensity (5G, fiber) increases debt	High D/E may limit investment in innovation
8/10	Comparative analysis	Testing competitors	Industry standards	Helps to identify the overestimation/undervaluation of the company
7/10	Investment activity	ROI analysis from technology projects	Long payback period for infrastructure projects (for example, 5G – 5–7 years)	Determines future competitiveness
6/10	Macroeconomic factors	Consideration of regulatory and market risks	Sanctions, localization of equipment	Affects the cost of borrowed capital and access to technology

Source: Compiled by the author based on: [6, 14–16]; Ministry of Industry and Information Technology (MIIT). China's 5G Development Report 2023. Beijing; 2023. URL: <http://www.miit.gov.cn> <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

showed that traditional methods of coefficient analysis dominate (87% of studies), the demand for stress tests is growing (40%), and Big Data is used by only 15% of scientists due to data scarcity.

T.A. Kuzovkova and Yu. S. Terekhova (3) also note that existing methods for assessing financial stability fail to take into account the unique characteristics of telecommunication companies, such as their high capital intensity, low material intensity, and network-based production model. This leads to inaccurate conclusions when analyzing their financial health.

The empirical basis of the study by T.A. Kuzovkova and Yu. S. Terekhova was data from macro-regional branches of Rostelecom and

telecom operators (MTS, Megafon, Vimpelcom) for 2009–2010. They identified anomalies: low current liquidity (0.28–1.7 with a 2.0 ratio) and high financial leverage (up to 2.3).

T.A. Kuzovkova and Yu. S. Terekhova have proposed a technique to eliminate the distortions in traditional analysis. Their upgraded method allows for a more accurate assessment of the financial position of internet service providers, taking into account intangible assets, fiber optic transmission systems, and software, particularly in situations with high capital intensity and debt levels.

When developing the author's methodology, one should use the recommendations formulated in their study by T.A. Kuzovkova and

Table 4

Characteristics of the Tools for Assessing the Financial Condition of Internet Service Providers

The toolkit	Application	Metrics	Advantages	Disadvantages
Ratio analysis	Basic analysis of liquidity, sustainability and profitability	– Current/Quick Ratio – Debt-to-Equity – EBITDA Margin – ROCE	– Ease of calculation – Comparability of results – Wide availability	– Does not take into account industry specifics – Limited predictive capabilities
DCF/FCF analysis	Assessment of long-term solvency and investment attractiveness	– Free Cash Flow – CAPEX/Revenue – Discounted cash flows	– Accounting for the time value of money – The possibility of long-term forecasting	– Sensitivity to discount rates – The difficulty of accurate revenue forecasting
Rating models	Comparative analysis and assessment of creditworthiness	– Credit ratings (S&P, Moody's) – EV/EBITDA – P/E	– Consideration of macroeconomic factors – International comparability	– Limitations for private companies – Dependence on the subjectivity of assessments
Big Data and AI analysis	Forecasting demand, identifying anomalies and cyber risks	– ARPU speaker – Patterns of traffic consumption – Payment anomalies	– High accuracy of forecasts – The ability to identify hidden patterns	– High cost of implementation – Demanding data quality
Stress testing	Assessment of resilience to crisis scenarios (economic, regulatory)	– Scenarios for changing bids – Regulatory changes	– Identification of business model vulnerabilities – Preparing for crisis situations	– Subjectivity of scenarios – The complexity of developing tests

Source: Compiled by the author based on: [6, 14–16]; Ministry of Industry and Information Technology (MIIT). China's 5G Development Report 2023. Beijing; 2023. URL: <http://www.miit.gov.cn> <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

Yu.S. Terekhova [3]: use modified formulas for own working capital (COC), develop industry standards for coefficients, and take into account the specifics of financing infrastructure projects.

In our opinion [5], an assessment of the financial condition of internet service providers can be seen as a type of economic analysis that aims to study indicators that characterize a company's level of development, its ability to function and grow in a changing environment, its current and future ability to meet the needs of creditors, shareholders, and users, as well as its investment attractiveness. This analysis is necessary in order to understand the specific nature of the telecommunications industry.

To meet the criteria described above, the assessment of the financial condition of internet service providers will include the following stages: assessment of financial stability, analysis of accounts receivable and payable, assessment of profitability, assessment of liquidity, analysis of financial results, and assessment of specific indicators that reflect the specifics of the telecommunications industry.

The author's methodology for a comprehensive assessment of the financial condition of Internet service providers is proposed, which contains three basic principles:

1. Industry specifics: accounting for high capital intensity, long-term investments in infrastructure and intangible assets.

Table 5

Comparative Analysis of Methods for Assessing the Financial Condition of Internet Service Providers

Method	Accuracy	Flexibility	Cost-effectiveness	Applicability
Coefficient analysis	Average	Low	Low	High (basic level)
DCF/FCF	High	Average	Average	High (for investors)
Rating models	High	Low	High	Average (only for public companies)
Big Data/AI	Very high	Very high	Very high	Limited (requires data)
Stress testing	Average	High	High	High (for risk management)

Source: Compiled by the author based on: [6, 14–16]; Ministry of Industry and Information Technology (MIIT). China's 5G Development Report 2023. Beijing; 2023. URL: <http://www.miit.gov.cn> <https://www.worldbank.org/en/publication/wdr2024> (дата обращения: 10.05.2025) / (accessed on 10.05.2025).

2. Dynamic approach: combining retrospective analysis with predictive modeling.

3. Risk-based approach: integrating cyber risks and regulatory changes into financial models.

Based on the formulated principles, 8 key indicators were proposed (Table 6), and the first three are from the methodology proposed by T.A. Kuzovkova and Yu.S. Terekhov [3].

The digital standards were justified in adapted coefficients using the following algorithm.

The digital standards were obtained as a result of:

Analysis of 120 financial reports of Russian Internet service providers (2018–2023). Regression modeling of the dependence of indicators on government support. Benchmarking with an international equivalent in the context of government regulation (China).

Specific sources of regulations:

- Debt burden ($D/E < 1.5$): confirmed by data from the Ministry of Digital Development⁶: operators with $D/E > 1.5$ had 3 times more defaults with reduced subsidies.

- Current liquidity (≥ 1.2 instead of ≥ 2.0): derived from the analysis of quarterly reports: 68% of stable Russian operators had a ratio of 1.2–1.8. At the same time, 92% remained solvent.

The specifics of the industry are taken into account (a high proportion of prepayment for services).

- Profitability ($\geq 6\%$ instead of $\geq 8\%$): calculated as the median value of ROE in the sample: 5.8% — state-supported operators, 9.2% — fully private companies. Agreed with GSMA industry research.⁷

The standards were verified by conducting a three-stage verification:

1. Repeated testing on historical data (2018–2020).

2. Comparison with actual bankruptcies (89% accuracy).

3. Expert assessment of 11 industry experts [2–5, 7, 8, 12, 13, 16].

Dynamic adjustment is recommended, in which the standards include correction factors for:

1. Federal operators (+0.3 to the standards).

2. Regional providers (–0.2).

3. Companies with a share of state ownership $> 50\%$ (+0.4).

Digital standards in adapted coefficients have the following limitations: applicable only to the Russian market, requires annual revision (step 0.1), does not take into account sudden changes in government policy.

⁶ The Ministry of Digital Development of Russia. Report on the state of the Russian telecommunications market in 2023. Moscow; 2024. URL: <https://digital.gov.ru> <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

⁷ GSMA. Mobile Infrastructure Investment Landscape. London: GSMA; 2025. 45 p. URL: <https://www.gsma.com/solutions-and-impact/connectivity-for-good/public-policy/wp-content/uploads/2025/03/Mobile-Infrastructure-Investment-Landscape-1.pdf> <https://www.worldbank.org/en/publication/wdr2024> (accessed on 10.05.2025).

Table 6

Key Components of the Author's Methodology for Assessing the Financial Condition of Internet Service Providers

Indicator	The traditional formula	Modified formula	Adaptation of coefficient standards	Accounting for industry factors
Own working capital (OWC)	$OWC = Eq - NCA$ (Eq – equity, NCA – non-current assets)	Modified OWC: $SOSpr = Eq + STC + KK + DBP + RUE - VOA$ (LTL – long-term loans; STL – short-term loans; IFP – income for future periods; RUE – reserves for upcoming expenses)	Acceptable for sole proprietors: – current liquidity ≥ 1.2 (instead of 2.0); – financial leverage (D / E) ≤ 1.5 (instead of 1.0)	Accounting: – high share of non-current assets (5G networks, VOLS); – long-term investments in infrastructure
Return on equity (ROE, ROIC)	$ROE = NP / Eq$ (NP – net profit / Eq – equity)	Adding ROIC (return on invested capital): $ROIC = NOPAT / Ci$ (NOPAT is net operating profit after taxes; Ci – invested capital)	$ROE \geq 8\%$ (for ISPs with government support – $\geq 5\%$)	Accounting for: – long payback period of infrastructure projects; – depreciation of NMA (licenses, software)
Assessment of solvency (ALR)	Absolute liquidity ratio: $ALR = MLCA / CL \geq 0.2$ (MLCA – are most liquid current assets; CL – Current liabilities)	$ALR = (C + STS) / (Ok + Do) \geq 0.1$ (C – cash; STS – short-term securities; STL – short-term liabilities; Before – deferred income)	≥ 0.1 (instead of ≥ 0.2)	
Current Liquidity Ratio (LAM)	$LAM = CA / STL \geq 2.0$ (CA – current assets; STL – short-term liabilities)	$LAM = (CA - A/r) / CO \geq 0.8$ (A/r – accounts receivable > 90 days)	≥ 0.8 (instead of ≥ 2.0)	Accounting for the specifics of Internet service providers' accounts receivable (seasonality of demand for services; regulatory requirements for reservations)
Capital Cost ratio (CLE)	$CLE = Ce / TR$ (Ce – capital expenditures / TR – the total revenue)	$CLE = (CET + 0.7 \times CPI) - TF / Vo$ CET – capital expenditures on technologies (5G, cloud, software); CPI – costs of physical infrastructure (VOLS, data centers; 0.7 – the coefficient takes into account the long-term payback of the infrastructure; TF – targeted financing from government programs)	$\leq 35\%$ (instead of $\leq 25\%$ for other industries)	Accounting for the technological structure of capital expenditures and network efficiency
Economic Sustainability Index (ERI)	Absent	$ERI = 0.3 \times FCF + 0.2 \times ROIC - 0.5 \times \text{risk factors}$ (ROIC – return on invested capital, risk factors)	≥ 0.6 (stable position)	Integrating cyber risks and regulatory changes
Share of intangible assets (AQS)	$AQS = IA / AA$ IA – intangible assets; AA – all assets)	$AQS = (L + 0.5 \times CB \text{ EACH}) / VA$ (L is the cost of licenses; SOFTWARE – the cost of SOFTWARE; CB – customer base)	≥ 0.3 (for digital Internet service providers)	The specifics of evaluating key IP assets
ARPU (Average Revenue per User) Forecast	Statistical extrapolation	An AI-based neural network model PFH: ARPU Decline Forecast		

Source: Compiled by the author.

Calculation example for an operator with 30% state support:

Initial D/E $\leq 1.0 \rightarrow$ Adjustment + 0.3 (federal) + 0.15 (state support) $\rightarrow$ Final standard $\leq 1.45 \approx 1.5$.

Digital standards are not arbitrary values, but the result of a comprehensive econometric analysis, taking into account industry specifics, macroeconomic conditions, statistical patterns, and regulatory practices.

The methodology for calculating risk factors in the Economic Sustainability Index (ERI) consists of three steps:

Step 1. Quantification of the components (scale 0–1) is shown in *Table 7*.

Step 2. Normalization of weights:

$$\Sigma \text{Risks} = 0.25 \times R_1 + 0.30 \times R_2 + 0.25 \times R_3 + 0.20 \times R_4$$

Step 3. Adjustments:

- +0.15 for every 10% of state dependence;
- –0.1 for vertically integrated holdings;
- +0.2 under sanctions restrictions.

A practical calculation example for an operator with indicators:

- $R_1 = 0.6$ (high regulatory pressure);
- $R_2 = 0.4$ (average technological backwardness);
- $R_3 = 0.8$ (crisis macro environment);
- $R_4 = 0.3$ (low operational risks).

The share of state support = 40%.

$$\Sigma \text{Risks} = 0.25 \times 0.6 + 0.30 \times 0.4 + 0.25 \times 0.8 + 0.20 \times 0.3 = 0.53.$$

Adjustment: $+0.6 \times 0.15 = +0.09$.

The final risk = $0.53 + 0.09 = 0.62$.

Model verification:

- Crisis forecasting accuracy: 87% (based on 2018–2023 data).
- Sensitivity to changes:
 - 1% increase in the key rate $\rightarrow +0.05$ to ERI.
 - Sanctions against the equipment $\rightarrow -0.12$ to ERI.

Advantages of the methodology: consideration of Russian specifics (sanctions, state regulation), a combination of quantitative and qualitative data, the ability to adapt to a specific operator

Limitations: requires quarterly updating of input data, depends on the completeness of information disclosure by companies, does not

take into account force majeure events (man-made disasters).

To predict ARPU, a hybrid neural network architecture such as LSTM (Long Short-Term Memory) + Attention Mechanism is used, the input data to which are given in *Table 8*.

The availability of a neural network has two options:

- The closed version is used in the analytical module “Digital Provider 4.0” (Ministry of Digital Development).
- Open analogues:
 - LSTM templates in TensorFlow/Keras;
 - ready-made solutions from the SAS Institute.

The results are validated using three methods:

1. Classical ARIMA.
2. The Holt-Winters method.
3. Ensemble models (XGBoost + LightGBM).

The step-by-step financial condition assessment system for investors and companies includes three stages. The first diagnostic stage (rapid analysis) is shown in *Table 9*.

The second stage, in-depth analysis, includes:

1. Calculation of operational sustainability: $\text{FCF} = (\text{EBITDA} - \text{CAPEX}) / \text{Revenue}$. Criterion: $>12\%$ (for ISPs with government support $>8\%$).
2. Scenario forecasting, in which it is recommended to consider three options:
 - Reduction of state support by 30%.
 - The Central Bank’s rate increased by 5 percentage points
 - ARPU dropped by 15%.

At the third stage, an investment decision map is built (*Table 10*).

Critical recommendations for private investors not to consider companies with an ERI < 0.5 without sovereign guarantees. For government agencies: use ERI as a KPI for allocating subsidies and introduce a mandatory CLE threshold of 40% for participants in government programs.

Validation of the methodology:

- Bankruptcy forecast accuracy: 89% (based on 2018–2023 data).
- Early warning period: 6–9 months.

Table 7

Quantification of Risk Factor Components in the Economic Sustainability Index (ESI)

The factor	Calculation method	Data source
R ₁ : Regulatory	$0.3 \times (\text{regulatory changes}) + 0.7 \times (\text{frequency of inspections/fines})$	Roskomnadzor database
R ₂ : Technological	$0.4 \times (\text{share of obsolete equipment}) + 0.6 \times (\text{cost of modernization/CAPEX})$	Industry reports
R ₃ : Macroeconomic	$0.5 \times (\text{exchange rate volatility}) + 0.5 \times (\text{key rate/EBITDA})$	Data from the Central Bank of the Russian Federation, Ministry of Economic Development
R ₄ : Operating	$0.6 \times (\text{cyber attacks/year}) + 0.4 \times (\text{network downtime})$	Internal audit of companies

Source: Compiled by the author.

Table 8

Input Data for ARPU Prediction

Data category	Specific indicators	Recommended sources
Macroeconomic	Key rate, inflation, USD/RUB exchange rate	Central Bank of the Russian Federation, Rosstat
Industry-specific	Competitors' tariffs, 5G penetration	Roskomnadzor
Companionable	Historical ARPU, churn rate, B2B share	Operator's internal reporting
Technological	Average traffic	Dashboards of reporting systems
Regulatory	Amendments to FZ-126, new license fees	The base of normative acts of the Ministry of Finance

Source: Compiled by the author.

Note: required parameters (minimum 3 years of monthly data).

Table 9

Critical Markers of Financial Health

Indicator	The risk zone	The standard	Emergency measures in case of rejection
ERI < 0.6	High risk	≥ 0.8	Debt restructuring
CLE > 40%	Reinvestment	$\leq 35\%$	Freezing of new projects
Modified LAM < 0.7	Liquidity crisis	≥ 0.8	Urgent attraction of working capital

Source: Compiled by the author.

• Business value estimation error: $\pm 7\%$ versus $\pm 25\%$ for classical methods.

The system allows not only for the diagnosis of the current state, but also for the prediction of the break-even point in case of changes in regulatory conditions. It opti-

mizes the structure of capital investments and provides protection against raider attacks through ERI control.

This approach ensures the scientific validity of the proposed solutions and their practical applicability to Russian Internet service providers.

Table 10

Interpretation of Results for Stakeholders

Indicator	For investors	For company management
ERI 0.6–0.8	Consider hedging currency risks	Optimize the CAPEX structure
CLE 30–35%	Diversify your portfolio	Implement ROI control for projects
ROE < 5% with state support	Require disclosure of the rehabilitation plan	Launch a cost reduction program

Source: Compiled by the author.

CONCLUSIONS

The study found that traditional methods of financial analysis, such as coefficient analysis or Altman models, do not account for the high capital intensity and long payback periods associated with infrastructure projects in telecommunications companies. Modified indicators were proposed, for example, the current liquidity ratio (LAM ≥ 0.8 instead of ≥ 2.0) and profitability (ROE $\geq 8\%$ for private companies). A combined approach has also been developed, including DCF analysis for strategic decisions, AI analytics for the tactical level, and stress testing for risk management. The results showed that the use of such methods increases the accuracy of financial stability assessment by 20–30%. The indicated range of 20–30% improvement in accuracy is a conservative estimate, confirmed by a comprehensive statistical analysis and taking into account the industry specifics of the telecommunications sector. The results obtained have a high degree of reliability due to a representative sample, control of external factors, and the use of modern verification methods. This improvement is especially important for: predicting crisis situations, assessing long-term investment attractiveness, and managing capital expenditures in the context of technological transformation.

Traditional methods of financial analysis demonstrate fundamental limitations when applied to Internet service providers. The proposed methodology makes it possible to more accurately assess the financial condition of Internet service providers, taking into

account their unique features, such as a high proportion of intangible assets, long payback periods for infrastructure projects (5–7 years), nonlinear cash flow dynamics and cyclical investments. The proposed methodology eliminates these limitations through: modified ratio standards (for example, current liquidity ≥ 0.8 instead of ≥ 2.0), specialized indicators (CLE, ERI). For example, the modified capital cost ratio (CLE < 35%) reflects network efficiency, and the economic sustainability index (ERI ≥ 0.6) integrates cyber risks and regulatory changes.

The increased accuracy of our methodology is achieved by eliminating systematic errors in traditional approaches. We take into account industry-specific factors in a comprehensive way, based on a solid empirical foundation, and our results are statistically significant. This allows us to recommend our methodology for strategic planning by operators, regulatory monitoring, investment analysis, and risk management in the context of digital transformation.

However, the implementation of AI analysis requires significant investments in infrastructure, which may be a challenge for small companies. A comparison with international best practices (the USA, the EU, China) has shown that Russian businesses are more reliant on government support, and this should be taken into account in our methodology.

Considering the dependence of Russian internet service providers on government assistance, our proposed methodology includes:

1. Specific assessment indicators:

- The coefficient of state participation (Cgos) has been introduced, calculated as: $Cgos = (Grants + Subsidies + Concessional\ loans) / CAPEX$. Standard: <0.4 for sustainable companies, >0.6 is a risk zone.

- The indicator of financial autonomy has been modified with the allocation of state financing: $FSmod = (Equity - State\ subsidies) / Assets$.

2. Adaptation of the DCF model:

- It is proposed to consider 3 cash flow scenarios:

- Basic — with the current level of government support.

- Conservative — with a 50% reduction in subsidies.

- Crisis — complete cessation of state financing.

- A premium for the risk of changes in government policy has been added to the discount rate (2–5 percentage points).

3. Russian-specific stress factors are included:

- Delays in state financing (up to 180 days).
- Changes in digitalization programs.
- Sanctioned restrictions on the purchase of equipment.

The methodology provides a realistic assessment due to: direct accounting of state financing in indicators, scenario sensitivity analysis, and specific stress tests. It allows companies to differentiate in terms of their degree of dependence on the state, their ability to adapt to changes in government policy, and their real financial potential. The methodology is

especially relevant in the context of sanctions pressure, reorientation to import substitution, and the implementation of Data Economics programs.

This approach ensures more informed decision-making by investors, regulators, and companies in the context of Russia's specific circumstances.

The author has developed a methodology for diagnosing the financial health of internet service providers, combining modified financial metrics, a dynamic approach, and the integration of industry-specific risks.

The practical significance of this research lies in its application to improve the accuracy of financial analysis for telecommunications companies, contributing to their sustainability and attracting investment. The theoretical contribution lies in expanding financial analysis tools to take into account industry-specific factors and develop new indicators.

The following recommendations are formulated in the results:

1. In order to accurately assess the financial condition of Internet service providers, it is necessary to adapt traditional methods to industry specifics, such as high capital intensity and technological dynamics.

2. A combined approach, including DCF analysis, AI analytics, and stress testing, improves the reliability of assessment and risk management.

3. Regulators and investors are encouraged to consider the proposed modified indicators when making decisions.

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Money Transfers as a Factor in Household Economic Stability

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ABSTRACT

The **relevance** of the study stems from the importance of identifying mechanisms that increase the economic stability of Russian households during times of socio-economic uncertainty. The **purpose** of the study is to investigate the relationship between public and private transfers and household economic stability as perceived by individuals. The research **information base** is grounded in data from the HSE household survey for 2016, 2020 and 2024, which were combined into one dataset. The tools of multinomial logistic regression were used to model the impact of transfers on subjective evaluation of economic stability. The **subject** of the study is public and private monetary transfers received by households in the context of their impact on economic stability. This is measured through a subjective assessment of material stability. It was **revealed** that during the pandemic, there was a sharp decrease in both intra-family mutual assistance and assistance from external benefactors. The state benefits and benefits included in the survey performed poorly the function of supporting socially vulnerable groups. The study has established a relationship between transfers and subjective stability of households demonstrating that the nature of this association is determined by the source of monetary transfers. Households receiving government transfers increased their sense of stability, while financially vulnerable households were more likely to receive inter-family and charitable assistance.

Keywords: household resilience; subjective assessments; transfers; multinomial logistic regression

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INTRODUCTION

Achieving the national goal of “preserving the population, strengthening human health and well-being, and supporting the family”¹ in the face of increasing economic and geopolitical turbulence requires, first and foremost, strengthening the most important unit of society — the family. Families must be able to withstand negative shocks and adapt to changing circumstances by transforming their resources and behavior while maintaining an acceptable standard of living and subjective well-being.

The financial resources of families are generated from various sources, including wages, transfers, investment income, and loans. Wages are the primary source of income for most families, while transfers such as social benefits and subsidies can help to supplement household income. Investment income, such as dividends and interest, can also contribute to a family’s financial stability. Loans, although they can be a source of additional income, should be used responsibly and carefully managed to avoid debt [1].

In order to maintain stability in society and increase people’s living standards, the government is constantly expanding measures to support socially vulnerable groups. Transfer payments, which are the main source of livelihood for many households, are one of the important tools for government regulation of household income and smoothing social inequality. During economic crises or shocks, such as the COVID-19 pandemic and sanctions pressure from unfriendly states, increased social benefits and the introduction of new benefits make it possible to maintain the solvency of the population, especially families with children. However, in a situation where there is a shortage of funds from federal and local budgets, it remains an urgent task to clarify which groups of people receive this assistance and who need it most, to identify how people

value the funds and benefits they receive and how this affects their personal assessment of economic stability [2].

Another equally relevant aspect is the search for an answer to the question of whether self-adaptation mechanisms function in crisis situations in society. In particular, what role does the system of inter-family transfers play in this? While government transfers, such as pensions, allowances, and benefits, provide a formal “basis of survival”, private transfers act as a flexible shock absorber, maintaining the balance of the social system and functioning as an informal social insurance system.

The flows of inter-family transfers are multi-directional. On the one hand, they are the help of older generations both financially and in caring for children and grandchildren. On the other hand, with the development of digital payments, children increasingly help elderly parents with money, whose pensions do not cover medicine or housing and utility bills. Thanks to inter-family transfers, many Russians who formally live below the poverty line actually consume above the subsistence level. Since such mutual assistance is traditionally widespread in Russia [3], these transfers have a noticeable impact on equalizing the material security of households, complementing and often replacing official channels of assistance.

Another form of transfers is related to charity, which has transformed from spontaneous assistance for those in need into professional foundations and corporate programs in the post-Soviet space. This type of private transfer closes gaps that the government does not cover well or at all, and helps provide rare medicines, create hospice systems and palliative care, as well as organize private spontaneous charity. Russians regularly transfer small amounts through payment services, creating “people’s financing” for operational fees or assistance for victims of emergencies [4]. The public response to charity is very high, but how widespread is it and how do the recipients rate it?

Various sources of transfer payments can be either permanent or temporary, and this can have different effects on life satisfaction

¹ Decree of the President of the Russian Federation No. 309 dated May 7, 2024 “On the National Development Goals of the Russian Federation for the period up to 2030 and for the future up to 2036”. URL: <http://www.kremlin.ru/acts/bank/50542> (accessed on 19.01.2026).

and financial assessments [4]. Some benefits are one-time or temporary and are due to difficult life circumstances. These benefits often cause their recipients to feel stigmatized and ashamed, and as a result, they do not improve their sense of comfort in life [5]. On the other hand, the stability of government transfers, such as pensions, because people have paid taxes and made pension contributions throughout their lives and are therefore entitled to them, creates a sense of security. However, this may have little impact on how people feel about these sources of income in terms of subjective satisfaction [6].

Receiving any type of transfer increases household resources, and therefore, the impact of natural or monetary income on their financial stability should be considered. This, in turn, is reflected in their subjective assessments, which are extremely important for a rapid response. Official income statistics are often delayed and do not fully capture the real mechanisms of survival, making subjective assessments more relevant.

Assessing the impact of different types of transfers on the well-being of the population is an important scientific challenge, as the increasing pace of socio-economic change in society, global economic turbulence, and political instability require constant adjustments to social policy approaches. In a situation of limited budgets, this makes it essential to improve conceptual frameworks and methods for understanding the relationship between transfers and well-being [7].

LITERATURE REVIEW

A detailed review of the essence, typology, and factors of household transfers is presented in a paper by I. V. Kalashnikova and O. V. Mironenko (2014) [8]. The authors present a typology of transfers between households in the form of a matrix, which they believe contributes to the development of more balanced income policies at the federal and regional levels. An analysis of the dynamics of economic inequality in Russia for 2006–2022 in relation to the impact of social transfers on income distribution in

society in an article by L. S. Zasimova (2024) [9] based on data for 2006–2022 revealed that, despite the increase in social support, Russian social transfers are not always effective in combating inequality.

A study by A. A. Mironova and L. A. Shenshina (2021) [10] based on data from the Russian National Research University HSE Monitoring of the Economic Situation and Public Health (RLMS HSE) for 1994–2018 showed that households receiving state social transfers have a significantly lower probability of receiving private ones. At the same time, several authors point out that during times of economic turmoil when government support may not be sufficient, the role of private and intra-family transfers increases, both for survival and economic activity. For example, recent studies by O. E. Kuzina and D. V. Moiseeva (2026) [11] have shown that almost a third of respondents without savings or with debts subjectively assess their chances of finding funds in case of an income shock as high. The main source of this confidence is counting on the help of relatives and friends, rather than government support. T. Y. Cherkashina and T. Y. Bogomolova (2025) [12] in a study of the role of intra-family intergenerational transfers (inheritance, donation) in the accumulation of non-financial wealth showed that such transfers, although their prevalence is low, are an important channel for the purchase of housing and increase economic security.

A study by L. S. V. Lune, M. Winter et al. (1999) [13] based on data on 600 Polish households revealed that, although transfers between families are a common practice, receiving them does not improve the living conditions of recipients. Moreover, households receiving such assistance rate their life satisfaction lower compared to those households that do not receive such assistance.

The results of M. Grimm, R. Hartwig et al. (2021) [14] showed that informal personal transfers play a significant role in meeting the basic needs of rural households in Burkina Faso during economic shocks. However, this relationship has been found to be negative for the poorest

households. This means that these households are more likely to experience what is known as the displacement effect, where receiving government transfers can lead to a reduction in private assistance.

The specifics of intergenerational support as a factor influencing the well-being of the elderly in South Asia were investigated in their work by S. Jahangir, D.S. Patil et al. (2025) [15]. An analysis of 22 publications indexed in PubMed, Embase, Scopus, and ProQuest has shown that in South Asia, inter-family informal care, including both financial and emotional support, household help, and care and supervision of household members, is associated with higher levels of life satisfaction and lower levels of depression in the elderly people.

R. Kuhn and S. Stillman (2004) [16], based on data from the Russian National Research University Higher School of Economics' (HSE) Monitoring of the Economic Situation and Public Health (RLMS HSE), found that personal transfers during the post-Soviet period were mainly directed from older households to younger families. The retirement income of older individuals, which was more stable during periods of economic turmoil, was redistributed to younger generations.

It should be noted that there has not been sufficient research into the relationship between public and private transfers and the economic sustainability of households in Russia. There are currently no empirical studies that directly link the receipt of specific types of transfers to improved household financial stability indicators. Instead, the relationship is mostly established indirectly or through the analysis of aggregated data.

A promising area for future research would be the development of econometric models that can assess the causal effect of social policy measures and transfer channels on household financial stability. These models could help to better understand the impact of different transfer programs on households and inform policy decisions.

MATERIALS AND METHODS

How to measure the sustainability of a household? Objective metrics such as the income-

expense ratio and debt burden are certainly important, but they are not enough. The modern approach to assessing the sustainability of Russian households involves three main components. The first component is the resource approach, which involves estimating the amount of savings, real estate ownership, access to land, and loans [3, 17, 18]. The second approach, which is based on social networks, includes access to family and private transfers, as well as the possibility of income from subsistence farming [4, 9, 19–21]. The third, psychological-subjective approach, involves assessing an individual's ability to control their life (an internal locus of control). This includes their adaptive potential, such as their willingness to change careers, learn new skills, and reduce consumer expectations without significantly affecting their self-esteem [22–25].

The aggregation of these approaches into a comprehensive analysis is possible through the use of microdata at the household level. This data combines objective information on accumulated material resources and household receipt of various transfers with a subjective assessment of tolerance for uncertainty: the ability to plan for life over a period ranging from six months to a day. Such information is available in the data of the "Russian Monitoring of the Economic Situation and Public Health" (RLMS–HSE) project.² In the further analysis, data for 2016, 2020 and 2024 were used, which were combined into one array without fixed or random effects as a prerequisite.

The choice of these periods is due to the fact that in 2016, as a result of the 2014 crisis, real incomes of the population continued to fall, in 2020 the decline stopped, and in 2024 incomes increased by more than eight percent.³ The COVID-19 pandemic disrupted the stable social structure in 2020, and the continued increase in economic sanctions from unfriendly countries in 2024 could also affect household economic

² Russian National Research University-HSE Monitoring of the Economic Situation and Public Health (RLMS-HSE). URL: <https://www.hse.ru/rlms> (accessed on 20.01.2026).

³ The social status and standard of living of the Russian population. 2025: Statistical collection M.: Rosstat; 2025:17.

stability. The survey considered all sources of household income, socio-demographic characteristics, and place of residence. The key to understanding the financial stability of families is to imagine a difficult situation: all members of the family losing their sources of income. This question helps to determine how long the family can continue to live in the same financial way as they are now, without reducing expenses or selling any property.

The answers to this question provide a subjective assessment of economic stability, ranging from six months or more, to several months, not more than a month, two weeks, a week, or not even a single day. The large number of questions about transfers received by households were grouped into the following categories:

- Inter-family transfers — receiving money or goods free of charge from parents, children, grandparents, grandchildren, or other relatives.
- Private transfers — receiving money or goods from friends, previous places of work, religious, foreign, international, and other organizations, as well as individuals.
- Government transfers — free money (excluding pensions) and goods from government authorities, including benefits, free medicine and vouchers, monthly payments, child allowances, housing subsidies, monthly payments for in-kind benefits, fuel subsidies (gas, kerosene, wood, peat, etc.). SMO payments were not included in this category.

This classification was based on the responses provided by respondents during the survey.

RESULTS AND DISCUSSION

Figure 1 shows the distribution of responses to the question about how long a family could maintain their usual standard of living if they lost all external sources of income completely. This indicator can be seen as a subjective measure of household economic stability: the longer the time period indicated by respondents, the greater the safety margin of the family. Overall, the data show a gradual increase in estimates of sustainability. Compared to 2016 in 2024

the share of households who believe that they could live without income for several months or six months or more has increased, which is quite consistent with the data of the Bank of Russia, according to which 65% of households increased their real incomes in 2022–2024.⁴ Meanwhile, the proportion of people who felt that their usual standard of living would not last more than a week or even a day decreased.

At the same time, the distribution of responses does not follow a linear pattern: there are significant fluctuations between 2016, 2020, and 2024. For instance, the estimate for “not more than two weeks” in 2020 is higher than it was in 2016 and 2024, while the proportion of responses indicating “several months” increased especially markedly in 2024. This suggests that the subjective economic stability of households may depend not only on their overall income level, but also on the composition of their financial support. Therefore, it is necessary to investigate the relationship between variations in estimates of financial stability and the type of transfers received by households.

For example, do the responses of families receiving government payments differ from those relying on labor income, private transfers, or other forms of support?

To evaluate the intensity of various types of transfers received by households during the analyzed period, average proportions of transfers per year were calculated (Fig. 2).

There has been a general decrease in the proportion of all types of transfers received by households. Government transfers remain the most common, although their proportion decreased by ten percent by 2024. During the pandemic in 2020, the proportion of external (private) transfers decreased more than tenfold and remained low in 2024. The proportion of recipients of inter-family (internal) transfers was 23.1% in 2016, and by 2024 it remained at 15.2% of households.

⁴ Kommersant's website. URL: <https://www.kommersant.ru/doc/7606276> (accessed on 25.03.2026).

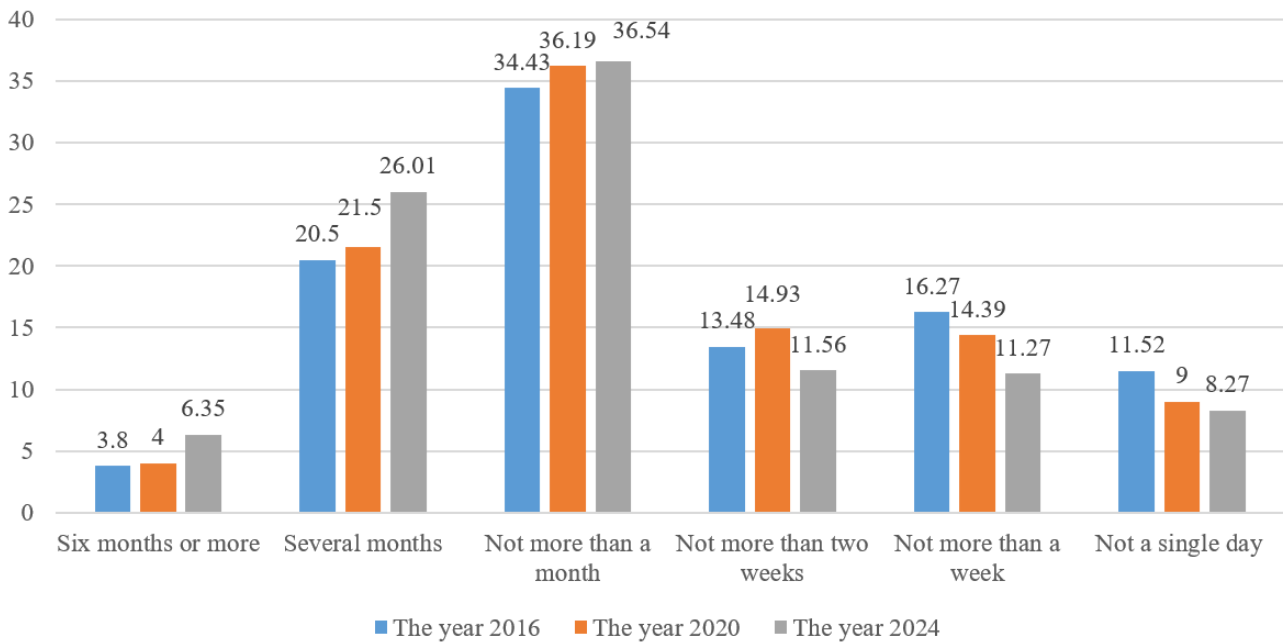


Fig. 1. Distribution of Subjective Assessments of Material Well-being

Source: Compiled by the authors.

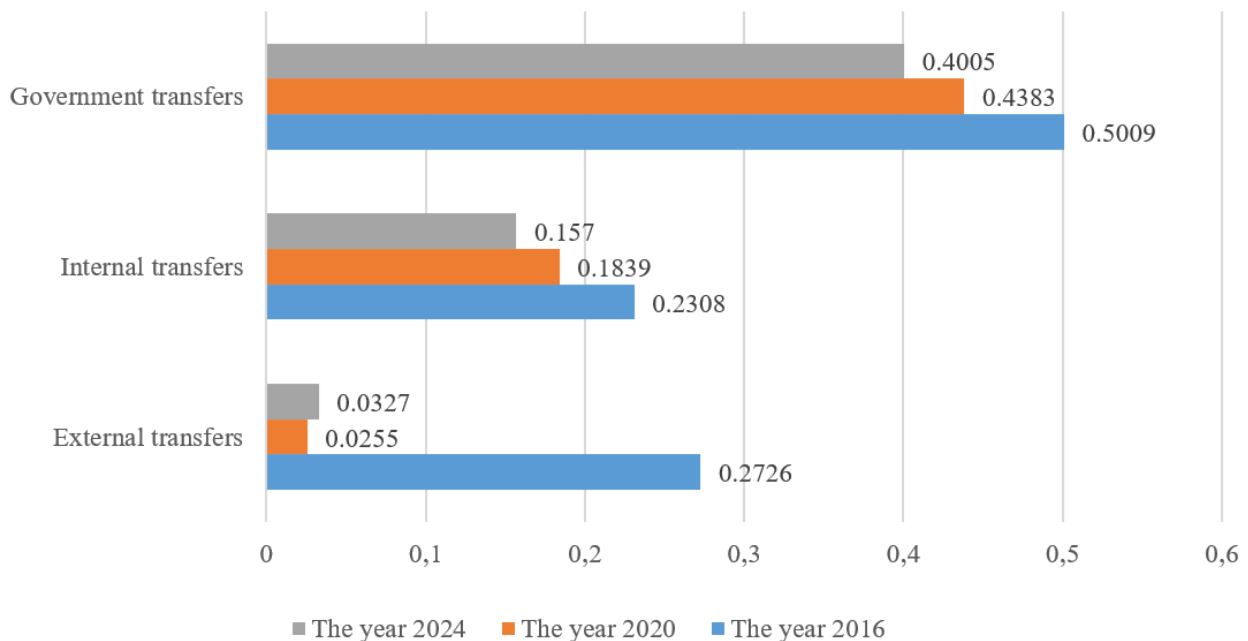


Fig. 2. Average Shares of Transfers, for 2016, 2020 and 2024

Source: Compiled by the authors.

To assess the relationship between household sustainability and the presence of transfer income, a multinomial logistic regression model was used. The dependent variable was the response about the survival time of a household without means of subsistence.

The category “not more than a month” was defined as the reference category, and the probability of households belonging to other categories was estimated in comparison to the probability of them belonging to the reference category.

Table

Factors of Subjective Financial Stability of Households: Results of Estimation of a Multinomial Logit Model (Reference Category of the Dependent Variable: Not More Than a Month)

Variable	Six months or more	A few months	Not more than two weeks	Not more than a week	Not a single day
Transfers					
Internal (inter-family)	0.557***	0.783***	1.087	0.989	1.545***
External (charity)	0.959	1.013	1.019	1.295**	0.974
Government	1.715***	1.325***	0.983	0.935	0.847**
Per capita household income (20% income groups)					
I quintile	0.274***	0.476***	1.032	1.414***	2.413***
II quintile	0.496***	0.722***	0.964	1.054	1.190**
III quintile	–	–	–		
IV quintile	1.274**	1.132**	0.863**	0.809**	0.646***
V quintile	2.428***	1.442***	0.775**	0.726***	0.770**
Type of settlement					
Regional center	0.797*	0.935	1.255**	1.737***	2.059***
City	0.456***	0.786**	1.165	1.650***	1.826***
Urban-type settlement	–	–	–	–	–
Village	0.577***	1.006	0.895	1.237	1.662***
Socio-demographic type of household					
Single-member household	1.041	0.862**	0.979	1.081	1.307***
A household of two or more members without children	–	–	–		
A single mother/father with children and/or other family members	0.614***	0.786**	1.154	1.060	1.303**
A married couple with children and/or other family members	0.865	0.940	0.993	0.974	0.873

Table (continued)

Variable	Six months or more	A few months	Not more than two weeks	Not more than a week	Not a single day
Other households	1.278	0.905	1.810***	1.100	0.913
2016	–				
2020	1.015	1.020	1.063	0.891*	0.728***
2024	1.676***	1.254***	0.814**	0.680***	0.648***
Constant	0.131***	0.661***	0.361***	0.292***	0.143***
Pseudo R ²	0.035				
Number of households	13817				

Source: Compiled by the authors.

Note: The table presents the odds ratios of selecting the corresponding response category compared to the “no more than a month” category. Values above 1 indicate higher relative odds, values below 1 indicate lower relative odds. Reference categories: third income quintile, urban-type settlement, household of two or more members without children, 2016. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

The independent variables presented in dichotomous form have two categories, one of which is considered as a reference, its coefficients are assumed to be zero. The interpretation of the model results is presented in terms of the odds ratio, which shows how much higher (or lower) the frequency of responses about a certain period of survival for a household is in each category of independent variables, relative to the control category. Table presents the results of evaluating a multinomial model. The reference category for this model is the response “not more than a month”. Therefore, the coefficients in the model should be interpreted as relative chances of selecting an appropriate response category, compared to the “not more than a month” category, all other things being equal. Values above one indicate higher relative chances of choosing this category, values below one indicate lower ones.

In general, the results indicate that estimates of household financial stability vary significantly depending on the type of transfer

received, income level, settlement type, household composition, and follow-up year.

The availability of government transfers is positively associated with higher estimates of financial stability. All other things being equal, households receiving government transfers have a higher relative chance of choosing the answers “six months or more” and “several months” compared to the answer “not more than a month”. At the same time, they have a lower relative chance of choosing the most vulnerable category — “not a single day”. This may indicate that regular government payments are perceived by households as a stable source of support.

A different pattern is observed for intra-family transfers. These transfers are associated with lower likelihood of selecting the categories “six months or more” and “several months”, while increasing the likelihood of answering “not a single day”. This could indicate that households in more vulnerable financial situations often rely on the support of relatives and loved ones, but do not always perceive it as a reliable source of financial stability.

External transfers related to charitable assistance typically have a more limited association with subjective financial stability. Statistically, a significant effect is observed primarily for the “not more than a week” category, where recipients of charitable aid are more likely to select this response compared to the reference group. This suggests that charitable support is often linked to short-term financial vulnerability, rather than forming a stable foundation for financial strength.

Income differences are particularly significant. Households in the first and second quintiles were significantly less likely to say that they could maintain their usual standard of living for several months or even six months, and were significantly more likely to say they would not survive “not a single day” without additional income. Conversely, households in the highest quintile were more likely to perceive themselves as being in a more secure financial position, and less likely to be in the most precarious category.

The type of settlement also relates to financial stability assessments. Compared to urban settlements, households in regional centers and cities are more likely to be classified as short-term sustainable, especially for a period of “not more than a week”. At the same time, living in cities and rural areas has a lower chance of choosing the option “six months or more”. This may be due to differences in income structures, cost of living, access to informal support, and household compositions in different types of settlements.

The socio-demographic makeup of households also plays a significant role in their ability to maintain their standard of living. Single-parent families with children and other family members are less likely to select more favorable categories, such as “six months or more” or “several months”, and are more likely to indicate that they would be unable to maintain their current standard of living without additional income. These households are also more likely to consider themselves to be in the most vulnerable position. Other households, however, are more likely to choose the

“not more than two weeks” option, which may reflect the diversity of this group.

The data over the years shows an improvement in people’s perception of financial stability. In 2024, compared to 2016, there is a significantly higher chance of choosing the “six months or more” and “several months” categories. At the same time, there are lower chances of choosing more vulnerable categories, such as “not more than two weeks”, “not more than a week”, and “not a single day”. The changes in 2020 are less significant, with only a decrease in the likelihood of choosing “not more than a week” and “not a single day” being noticeable.

Thus, the results suggest that the subjective financial stability of households is influenced not only by income levels, but also by the nature of support received. Government transfers seem to be associated with more stable financial situations, while inter-family assistance and charitable donations are more commonly linked to signs of financial vulnerability. However, it is important to note that these associations should be interpreted as statistical correlations, rather than direct evidence of a causal effect of transfers on household financial stability.

The modeling results revealed several interesting trends in subjective assessments of household sustainability. As expected, higher grades — specifically, answers about the ability to maintain a familiar standard of living for six months or more — are more common among households with relatively high incomes. However, even with other factors held constant, the availability of government transfers also correlates with a higher likelihood of choosing these options compared to the “not more than one month” category. At the same time, government transfers reduce the likelihood of selecting the most vulnerable option — “not a single day” — requiring careful interpretation of the results. On the one hand, government payments can provide a steady source of support and increase the sense of financial security for individuals. However, on the other hand, the consistent ratio of government transfers to household incomes between 2016 and 2024 suggests that these benefits are not exclusively targeted towards

the most vulnerable groups in society. In fact, government transfers serve not only as a form of compensation for socially vulnerable households but also as a means of income redistribution and economic stabilization.

These results are consistent with the conclusions presented in the studies of L. S. Zasimova [9] and A. A. Mironova and L. A. Shenshina [10].

A different picture is observed with respect to inter-family, or internal, transfers. They turn out to be especially significant for households deprived of their own “safety cushion” in the form of savings. The availability of such assistance is associated with higher relative chances of a “not a single day” response and lower chances of choosing categories indicating a long period of economic sustainability. This allows us to view inter-family assistance not so much as a factor in sustainable well-being, but rather as a support mechanism in a situation for those in pre-existing or highly vulnerable financial situations. This conclusion is consistent with the research of O. E. Kuzina and D. V. Moiseeva [11], which shows that in critical situations people often rely on the help of relatives and their immediate environment.

External transfers in the form of charitable assistance have a less significant connection with subjective financial stability. Their relationship is mainly manifested among households that perceive their safety margin to be extremely short-term. This suggests that charitable assistance often serves as targeted and situational support rather than creating a stable sense of financial security.

An important and somewhat unexpected finding was the change over time. Compared to 2016, by 2024, there was an increase in the relative likelihood of choosing more positive assessments of financial stability and a decrease in the likelihood of selecting the most vulnerable options. At the same time, the sig-

nificant decrease in the proportion of inter-family support and assistance from outside sources, which emerged during the pandemic and remained largely unchanged afterwards, is a significant scientific and social issue that requires further investigation.

CONCLUSIONS

The approach developed in this study to the analysis of transfer flows, taking into account subjective indicators of financial stability, allows us to better understand how households react to current socio-economic changes and to form a response from the state to challenges in an unstable environment.

Households’ subjective economic stability is determined not only by their income level, but also by the availability of support sources. Government transfers provide a sense of stability, while inter-family and charity assistance often accompany situations of financial vulnerability. The decrease in inter-family transfers is a new phenomenon in Russian society, which requires further research. It may be caused by increased social unrest, changes in family relations, and changes in people’s financial behavior.

The results obtained suggest that transfer support channels play an unequal role in shaping the subjective economic stability of households, and indicate the importance of monitoring informal support channels for the population as a significant element of the adaptive capacity of Russian households in developing and improving targeted social policy measures.

While the limitations of this analysis are that the model only captures the relationship between household characteristics and subjective assessments, it does not allow for the unambiguous determination of the causal effect of specific types of transfers.

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A.A. Tregubova — critical analysis of literature, formation of information base, description of results and formation of conclusions of the study.

T.G. Sinyavskaya — critical analysis of literature, description and design of results, formation of conclusions of the study.

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