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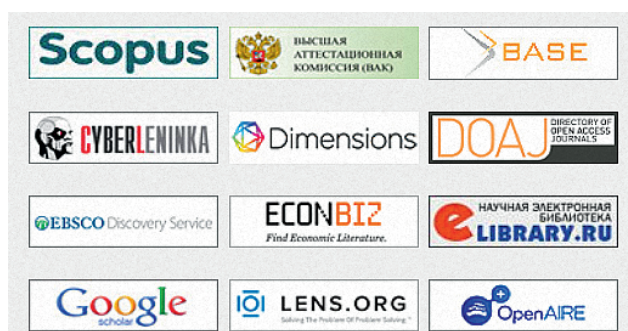
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# Budgetary Support for the Development of Russian Regions in Modern Conditions: Problems and Priorities (Using the Example of the Republic of Bashkortostan)

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## ABSTRACT

The aim of the study is to identify and analyze the problems and priorities of budgetary support for the socio-economic development in the Republic of Bashkortostan at the present stage and to develop recommendations for improving the balance of the parameters in the consolidated budgets of the regions from a perspective of strategic development priorities. The relevance of this study stems from the need to improve the quality of budget planning and support for socio-economic development at the regional level, based on the strategic priorities of the constituent entities of the Russian Federation, in the context of decreasing inter-budget transfers and increasing debt and tax burden on the regional economies. Research methods include systemic, logical and statistical approaches, as well as considering the requirements of budgetary legislation, strategic planning documents, and the parameters of regional economic security. Based on the results of the study, the following conclusions were drawn: 1) An analysis of the forecast parameters for the socio-economic and budgetary development in the Republic of Bashkortostan for 2026–2028 was conducted. This made it possible to identify the lag of the region in a number of indicators compared to the average for Russia (nominal GRP growth rates, average monthly wages, labor productivity, capital productivity). The revenue side of the regional budget is formed based on the planned increase in the contribution of tax revenue, primarily due to an increase in household income taxes; 2) The main problems and risks of budgetary support for sustainable socio-economic development in the region are highlighted – the negative impact of external environmental factors, such as maintaining sanctions and slowing growth rates in the global economy; imbalance of supply and demand in the economy; personnel shortages; insufficient levels of budget expenditure on education, healthcare and culture, affecting the quality of the human potential in the territory, from the standpoint of economic security requirements; growth of the debt burden; environmental risks, etc.; 3) Recommendations were given to improve the balance of the parameters in the consolidated budget of the Republic of Bashkortostan in order to achieve the strategic priorities for its development. Conclusions: The implementation of the proposed recommendations would contribute to improving the balance of regional budget systems and achieving the strategic priorities for the socio-economic development in the constituent entities of the Russian Federation.

**Keywords:** budget; socio-economic development; forecast; investments; region; balance; sustainability; economic security

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## INTRODUCTION

One of the significant sources of financial support for the sustainability of socio-economic development at the regional level is the budget of the constituent entities of the Russian Federation and local budgets, which form the consolidated budget of the region. Modern conditions for budgetary support of socio-economic regional development are characterized by intensified processes of centralization of resources within both the “federation – region” and “region – municipalities” systems, manifested in the form of reduced actual and planned volumes of inter-budgetary transfers in 2026–2028. This forces regional authorities to cover growing budget deficits by increasing debt borrowing, leading to increased debt burdens.

According to the budget of the Republic of Bashkortostan for 2026–2028,<sup>1</sup> the government debt burden (the ratio of government debt to tax and non-tax revenues) is expected to increase from 30% in 2024 to 36.4% in 2026. Additionally, the tax burden on businesses is also increasing, including income tax and lower thresholds for VAT. Big part of the taxes collected goes to the federal budget, while sanctions and tight monetary policies from the Bank of Russia are limiting economic activity in regions. This emphasizes the importance of efficiently using budgetary resources.

To address these challenges, there are two key objectives that need to be addressed: directing resources to priority areas and maintaining a balanced budget. It is crucial to ensure that resources are allocated effectively and efficiently to support economic growth and development in the region.

The research of N.V. Apatova [1], A.V. Veriga [2], L.M. Borsch and S.V. Gerasimov [3] and other authors is devoted to the issues of budget financing as a significant factor in ensuring sustainable socio-economic development of

territories. In [4], using the example of the Arctic regions of Russia, it was shown that the subjects of the Russian Federation with a high contribution of the budget sector to the development of the territory have a fairly balanced budget, an average level of budget security, a low level of public debt, and the presence of significant tax potential and a diversified economy act as drivers of development. These characteristics are largely true for the Republic of Bashkortostan, which is confirmed both by the parameters of the budget and debt development of the region,<sup>2</sup> and by the earlier analysis of its economic specialization [5], which showed a relatively high level of economic diversification of the subject.

The article [6] highlights an increase in the quality of program development and implementation in recent years. However, the lack of a unified strategic planning document at the national level, such as the Strategy of Socio-Economic Development of the Russian Federation, is a limiting factor. We believe that this aspect is also significant because it creates certain difficulties in setting goals and coordinating strategies for socio-economic development in the regions of the Russian Federation. These strategies have been adopted and are already in operation in the regions.

Other researchers [7] assign a significant role to the availability of budgetary and debt stability in the territory in ensuring the sustainability of regional development, reflecting the balanced development in a changing external environment.

In modern conditions of sanctions pressure on the Russian economy, the identification and assessment of factors of long-term ensuring the competitiveness of the country's economy becomes a priority for the implementation of socio-economic policy [8].

Strategic planning is also identified as a tool for long-term development of meso-level territories [9], which makes it possible

<sup>1</sup> Law of the Republic of Bashkortostan dated 12/22/2025 No. 375-z “On the Budget of the Republic of Bashkortostan for 2026 and for the planning period of 2027 and 2028”. URL: <https://minfin.bashkortostan.ru/documents/active/> (accessed on 15.01.2026).

<sup>2</sup> With the exception of recent years, the Republic of Bashkortostan had one of the lowest debt burden levels in the Volga Federal District (21.2% in 2022–3rd place).

to unlock the potential of territories and use available resources more efficiently, including in the budgetary and financial sphere. The existing problems of improving the quality of the strategic planning system [10] indicate the relevance of this area for both the federal and regional levels of government, including in the framework of the division of responsibility between them in various aspects [11].

Increasing their financial self-sufficiency is essential for budgetary support of long-term sustainable socio-economic development of regions. In [12], the author correctly notes that there is a need to more actively use budgetary policy instruments related to permanently assigning standards for deductions on tax revenues to regions, instead of relying on budget equalization through inter-budget transfers at a higher level in the budget system. Stable rules for distributing tax revenues and a clear understanding of the amount of fiscal resources available by regional and municipal authorities will contribute to improving the balance of territorial budgets and enhancing the effectiveness of strategic planning policies for the socio-economic development of territories.

Foreign researchers also highlight fiscal decentralization as a positive factor in ensuring sustainable, balanced development of territories, characterized by the consolidation of rates and standards for the distribution of tax revenues for territorial budgets. At the same time, the intensity of tax administration is important [13], ensuring the completeness of collection and efficient allocation of available tax resources. In addition, in order to increase the efficiency of using budget funds, fiscal decentralization should be interconnected with the decentralization of expenditures [14].

Indian scientists have concluded that fiscal decentralization plays a key role in the development of green energy. This conclusion was made based on an analysis of the experience of the European Union countries [15].

Chinese scientists have found that technological innovations that increase the

profitability of local companies have a positive effect on fiscal decentralization [16].

At the same time, excessive fiscal decentralization reduces the share of the federal budget and limits opportunities for financing national projects and addressing federal tasks such as mitigating the effects of large-scale natural disasters that affect several regions, strengthening the state's defense capabilities, and other important objectives. This also leads to a decrease in the share of tax revenues in the country's gross product due to differences in the effectiveness of tax administration in the regions [17], technical problems and lower economies of scale [14].

It is essential to strike a balance between centralization and decentralization of tax resources in order to ensure the most efficient use of budget funds and the formation of a sufficient financial base for implementing strategic priorities at the national, regional, and local levels.

This study aims to identify and analyze problems and priorities in budgetary support for socio-economic development in the regions of Russia (using the Republic of Bashkortostan as an example) at the current stage, as well as to develop recommendations for enhancing the balance of consolidated regional budgets in light of strategic development priorities. To accomplish this goal, the following objectives must be addressed:

- To analyze the forecast parameters of socio-economic and budgetary development of the Republic of Bashkortostan for 2026–2028, as outlined in the relevant strategic planning documents, such as the forecast of socio-economic development and the draft budget of the region, taking into account consolidated budget data.
- To identify the challenges of budget support for the sustainable socio-economic development of regions in terms of achieving strategic priorities and ensuring sufficient budget support to meet economic security requirements in modern conditions.
- To provide recommendations on improving the balance of parameters in the

consolidated budgets of Russian regions aimed at achieving strategic development goals.

## MATERIALS AND RESEARCH METHODS

The obtained research results are based on systematic, logical, statistical methods, as well as taking into account the requirements of budget legislation, strategic planning documents, and parameters of regional economic security. The information basis of the study was the official statistical data of Rosstat, Bashkortostan, the Forecast of socio-economic development of the Republic of Bashkortostan for 2026 and for the planning period of 2027 and 2028,<sup>3</sup> the main parameters of the forecast of socio-economic development of the Republic of Bashkortostan for 2026, for the planning period of 2027 and 2028. and for the period up to 2042<sup>4</sup> (in terms of forecast values for 2029–2042), the Forecast of socio-economic development of the Russian Federation for 2026 and for the planning period of 2027 and 2028,<sup>5</sup> the Draft Law of the Republic of Bashkortostan “On the Budget of the Republic of Bashkortostan for 2026 and for the planning period of 2027 and 2028”,<sup>6</sup> the Law of the Republic of Bashkortostan “On the Budget of the Republic of Bashkortostan for 2026 and for the planning period of 2027 and 2028”,<sup>7</sup> Strategy of socio-economic

development of the Republic of Bashkortostan for the planning period up to 2030.<sup>8</sup>

## THE RESULTS OF THE STUDY

As part of solving the first task of the study, we will analyze the forecast parameters of socio-economic and budgetary development in the Republic of Bashkortostan (hereinafter — RB).

### 1. Forecast of socio-economic development for 2026–2028 in the Republic and main parameters until 2042 (hereinafter — Forecast).

**1.1. Gross regional product** is one of the most general indicators characterizing total value of goods and services produced in region over certain period (hereinafter — GRP). Its value in RB has been increasing in recent years except for 2020 due to COVID-19 restrictions. According to presented estimates, by 2025, this indicator will increase by 104.6% (*Fig. 1*).

It should be noted that the nominal growth rate of GRP over the entire period will be lower than the indicators set out in the Strategy of Socio-Economic Development of the Republic of Bashkortostan for the planned period up to 2030 (hereinafter referred to as the Strategy). On the one hand, due to the outstripping growth of GRP accumulated in 2021–2024, even with the implementation of a conservative forecast scenario, achieving the GRP per capita values planned in the Strategy in the amount of 898.6 thousand rubles by 2030 seems possible and beyond doubt.

On the other hand, the reduction in the bar for GRP growth relative to the republic's strategic targets for 2026–2030, as well as the projected dynamics of Russia's GDP, is indicated in Figure 1 as “RF (basic)” (nominal GRP growth of the RB by 127.5% by 2028 compared with 2024, with an average growth in the Russian Federation of 137.4%) — indicate the need to increase the efficiency of the economy of the RB, since the region's share in the country's

<sup>3</sup> Approved by the Decree of the Government of the Republic of Bashkortostan dated October 24, 2025 No. 1359-R. URL: <https://economy.bashkortostan.ru/activity/22338> / (accessed on 11/26/2025).

<sup>4</sup> Adopted as the basis for the preparation of the draft budget of the Republic of Bashkortostan at the meeting of the Strategic Committee of the Republic of Bashkortostan on July 4, 2025 (Appendix No. 1 to Protocol No. 1).

<sup>5</sup> Approved at a meeting of the Government of the Russian Federation on September 24, 2025 (Protocol No. 32). URL: [https://www.economy.gov.ru/material/directions/makroec/prognozy\\_socialno\\_ekonomicheskogo\\_razvitiya](https://www.economy.gov.ru/material/directions/makroec/prognozy_socialno_ekonomicheskogo_razvitiya) / (accessed on 11.26.2025).

<sup>6</sup> The draft Law of the Republic of Bashkortostan “On the Budget of the Republic of Bashkortostan for 2026 and for the planning period of 2027 and 2028”. URL: <https://minfin.bashkortostan.ru/activity/2870> / (accessed on 11.20.2025).

<sup>7</sup> Law of the Republic of Bashkortostan dated 12/22/2025 No. 375-z “On the Budget of the Republic of Bashkortostan for 2026 and for the planning period of 2027 and 2028”. URL: <https://minfin.bashkortostan.ru/documents/active> / (accessed on 15.01.2026).

<sup>8</sup> Resolution of the Government of the Republic of Bashkortostan dated December 20, 2018 No. 624 “On the Strategy of Socio-economic development of the Republic of Bashkortostan for the period up to 2030”. URL: <https://economy.bashkortostan.ru/documents/active/298367> / (accessed on 27.10.2025).



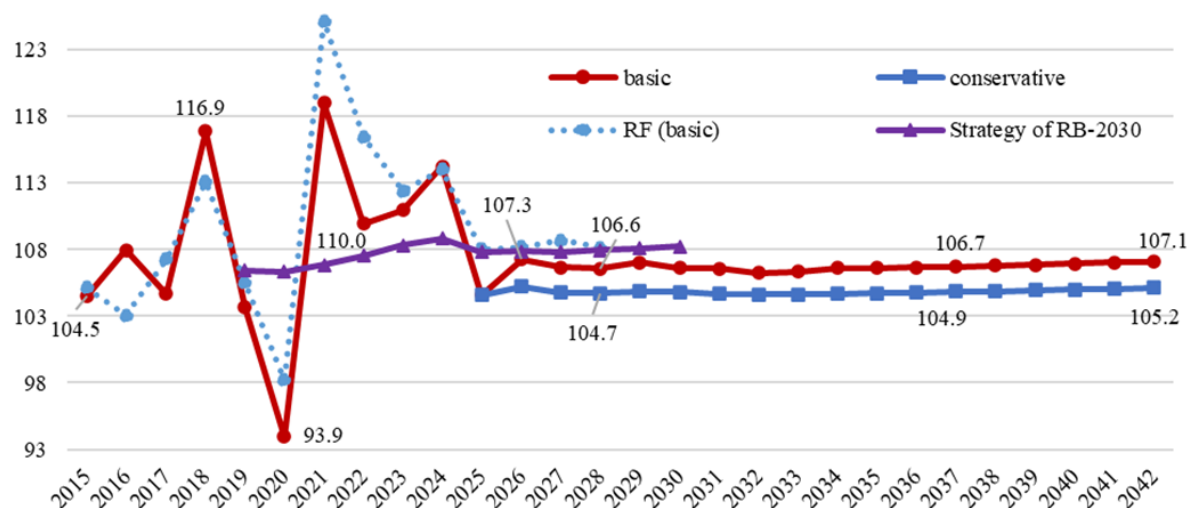


Fig. 1. Growth Rates of the Nominal GRP of the RB and the GDP of Russia, in % of the Previous Year

Source: Compiled by the authors.

Note: From here on the abbreviations “conservative” and “basic” correspond to the socio-economic development options presented in the Forecast – conservative and basic.

GDP will decrease from 1.40% in 2024 to 1.30% in 2028.

Considering the above, improving the efficiency of the regional economy will depend largely on the improvement of the quality of strategic planning. This includes improving the methodological support for managerial decision-making through the use of modern economic and mathematical modeling tools in public administration [18].

**1.2. The industrial production index of the RB** and the Russian Federation is estimated at 101.5% in 2025. In 2026–2028, the indicator is expected to grow in the region to 105.0% according to the baseline and to 103.0–103.5% according to the conservative scenario, which is higher than the baseline forecast for the Russian Federation (102.3–103.1%). However, in 2029–2032. The forecast provides for multidirectional dynamics in the industry of the RB, depending on the chosen scenario (a decrease of 1.3 percentage points according to the baseline scenario while maintaining growth rates according to the conservative scenario) (Fig. 2).

The realism of implementing the projected growth rates of industrial production in the RB according to the baseline scenario will largely depend on the effectiveness of the industrial policy. In this regard, the implementation of

the Comprehensive Industrial Development Program of the RB until 2030,<sup>9</sup> developed by the Institute of Socio-Economic Development of the UFIC RAS in cooperation with the republican executive bodies, will contribute to the further development of the priority areas of the region’s industry. It seems advisable to consider the issue of approval by the Government of the RB of this program and its active implementation in the practice of public administration in the field of industry.

**1.3. The dynamics of investments in fixed assets** is determined by a variety of factors, such as the state of the economy, investment climate, political stability, tax policy, availability of resources, demographic and environmental processes, etc. In recent years, there has been a significant change in investment levels in the RB, which ranged from 74.7% in 2017 to 119.0% in 2019 (Fig. 3).

According to the current Strategy, by 2030 it is planned to reach the level of 305.2 thousand rubles of investments in fixed assets per capita, which corresponds to 1240.7 billion rubles. The basic Forecast scenario developed by the Ministry of Economic Development of

<sup>9</sup> URL: <https://industry.bashkortostan.ru/documents/projects/524085/> (accessed on 02.12.2025).

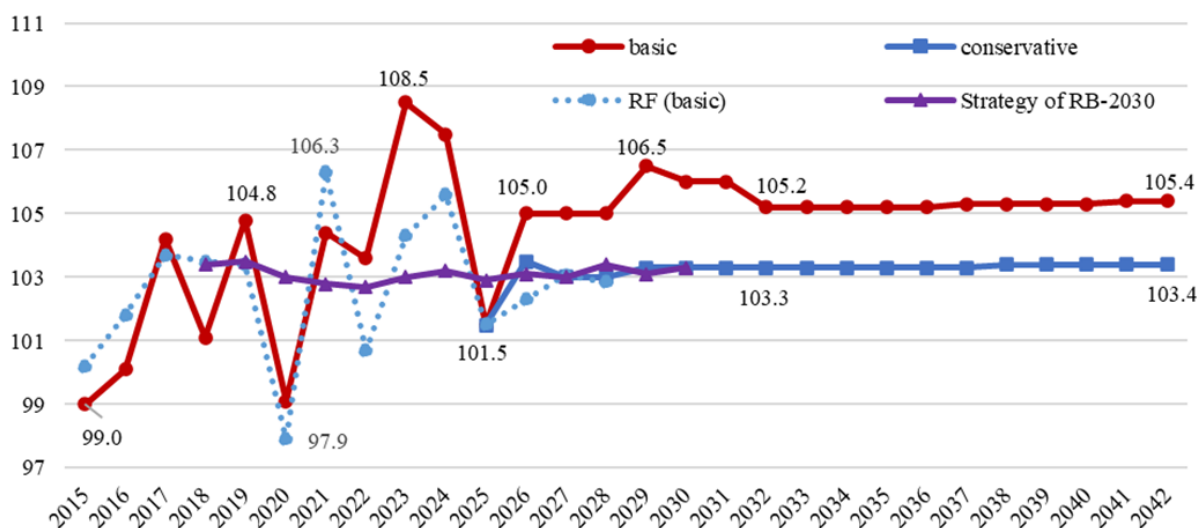


Fig. 2. Industrial Production Index of the RB and Russia, in % Compared to the Previous Year

Source: Compiled by the authors.

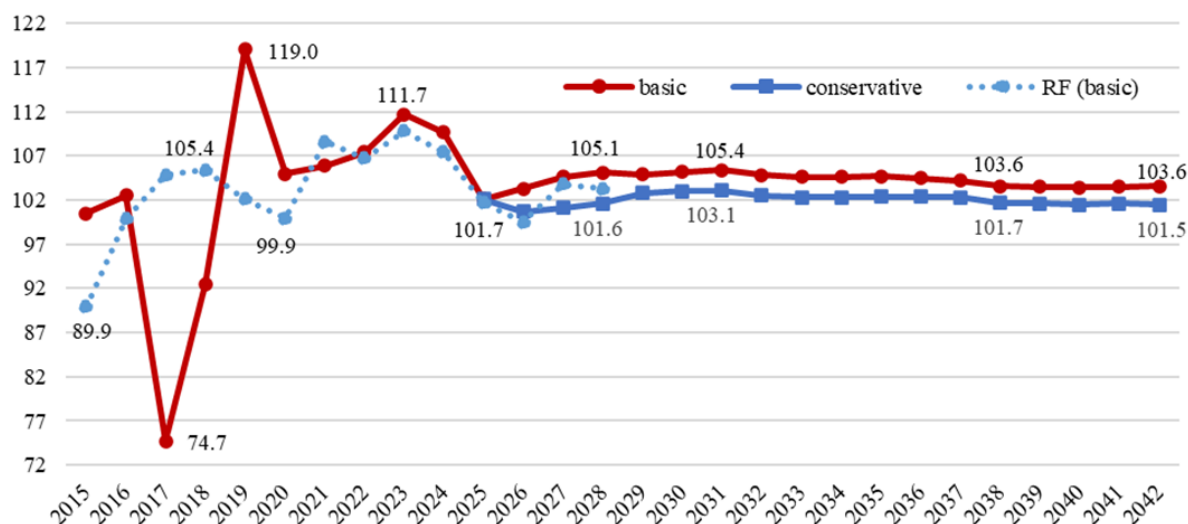


Fig. 3. The Dynamics of Investments in Fixed Capital in the RB and the RF, in % Compared to the Previous Year

Source: Compiled by the authors.

the RB assumes reaching the level of 1.325.2 billion rubles, which is close to the guideline set in the Strategy and gives grounds to expect achievement of the set goals.

#### 1.4. Remuneration and labor productivity.

Increasing productivity and wages in the region should be considered as a priority. The relatively low level of wages (Fig. 4) poses a threat to increased labor migration from the region.

The salary in the republic in 2017 was 77.5% of the national average, and in 2024 it was 76.8%. According to estimates, the situation

continued to deteriorate in 2025, with the same indicator being only 74.0% by then. In the medium term, according to a baseline scenario, by 2028 the gap in this ratio was expected to remain at the level of 2025. (It should be noted that, according to results of a macroeconomic survey by the Bank of Russia, nominal wage growth would be slightly lower, amounting to 108.4% in 2026 and 107% in 2028.) Thus, there was no reason to speak of overcoming the current gap in the medium-term.

It seems that it is impossible to solve the task of ensuring wages in Bashkortostan to be



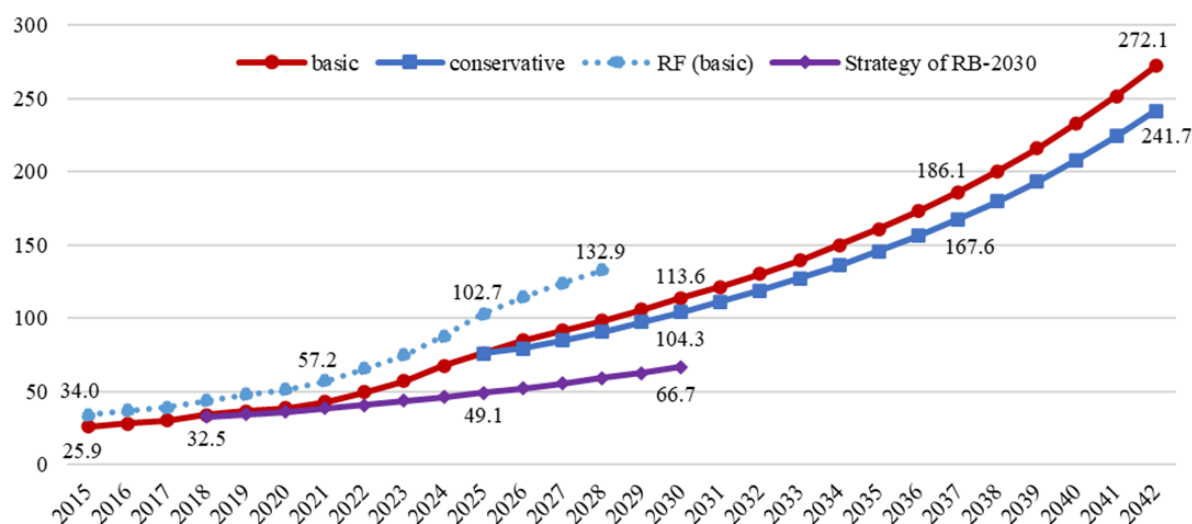


Fig. 4. The Average Monthly Salary in the RB and the RF, in Thousands of Rubles

Source: Compiled by the authors.

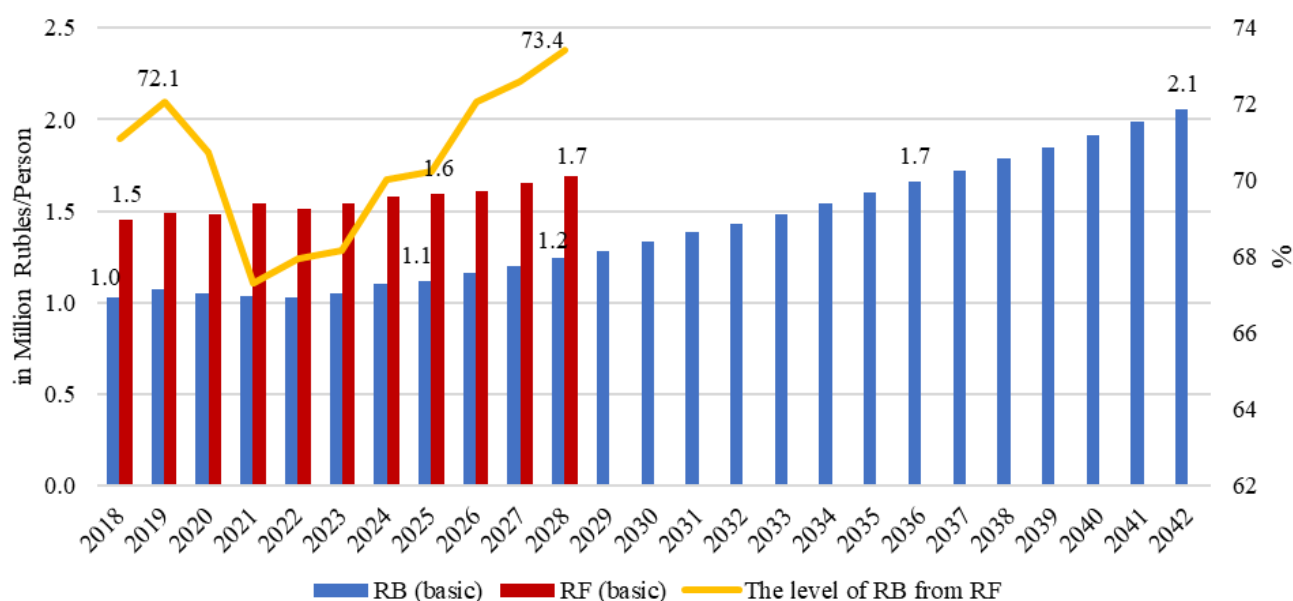


Fig. 5. Labor Productivity Indicators in the RB and the RF (in 2018 Prices), in Million Rubles/Person

Source: Compiled by the authors.

at or above the average Russian level by 2030 in the current conditions. Given the significant lag in wages in the republic compared to the Russian average, many other socio-economic challenges, such as increasing the migration attractiveness of the territory and improving the standard and quality of life for the population, are also difficult to address.

Due to resource constraints, the issue of improving efficiency in the use of resources in the Republic of Bashkortostan has become

a priority, requiring the introduction of innovative technologies and optimization of production processes to increase competitiveness. This is especially true in terms of ensuring labor productivity, which is 30% below the Russian average (Fig. 5).

Capital efficiency (GRP to investment ratio) in RB at comparable prices is also 10–15% below the national average. According to the Forecast parameters in real terms, in the long term, in general, a further decrease in the level

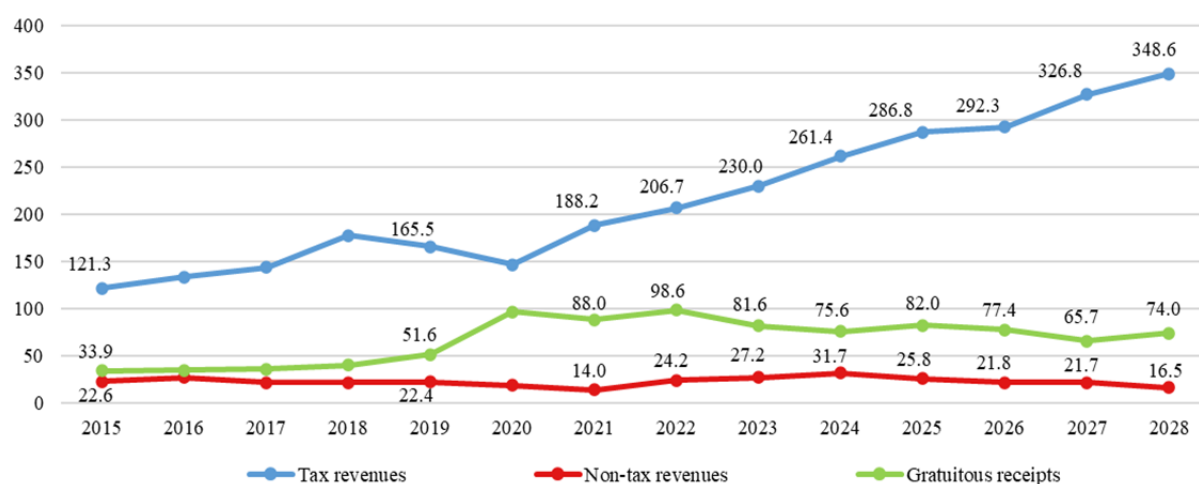


Fig. 6. The Dynamics of Nominal Revenues in the Consolidated Budget of the RB, in Billions of Rubles

Source: Compiled by the authors.

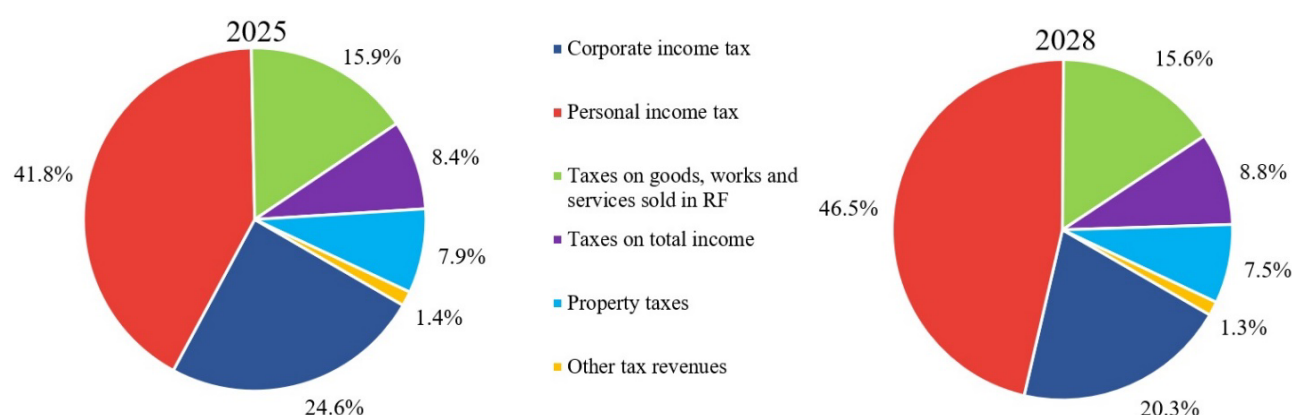


Fig. 7. The Structure of Tax Revenues in the Consolidated Budget of the RB for 2025 and 2028, in %

Source: Compiled by the authors.

of capital investment in RB is predicted relative to the actual values of 2018–2024.

Next, we will consider the budgetary parameters of the region's development. The data from the draft budget of RB for the consolidated budget (hereinafter referred to as the CB RB), reflecting the total budgetary resources of the region, were taken as a basis. The updated data included in the law on the budget of the region for 2026–2028 were used as forecast data for the budget of the constituent entity of the Russian Federation.

## 2. The Consolidated budget of the Republic of Bashkortostan.

**2.1. Revenue side of the budget.** The materials of the draft budget of RB include the forecast parameters of the consolidated

budget for 2026 and for the planning period of 2027 and 2028, which are characterized by the following indicators of budget revenues (Fig. 6).

In nominal terms, the total revenue of CB RB by the end of 2028 will increase by 19.1% compared to the level of 2024 and amount to 439.1 billion rubles. However, this increase is due to the influence of the price factor. As a result, by 2028, the volume of consolidated budget revenues in a comparable form is estimated to be 0.9% lower than in 2024, which poses a threat to the implementation of the provisions stipulated in the strategic development documents of the region. The result of this dynamic is a change in the income structure, which manifests itself in the form of an increase in the share of tax revenues from

Table 1

## Budgetary Capacity Assessment, in Thousand Rubles/Person

| Indicator                                                        | 2023<br>(fact) | 2024<br>(fact) | 2025 (updated plan<br>for December 1) | 2026<br>forecast | 2027<br>forecast | 2028<br>forecast |
|------------------------------------------------------------------|----------------|----------------|---------------------------------------|------------------|------------------|------------------|
| Budgetary security                                               | 83.2           | 91.0           | 97.6                                  | 96.8             | 102.4            | 108.6            |
| Budget security, in<br>a comparable estimate<br>(in 2023 prices) | 83.2           | 83.5           | 83.9                                  | 80.0             | 81.4             | 83.0             |

Source: Compiled by the authors.

Note: \* by total revenue.

72.7% in 2025 to 79.4% in 2028 and a decrease in the share of non-tax revenues and gratuitous receipts.

The revenue forecast of CB RB reflects the increasing importance of the tax component. However, the growth rate of tax revenues since 2021 has lagged behind the national average. By the end of 2024, the share of tax revenues of RB in the consolidated budget of the Russian Federation amounted to 1.1% (in 2020, 1.8%). At the same time, almost half of the budget's tax revenues are generated from taxes on individuals, while the impact of corporate income tax will decrease from 24.6% to 20.3% (Fig. 7).

For key types of tax revenues at current prices, positive dynamics is projected in 2026–2028 (with the exception of income tax receipts in 2026). In general, the tax burden on the republic's economy in 2026–2028 will remain at the level of 2025–9.7% of GRP (except for 2026, where, due to the projected drop in tax revenues, their share relative to GRP will decrease to 9.3%).

In 2028, budget security in terms of income is projected at 108.6 thousand rubles/person, which is 19.4% higher than in 2024 (Table 1).

In comparable prices, the level of budget provision will decrease by 0.6%, which is caused by the influence of both the price factor and the strengthening of fiscal policy to centralize budget funds in higher-level budgets (typical for both the system of inter-budgetary relations “federation — region” and “region —

municipalities”). As a result, the increase in tax revenues from an increase in the tax burden will be largely offset by a decrease in gratuitous revenues from the federal budget, which will have a restraining effect on the pace of socio-economic development of the republic.

## 2.2. The expenditure part of the budget.

The dynamics of RB Design Bureau expenses corresponds to the parameters of the revenue side. In 2025, the amount of expenses is estimated at 431.4 billion rubles, which is 9.3% higher than the amount of income (Table 2).

At the same time, the structure of budget expenditures undergoes a number of changes in the forecast period (Fig. 8).

By 2028, a significant increase in public debt servicing costs is projected (2.4 times in real terms). In 2026, the volume of expenditures under this budget item will exceed 7 billion rubles. (2% of all expenses), which is comparable to expenses in such areas as “Physical education and sports”. As a result, the debt burden of the republic's budget in 2026 It will grow to 36.4%, which indicates the need to increase the effectiveness of the debt policy, taking into account the goal set at the government level to preserve the republic's status as a borrower with a high level of debt sustainability.<sup>10</sup> The main debt instrument for attracting borrowed funds to finance the budget deficit in the coming years will be the

<sup>10</sup> Appendices No. 2 and No. 3 to the Minutes of the Strategic Committee meeting No. 2 dated October 8, 2025

Table 2

**The Expenditures of the Consolidated Budget of the RB for the Periods 2023–2025 and 2026–2028**

| Indicator                                                                                                                           | 2023<br>(fact) | 2024<br>(fact) | 2025 (updated plan<br>for December 1) | 2026<br>forecast | 2027<br>forecast | 2028<br>forecast |
|-------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|---------------------------------------|------------------|------------------|------------------|
| The nominal volume of the expenditure part of the consolidated budget, billion rubles                                               | 355.5          | 385.0          | 431.4                                 | 414.1            | 423.2            | 439.1            |
| The nominal volume of the expenditure part of the consolidated budget per capita, thousand rubles/person                            | 87.3           | 95.0           | 106.7                                 | 102.4            | 104.7            | 108.6            |
| The real volume of the expenditure part of the consolidated budget, adjusted for inflation (in 2023 prices), thousand rubles/person | 87.3           | 87.2           | 91.7                                  | 84.6             | 83.2             | 83.0             |

Source: Compiled by the authors.

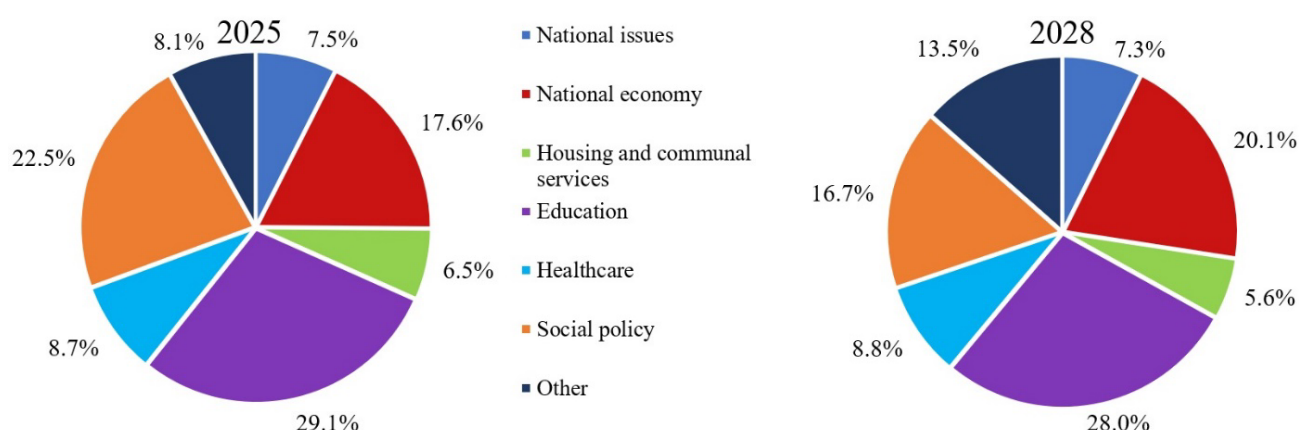


Fig. 8. The Structure of expenditures in the consolidated budget of the RB in 2025 and 2028, in %

Source: Compiled by the authors.

issue of government securities, the share of which in the structure of the national debt of the republic will increase from 37.1% (as of 01.01.2026) to 45.6% by the end of 2026 and 48.4% by 2028. On the contrary, the share of budget loans will decrease from 46.5% to 38.9%, and 39.0%, respectively.

The sufficiency of expenditures on *education, health care and culture* as areas for improving the quality of human potential and labor resources in the region has a significant impact on the sustainable socio-economic development

of the territory. The actual and projected dynamics of expenses for these items tends to decrease. The cumulative reduction in education costs by 2028 compared to the level of 2024 in comparable prices will amount to 13.7%, and for culture — 11.1%. Some growth is observed only in healthcare (3.1%). Nevertheless, relative to the criteria of economic security, the level of spending on education, healthcare and culture is below the threshold level (at least 15% of GRP) and in 2026, compared with 2020, it will decrease by another 2.4% (Table 3).



Table 3

**The Budgetary and Social Indicators of the Development of the RB  
in the Context of Economic Security Requirements**

| Indicator                                                             | Threshold | 2020<br>(fact) | 2022<br>(fact) | 2023<br>(fact) | 2024<br>(fact) | 2025<br>(plan) | 2026<br>(plan) |
|-----------------------------------------------------------------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|
| Total fertility rate, units                                           | 2.15      | 1.52           | 1.41           | 1.41           | 1.35           | 1.42           | 1.44           |
| Life expectancy, years                                                | 80.00     | 70.62          | 72.98          | 73.17          | 71.99          | 72.55          | 74.81          |
| Budget expenditures on healthcare, education and culture, in % of GRP | 15.0      | 7.7            | 6.3            | 5.9            | 5.9            | 6.1            | 5.3            |

Source: Compiled by the authors [19, 20].

Table 4

**The Required Volume of Expenditures from the Consolidated Budget of the RB to Achieve the Threshold  
Level of Economic Security, in Million Rubles**

| Direction of expenses         | 2025    | 2026    | 2027    | 2028    |
|-------------------------------|---------|---------|---------|---------|
| On healthcare                 | 110 249 | 118 257 | 126 124 | 134 412 |
| On education                  | 286 647 | 307 468 | 327 924 | 349 472 |
| On culture and cinematography | 44 099  | 47 303  | 50 450  | 53 765  |
| Total                         | 440 995 | 473 028 | 504 498 | 537 650 |

Source: Author's calculations.

According to our calculations, in order to ensure a sufficient level of financing for the republic's educational sector in terms of economic security requirements, it is necessary to increase budget expenditures on education, healthcare and culture by 2.5–3 times to at least 537.7 billion rubles in 2028 (*Table 4*).

Expenditures on the national economy are projected to have unstable dynamics. In 2028, the cumulative increase from the level of 2024 is expected to be 8.4%, in comparable prices. However, compared to 2022, there will be a decrease of 11.9%.

The main item of expenditure in the national economy traditionally is the road sector, which accounts for about 70%.

A significant reduction in costs relative to the level of 2024 is projected in the areas of "Social Policy" and "Housing and utilities"

(by 19.1% and 27.2% in comparable prices). This creates risks for ensuring the sustainable development of the economy and the social sphere, as well as the safety of the population.

An analysis of the dynamics of the volume of financing of state programs according to the adopted budget law shows a decrease in program expenditures in 2026 relative to 2025 by 3.0%, in 2027 — by 6.3%, in 2028 — by 3.6%. At the same time, multidirectional dynamics is observed in the context of government programs. The largest increase in funding is demonstrated by programs in the field of development and support of small and medium-sized businesses (by 151.2%), justice (by 26.8%), development of physical culture and sports (by 25.8%). A significant reduction is planned under government programs aimed at the development of domestic and inbound

tourism (by 64.5%), industry (by 55.1%), and social protection of the population (by 49.3%).

The budget deficit of RB in 2026 is projected at 22.5 billion rubles, and in 2027–9.0 billion rubles. For 2028, the adopted budget of RB assumes equality of income and expenses.

## CONCLUSIONS

The analysis of the forecast parameters of the regional budget (using the example of the Republic of Bashkortostan) allows us to identify the following main *problems and risks* of budgetary support for sustainable socio-economic development of the regions of the Russian Federation:

1. Negative influence of environmental factors. Increased uncertainty in international trade, as well as the aggravation of the geopolitical situation, tougher sanctions, increase the volatility of budget revenues from oil and gas sales, which may adversely affect the balance of the budget system.

2. The need to ensure a balance between supply and demand, increase labor productivity and increase investment efficiency. According to the Ministry of Economic Development of Russia, the expansion of the supply-side economy is one of the priorities in the implementation of socio-economic policy by the Government of the Russian Federation. However, significant risks are the likelihood of excessive hypothermia of the country's economy as a result of the Bank of Russia's tight monetary policy, as well as an increase in the tax burden on entrepreneurs, which already entails a review of business investment programs in the direction of reducing them and reducing production.<sup>11</sup> At the same time, according to the Russian Ministry of Economic Development, it is investments and increased labor productivity that should become key factors for economic growth.<sup>12</sup> In addition,

the development of a balanced supply and demand economy requires the availability of appropriate incomes for the population living in the region. The analysis of the presented forward-looking estimates showed the need to increase the levels of wages, labor productivity and capital efficiency.

3. The aggravation of the situation on the labor market, manifested in a shortage of personnel, increased competition among employers for qualified specialists. Among the main factors are the deterioration of the demographic situation, characterized by a change in the age structure of the population, the migration outflow of the most active population, the departure of men of working age to their homes, shadow employment, etc.

4. Environmental risks. In modern conditions of increasing competition for global and regional markets, the risks of introducing more lenient environmental safety requirements as a way to increase the competitiveness of production are increasing. This may become an additional factor in deciding whether to move to other regions, especially among people of working age and young professionals. Such trends make measures to ensure ecological balance, the introduction of green technologies and compliance with the principles of sustainable development particularly relevant as key conditions for improving the quality of life and curbing negative migration.

5. The risks of territorial differentiation. The growing imbalances in the socio-economic development of regions at the local level creates risks of expanding depressive zones (mainly in rural areas and small towns), increasing the urgency of the problems of employment and poverty reduction, reducing the migration outflow of the population.

Taking these factors into account in the development and implementation of public policy will improve the effectiveness of regional authorities in making managerial decisions to ensure the sustainability of socio-economic development of the regions of the Russian Federation.

<sup>11</sup> URL: <https://www.vedomosti.ru/investments/news/2025/12/01/1159485-spad-delovoi-aktivnosti> (accessed on 02.12.2025).

<sup>12</sup> URL: [https://economy.gov.ru/material/news/zamglavy\\_minekonomrazvitiya\\_nazvala\\_factory\\_obespecheniya\\_rosta\\_rossiyskoy\\_ekonomiki.html](https://economy.gov.ru/material/news/zamglavy_minekonomrazvitiya_nazvala_factory_obespecheniya_rosta_rossiyskoy_ekonomiki.html) (accessed on 02.12.2025).

As *recommendations* for improving the balance of the budget parameters of the region, we suggest:

1) Ensuring increased labor productivity and innovation is essential for fully unlocking the potential of manufacturing industries, particularly in the face of current challenges and threats related to mining and mineral processing. This is crucial for ensuring food security amid climate change. To achieve this, it is advisable to increase budget allocations for the recapitalization of regional development institutions, such as regional industrial development funds and innovation support centers. Additionally, grant payments in the form of subsidies can be provided to legal entities and individual entrepreneurs to help finance the costs associated with implementing projects aimed at developing technological innovations, transferring technologies, and protecting intellectual property;

2) The need to determine the personnel requirements of regional economies, based on the annual formation and update of the labor market forecast for the constituent entities of the Russian Federation, has been identified as a task at the federal level, as part of the implementation of the National Human Resources Development Project.<sup>13</sup> This task is carried out in a sectoral and professional qualification context over a five-year period;

3) Updating the strategies of socio-economic development for the regions of the Russian Federation, with an expanded strategic horizon until 2045, and developing anti-crisis plans with the involvement of scientists and experts;

4) Improving the quality of strategic planning at the regional level by incorporating a “target” scenario into strategic planning documents, which reflects the image of the future and the state of the socio-economic system that needs to be achieved. This scenario should include a description of the factors and conditions necessary for its realization;

5) In order to achieve strategic priorities in the field of socio-demographic development of the regions (growth of the total fertility rate (TFR) and life expectancy), it is necessary to update the activities of regional government programs with regard to ensuring comprehensive consideration of their impact on the planned values of the TFR;

6) In light of the planned retention of low-income tax revenues in consolidated regional budgets in the coming years, it would be advisable for the federal government to consider preparing proposals to review the distribution of these taxes between different levels of the budgetary system. For example, the standard for budget allocations for constituent entities of the Russian Federation could be increased from 17% to 20% for any over-fulfilment of the tax collection target;

7) It seems advisable to increase the balance of the budget expenditure structure, primarily in the areas of “Housing and utilities” and “Social Policy”. A decrease in the share of these areas in budget expenditures is projected to be especially strong, which will contribute to the implementation of strategic priorities for the development of the Republic and the formation of conditions for meeting the requirements of economic security. In the housing and utilities sector, it is necessary to further expand the use of infrastructure tools for the modernization of municipal infrastructure facilities. This will also have a positive impact on the region’s debt burden by reducing the cost of budget loans. Regarding socio-demographic policy, it is essential to increase financing for subsidies to young families for housing. This will help support families and create a more stable and prosperous society. In 2026–2028, the budget of RB allocated 300 million rubles annually for this purpose, which is approximately 2.500 square meters of housing (based on the average market price per square meter in the Republic<sup>14</sup>) or approximately 0.5 square

<sup>13</sup> URL: <http://government.ru/news/54925/> (accessed on 02.12.2025).

<sup>14</sup> URL: <https://www.bashinform.ru/news/social/2026-01-22/v-bashkirii-utverdili-srednyuyu-rynochnuyu-stoimost-1-kvadratnogo-metra-zhilya-4547168> (accessed on 06.03.2026).

meters per young family registered in need of residential premises;<sup>15</sup>

8) It is necessary to improve the effectiveness of implementing state programs (SPs). It would be advisable to update the planned values for indicators and SP activities (in some programs, there is an underestimation of plans, while in others, there is a significant failure to meet the indicators, despite most of the planned activities being implemented);

9) The urgent need to increase budget spending to the level of economic security requires creating conditions for increasing labor productivity. This can be achieved primarily through the introduction of innovative technologies and industries in the regions of the Russian Federation. The state-owned enterprises (SOEs) adopted in many regions for scientific and technological development, such as in the RB,<sup>16</sup> are often complex and coordinated with other SOEs. However, implementing an effective scientific and technological policy in the regions also requires having SOE passports that are relevant to modern challenges and threats in industrial and educational development. Additionally, updated versions of regional socio-economic development strategies are needed. In the event of a reduction in budget funding for the aforementioned programs, the risk of not reaching the targets for scientific and

technological development in the regions of the Russian Federation increases;

10) In the context of deteriorating debt sustainability, it is necessary to pay special attention to the effectiveness of investments in the regional economy in order to ensure faster growth in tax revenues relative to the dynamics of public debt;

11) It is necessary to work towards creating a budget that will ensure the stable development of regions in the face of continued sanctions from a number of Western countries. We need to focus on improving budget discipline, including enhancing the quality of planning and monitoring of financial support for state-owned enterprises and their implementation. The solution to these challenges lies in involving the expert and academic community in collaboration with government authorities to improve methodological support through the use of economic and mathematical modelling tools.

The theoretical significance of this research lies in its proposal of an approach for assessing the adequacy of budgetary support for socio-economic development in terms of economic security needs.

The practical significance is in the potential use of these proposed recommendations by regional authorities to make better-informed management decisions regarding the balance of their budgets and the support they provide for sustainable socio-economic growth.

In future publications, we plan to expand and further develop our research in terms of enhancing budget policy as a response to global challenges while taking into account the specific needs and opportunities of each region to pursue independent budgetary policies.

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<sup>15</sup> Resolution of the Government of the Republic of Bashkortostan dated February 25, 2025 No. 56 "On approval of the regional program «Increasing the birth rate in the Republic of Bashkortostan for the period up to 2027»" (Table 26). URL: <https://docs.cntd.ru/document/407683593> (accessed on 03.06.2026).

<sup>16</sup> Resolution of the Government of the Republic of Bashkortostan dated December 27, 2024 No. 549 "On Approval of the State program «Scientific and Technological Development of the Republic of Bashkortostan»" and on Invalidation of Certain Decisions of the Government of the Republic of Bashkortostan.



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**A.G. Karimov** — substantiation of the general methodology and scientific and methodological apparatus of research.

**M.M. Nizamutdinov** — development of the research concept, determination of the structure of the presentation of the material, generalization of the obtained results, formation and verification of the scientific conclusions of the research.

**P.A. Ivanov** — selection of indicators for analysis, description of the research methods used, calculation and analysis of the obtained results, formation of the scientific conclusions of the research.

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# Developing Tax Instruments to Stimulate Innovation in the Russian Economy

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## ABSTRACT

The **relevance** of the study lies in the gradual regionalization of the entire world economy, where Russia has sufficient potential to improve its position on the international stage. This is possible, among other things, through increasing the level of innovation in the Russian economy. The **purpose** of this work is to test a hypothesis about the positive impact of the used instruments of the state tax policy regulation in order to increase the level of innovation of the Russian economy in the context of sanctions pressure and transformation of the country's foreign economic relations within the global economy. The **objective** of this study is to analyze and identify the instruments of tax policy for state regulation in order to increase the level of innovation in the Russian economy. The **main methods** used in this study include the collection and processing of statistical data, their comparative analysis, study of regulatory framework for the fiscal policy on innovative development of the country, as well as other documents related on sustainable economic development. The **scientific novelty** of the research conducted consists in determining the relationship between the indicators of the innovativeness of the economy and measures of tax incentives for R & D. As a **result of the research**, proposals are made to improve the existing fiscal instruments in the Russian tax law to stimulate innovative development of the economy. A conclusion is drawn about the significant innovative contribution of tax preferences and the possibility of strengthening their role in the area under study. The **practical significance** of the work done consists in the possibility of using the research results to improve the effectiveness of implementing of state tax policy in relation to business in order to stimulate R & D expenditures, increase the production and consumption of domestically produced innovative products, and export high-tech products.

**Keywords:** tax benefits; tax incentives; R&D expenditures; government tax regulation; regionalization of the world economy; level of innovation; volume of venture capital received; production of high-tech products; patent; innovative input

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## INTRODUCTION

At present, we are seeing a gradual regionalization of the global economy into two main blocs: the Western bloc led by the United States and an expanding alliance of BRICS countries, including China and Russia. This development is the result of several factors.

Firstly, China has emerged as a significant rival to the United States in the international system, due to its sizeable economy, number of key trading partners, demographic makeup, and consequently, consumer market size. Additionally, China's potential for forming trade agreements with all necessary financial infrastructure makes it a formidable force.

Secondly, the global economy is undergoing a transition to a new technological order. The latest developments and technologies require an appropriate resource base that is competitive on the international market in terms of cost. Therefore, the development of microprocessors and semiconductor chips of the latest models has become a crucial part of the competitive race between key economies such as the United States and China. Countries with reserves of rare earth metals play an essential role in ensuring the mass production of these latest products.

Thirdly, the current global economic situation has led to a reorientation of trade flows between countries and the creation of new global value chains. This has the potential to increase economic growth in some countries, such as Russia, which is ranked fourth in the world by purchasing power parity,<sup>1</sup> while simultaneously leading to stagnation in others, such as Germany<sup>2</sup> and Japan.<sup>3</sup>

<sup>1</sup> The IMF named Russia the fourth economy in the world in terms of purchasing power parity. URL: <https://www.kommersant.ru/doc/7249067> (accessed on 01.08.2025).

<sup>2</sup> Not only because of Russia: why the German economy is in crisis. URL: <https://www.rbc.ru/economics/10/02/2025/679b86449a7947c4ee12e632> / (accessed on 01.08.2025).

<sup>3</sup> Why Japan dropped out of the top three strongest economies and how it is going to fix it. URL: <https://www.forbes.ru/society/507247-pocemu-aponia-vypala-iz-trojki-sil-nejsih-ekonomik-i-kak-sobiraetsa-eto-ispravlat> / (accessed on 01.08.2025).

In this regard, Russia has an opportunity to develop its economy under new circumstances, taking into account existing potential in various sectors. This includes the agro-industrial complex, military industry, aviation and mechanical engineering, as well as a high level of digitization of services. Additionally, opportunities are emerging for new trade connections with growing markets such as Southeast Asia (ASEAN countries), the Middle East, Africa, and Latin America. The establishment of new trade relationships can contribute to technological advancement and innovative solutions, which are becoming a priority for the continued growth of the Russian economy on the international stage.

If we consider the sustainability of any economy, there are several main factors that determine its ability to function. These include access to cheap natural resources, a high level of food security, a demographic component with a sufficient number of highly skilled workers, the financial security of the country, and access to the latest technologies.

At the same time, the level of innovation in the economy requires a more careful and detailed study of the above factors, taking into account the strengths of the analyzed market, including, among other things, the level of development of institutions in the country, human capital, infrastructure, market and business, as well as the profits generated based on the development and implementation of new ideas in the production of goods and services.<sup>4</sup> It is these aspects that have become crucial in this study, which was conducted in order to explore possible tools and approaches for increasing the level of innovation in the Russian economy by developing the potential of fiscal instruments of state regulation.

## LITERATURE REVIEW

The issue of the level of innovation in the Russian economy has been a key concern

<sup>4</sup> The rating of the level of innovation of economies. URL: <https://www.wipo.int/portal/en/> (accessed on 31.07.2025).



for Russia in recent years. This is due to the global trends towards regionalization in the global economy, which has a direct impact on countries' positions in the new hierarchy of trade and international relations.

Innovation, in its essence, is the ability of an economy to generate, implement, and disseminate new ideas, technologies, products, processes, and business models. These innovations lead to increased efficiency in the production of high-value, high-tech goods, which determine a country's position in global value chains [1].

The issue of promoting and enhancing innovation levels in cities, countries, and regional associations has been a subject of study for a long time. Various approaches and methodologies have been proposed by both foreign and Russian scholars [2]. Thus, the indicators of innovative economic development act as a tool for measuring the transformation of the modern economy. They take into account the experiences of countries such as China, India, Russia, and Brazil, and help to identify the weaknesses of a particular economy [3]. At the same time, the assessment of innovation potential can be considered not only at the level of one country, but also of a certain regional unit [4]. This helps to identify not only the weaknesses, but also the strengths of one region and use the results obtained for the development of other regions of the country [5, 6]. Moreover, the factors of innovative development can be considered from the point of view of ensuring the economic security of the region, which helps in forming an effective structure of key performance indicators (KPIs) of the region and the achievements of its economic growth [7].

It is interesting to analyze the factors of innovation at the level of individual sectors of the economy, as represented by T. Kurina and L. Ustinov. These factors influence the transformation of sectors and the achievement of necessary results within the framework of the innovative development of the entire country's economy [8, 9].

The creation of innovative potential can also be achieved through the development of sustainable innovation within individual large enterprises. This forms the basis for promoting industries in regions and the country as a whole [10].

Foreign scientists have also conducted research on this topic, analyzing the innovative industrial potential of the BRICS countries [11], considering the role of start-ups in strengthening and further developing certain sectors of the country's economy [12]. It is the number of unicorn startups that is analyzed in the WIPO international ranking, which measures the level of innovation in each economy.

Some foreign scientists, exploring the relationship between innovation and employment growth, especially in developing countries, emphasize the role of market structure. They note the differences between the leading innovative economies and the rest [13]. A. Ghimir et al. [14] point to the influence of regional logistics projects that contribute to the innovative development of all participating countries. These projects affect not only technological aspects, but also economic and social interaction between countries within the framework of a regional association.

Trends in the field of innovative development of ecosystems and circular economies are also being explored. These trends have a significant impact on entire sectors within isolated economies [15, 16].

The main aspect of the development of the level of innovation in the country, touched upon in this study, is the influence of financial instruments on the formation of effective innovative economic development. For example, A. Levandowska [17] points to the creation of competitive enterprises in the field of small and medium-sized businesses through financial instruments that affect the innovative component of companies. This is also considered by B. Levandowska, who studies the methodological principles and financial mechanisms of macro-strategic

management of the dynamics of technological innovation systems in the Russian Federation from the point of view [18]. Yu. Bogachev et al. study the support of the innovative economy in Russia through institutional mechanisms. They also take into account the impact of tax instruments on the level of innovation in various economies [19]. However, the most detailed financial and economic mechanisms for creating innovative potential were analyzed by T. Pogodina et al. [20] using the example of territorial clusters. At the same time, the impact of tax instruments on the innovativeness of the entire Russian economy and the consideration of relevant indicators in the works of Russian and foreign researchers are practically not considered.

Analyzing the existing work on increasing the innovativeness of economies, we can conclude that this issue is considered from the perspective of the development of the economy at both the micro and meso levels. Various components, including investments and ESG development, are taken into account in the analysis, as well as the formation of key performance indicators (KPIs) for companies and economic sectors.

Special attention is paid to the impact of regional projects on innovation and the economies of participating countries. These projects are seen as a means of promoting innovation and economic growth within these regions.

Increasing the level of innovation through fiscal incentives and developing an algorithm to support the country's innovation system, while taking into account key indicators, are essential conditions for the continued sustainable development of the Russian economy. This is the primary focus of this study.

## METHODOLOGY

The aim of this research is to analyze the fiscal policy instruments in Russia and determine how they can stimulate innovation in the economy. The object of the study is the current level of innovation in the

Russian economy, considering international changes. The focus of the research is on the measures of fiscal policy implemented by the government to increase innovation levels in order to create new economic connections within the context of the global economic fragmentation.

The goal of this work is to verify the hypothesis that fiscal policy tools can have a positive impact on innovation levels in Russia in the face of sanctions and changes in foreign economic relations.

The main methods used in this study include the collection and processing of statistical data, its comparative analysis, an examination of the regulatory framework for the fiscal policy supporting innovative development in the country, and other documents related to sustainable economic growth.

## RESULTS AND DISCUSSIONS

The Russian economy has seen significant progress in recent years, thanks to policies such as import substitution and the reorientation of products to new markets. This has led to the development of new global value chains and the creation of a more sustainable economy. However, in order to further enhance innovation, it is necessary to analyze key indicators that will have the greatest impact on sustainable development.

The level of innovation in an economy can be measured by various indicators that reflect its contribution to the country's overall development. It's important to note that achieving high scores on these indicators often requires long-term investment and the use of specific strategies to accelerate progress. For example, the use of fiscal policies within a given economy, taking into account its unique characteristics, can play a significant role.

*Table 1* presents some examples of these indicators, which characterize the innovative contributions of leading economies based on their level of innovation. These indicators

Table 1

## Indicators of Innovation Input by Countries, 2024

| Place in the rating | Country         | Education spending, % of GDP | The percentage of engineering graduates, % | The number of researchers per million people (total number of researchers in the association divided by the population) | R&D spending, % of GDP | The amount of venture capital received in USD millions |
|---------------------|-----------------|------------------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------------------------------------|
| 1                   | Switzerland     | 5.6                          | 25.3                                       | 5999                                                                                                                    | 3.3                    | 2.1                                                    |
| 2                   | Sweden          | 6.7                          | 28.9                                       | 9929                                                                                                                    | 3.4                    | 2.7                                                    |
| 3                   | The USA         | 5.4                          | 20.1                                       | 4932                                                                                                                    | 3.6                    | 110.5                                                  |
| 4                   | Singapore       | 2.4                          | 35.9                                       | 7488                                                                                                                    | 2.2                    | 4.5                                                    |
| 5                   | Great Britain   | 5.4                          | 22.3                                       | 4763                                                                                                                    | 2.9                    | 12.4                                                   |
| 6                   | South Korea     | 5.4                          | 30.4                                       | 9467                                                                                                                    | 5.2                    | 3.1                                                    |
| 7                   | Finland         | 5.7                          | 29.4                                       | 8073                                                                                                                    | 2.9                    | 0.6                                                    |
| 8                   | The Netherlands | 5.1                          | 19.3                                       | 6533                                                                                                                    | 2.3                    | 2.1                                                    |
| 9                   | Germany         | 4.5                          | 35.1                                       | 5825                                                                                                                    | 3.1                    | 7.1                                                    |
| 10                  | Denmark         | 5.9                          | 23.9                                       | 8736                                                                                                                    | 2.9                    | 1.1                                                    |
|                     |                 |                              |                                            |                                                                                                                         |                        |                                                        |
| 59                  | Russia          | 3.7                          | 31.4                                       | 2698                                                                                                                    | 0.9                    | 0.9                                                    |

Source: Report on the innovation development index by countries. URL: <https://www.wipo.int/en/web/global-innovation-index/2024/index> (accessed on 30.07.2025).

can help us understand the strengths and weaknesses of different countries in terms of their innovative potential.

If we compare the contribution of the Russian government to the innovative development of the country with that of the leading innovative economies, it is worth noting the expenditure on education as a percentage of GDP. This rating takes into account the percentage of total gross product produced in each country. When calculating the contribution of each economy to higher education in monetary terms, Russia's figures correspond to those of South Korea

(0.1 trillion dollars),<sup>5</sup> surpassing those of the Netherlands, Switzerland, Sweden, Singapore, Finland, and Denmark.

Regarding the share of engineering graduates, Russia is among the leaders, along with Germany and Singapore. The number of researchers in Russia (391.210) is second only to the United States (1.676.880), South Korea (489.917), and Germany (486.445).<sup>6</sup>

<sup>5</sup> Calculated by the authors on the basis of nominal GDP statistics for the countries presented in the table at the end of 2024.

<sup>6</sup> Calculated by the authors on the basis of population statistics by country at the end of 2024.

Table 2

## Indicators of Innovation Results by Countries, 2024

| Place in the rating | Country         | Number of patents, units | The cost of "unicorns" to GDP, % | Production of high-tech products for the entire industry, % | Exports of high-tech products worth billions of dollars | The value of global brands is in the trillions of dollars |
|---------------------|-----------------|--------------------------|----------------------------------|-------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------------|
| 1                   | Switzerland     | 10 240                   | 1.26                             | 71.49                                                       | 83.1                                                    | 0.185                                                     |
| 2                   | Sweden          | 6840                     | 3.48                             | 47.12                                                       | 25.5                                                    | 0.120                                                     |
| 3                   | The USA         | 252 320                  | 7.55                             | 43.23                                                       | 329.59                                                  | 5.99                                                      |
| 4                   | Singapore       | 1710                     | 18.18                            | 81.95                                                       | 218.74                                                  | 0.07                                                      |
| 5                   | Great Britain   | 16 880                   | 4.92                             | 40.02                                                       | 82.43                                                   | 0.494                                                     |
| 6                   | South Korea     | 183 750                  | 1.81                             | 58.21                                                       | 198.4                                                   | 0.326                                                     |
| 7                   | Finland         | 3500                     | 3.94                             | 37.22                                                       | 6.14                                                    | 0.036                                                     |
| 8                   | The Netherlands | 8660                     | 2.11                             | 43.62                                                       | 105.57                                                  | 0.102                                                     |
| 9                   | Germany         | 61 880                   | 1.69                             | 57.54                                                       | 260.17                                                  | 0.711                                                     |
| 10                  | Denmark         | 3710                     | 1.55                             | 47.46                                                       | 15.36                                                   | 0.062                                                     |
|                     |                 |                          |                                  |                                                             |                                                         |                                                           |
| 59                  | Russia          | 19 410                   | 0                                | 26.77                                                       | 10.97                                                   | 0.041                                                     |

Source: Report on the innovation development index by countries. URL: <https://www.wipo.int/en/web/global-innovation-index/2024/index> (accessed on 30.07.2025).

An insufficient contribution to the innovative development of the Russian economy is R&D spending, which, as a percentage of the country's GDP, has not changed since the 1990s. Additionally, the amount of venture capital received is also insufficient, and the development of this sector requires additional fiscal instruments in the economy.

Regarding the indicators characterizing innovation outcomes in key countries (Table 2), the Russian economy faces several areas where additional tools of influence, including fiscal measures, are needed. For

example, although Russia ranks second only after the USA, South Korea, and Germany in terms of patent applications, it still has a significant deficit in additional support for the growth of unicorn-class startups.

In addition, decades of reliance on imported finished goods from abroad have resulted in a decline in the production of high-tech products, leading to a decrease in exports to other markets. This is also reflected in the table above.

In order to enhance the innovativeness of the Russian economy, it would be advisable to utilize fiscal instruments of state regulation



Table 3

**Demand for the Benefits in Force in the Russian Tax Law that Promote Innovative Development**

| Tax Benefit                                                                                                 |                                                                                                 | 2020    | 2021     | 2022     | 2023     | 2024     |
|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------|----------|----------|----------|----------|
| An increasing coefficient to the depreciation rate for fixed assets used in R&D                             | Amount of accrued depreciation (million rubles)                                                 | 163.7   | 163.3    | 184.8    | 216.1    | 336.7    |
|                                                                                                             | Number of taxpayers who used the benefit (units)                                                | 4       | 5        | 4        | 3        | 4        |
| Increasing ratio to R&D expenses according to the list approved by the Government of the Russian Federation | R&D expenses in tax accounting to which the increasing coefficient was applied (million rubles) | 12037.2 | 29333.1  | 22804.8  | 32154.5  | 42410.1  |
|                                                                                                             | Number of taxpayers who used the benefit (units)                                                | 61      | 64       | 55       | 57       | 60       |
| Investment tax deduction                                                                                    | Amount of investment tax deduction (million rubles)                                             | 4306.2  | 26 879.0 | 55 181.8 | 69 247.3 | 73 842.4 |
|                                                                                                             | Number of taxpayers who applied the investment tax deduction (units)                            | 130     | 250      | 349      | 557      | 808      |

Source: Data from the Federal Tax Service of Russia according to form 5-P. URL: [https://www.nalog.gov.ru/rn77/related\\_activities/statistics\\_and\\_analytics/forms/](https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/) (accessed on 08.07.2025).

in order to influence indicators such as the share of research and development (R&D) expenditures in gross domestic product (GDP), the proportion of high-technology products in total output, and the volume of exports of innovative goods. Additionally, it is essential to consider foreign experience, which demonstrates the success of tax incentives in encouraging buyers' interest in purchasing domestically produced goods with new features, which ultimately benefits not only consumption but also production. Through tax instruments, it is feasible to stimulate other indicators that characterize the innovativeness of Russia's economy, although the impact may not be as pronounced. Nevertheless, this does not preclude us from exploring their potential.

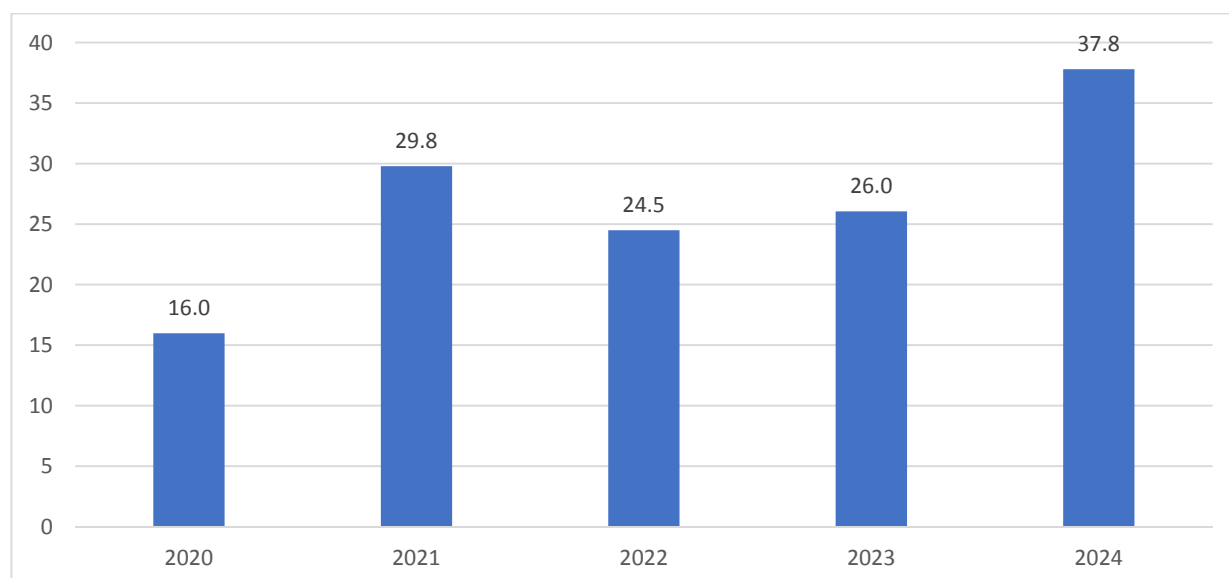
When calculating the share of research and development (R&D) expenditures in gross domestic product (GDP), both budget allocations for R&D purposes and business investments in scientific research from their own funds are taken into account. However,

the resources of the state budget are limited and have little growth potential. Therefore, it is important to note that the potential for increasing this indicator lies in encouraging private companies to expand their financing of their own research. Countries with the highest share of science spending in GDP have achieved their positions in the rankings by doing so [21]. At the same time, fiscal incentives play a significant role in attracting private business resources for applied research.

To increase the financial incentive for private companies to invest their own funds in R&D, both domestic and foreign tax policies use various tools, such as an increased coefficient for R&D expenses in tax accounting,<sup>7</sup> accelerated depreciation,<sup>8</sup>

<sup>7</sup> Paragraph 7 of Article 262 of the Tax Code of the Russian Federation. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/aa9832fb416dd0274acf737be8e4c157866abf0b/](https://www.consultant.ru/document/cons_doc_LAW_28165/aa9832fb416dd0274acf737be8e4c157866abf0b/) (accessed on 05.06.2025).

<sup>8</sup> Paragraph 2 of Article 259.3 of the Tax Code of the Russian Federation. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/8f5e360a53d29554be20fe46a6b79f85e5bbbd0d/](https://www.consultant.ru/document/cons_doc_LAW_28165/8f5e360a53d29554be20fe46a6b79f85e5bbbd0d/) (accessed on 05.06.2025).



**Fig. 1. The Percentage of R&D Spending in Priority Areas out of the Total Volume of Companies' Expenditure on Scientific Development, %**

Source: Data from the Federal Tax Service of Russia according to form 5-P. URL: [https://www.nalog.gov.ru/rn77/related\\_activities/statistics\\_and\\_analytics/forms/](https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/) (accessed on 08.07.2025).

and investment tax credits. In Russia, this is referred to as the investment tax deduction.<sup>9</sup> Additionally, residents of special economic zones with a focus on technology and innovation have the right to apply reduced corporate income tax rates.<sup>10</sup> Small technology companies<sup>11</sup> may also be eligible for certain benefits related to R&D. Accelerated depreciation is considered a tool of tax policy due to its impact on corporate income tax liabilities. Its use allows companies to shift expenses to earlier periods, which does not affect the total amount of

taxes paid over multiple tax periods, but rather delays payments, positively impacting the financial position of the company.

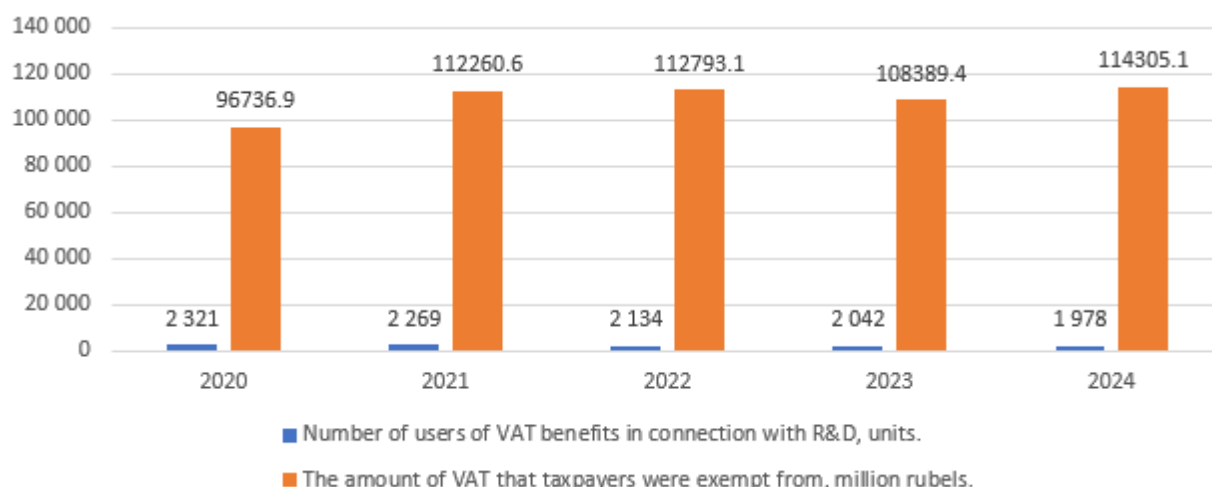
The main challenge is to evaluate the effectiveness of current fiscal incentives, as any tax reduction represents a loss in government revenue and needs to justify its existence. If it fails to achieve its intended purpose, the incentive should be adjusted or eliminated.

The relevance and effectiveness of fiscal instruments used to stimulate innovative development in Russia can be evaluated based on the data presented in *Table 3*. Among these instruments, the investment tax deduction has proven to be the most popular, both in terms of the number of taxpayers applying for it and the amount of benefits received. Its appeal to taxpayers is due to the fact that it is applied not to the tax base but to the amount of taxes. However, it is worth noting that the deduction applies not only to research and development (R&D). This benefit was introduced in Russian tax legislation as a federal tax deduction and began to be applied in 2025. From a financial perspective, its advantage is the ability to reduce corporate income tax paid to the

<sup>9</sup> Regional investment tax deduction, Article 286.1 of the Tax Code of the Russian Federation. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/7260ba686ad1fa7b436a67a764ee41663d78d2cb/](https://www.consultant.ru/document/cons_doc_LAW_28165/7260ba686ad1fa7b436a67a764ee41663d78d2cb/) (accessed on 05.06.2025). Federal investment tax deduction, Article 286.2 of the Tax Code of the Russian Federation. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/e0308f2eb8fed542c0514e9a425981768caef90e/](https://www.consultant.ru/document/cons_doc_LAW_28165/e0308f2eb8fed542c0514e9a425981768caef90e/) (accessed on 05.06.2025).

<sup>10</sup> Paragraph 1.2 of Article 284 of the Tax Code of the Russian Federation. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/eb9180fc785448d58fe76ef323fb67d1832b9363/](https://www.consultant.ru/document/cons_doc_LAW_28165/eb9180fc785448d58fe76ef323fb67d1832b9363/) (accessed on 05.06.2025).

<sup>11</sup> Paragraph 9 of Article 262 of the Tax Code of the Russian Federation. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/aa9832fb416dd0274acf737be8e4c157866abf0b/](https://www.consultant.ru/document/cons_doc_LAW_28165/aa9832fb416dd0274acf737be8e4c157866abf0b/) (accessed on 05.06.2025). Paragraphs 1.8–5 of Article 284 of the Tax Code of the Russian Federation. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/eb9180fc785448d58fe76ef323fb67d1832b9363/](https://www.consultant.ru/document/cons_doc_LAW_28165/eb9180fc785448d58fe76ef323fb67d1832b9363/) (accessed on 05.06.2025).



**Fig. 2. The Effectiveness of R&D Incentives Through Indirect Taxation**

Source: Data from the Federal Tax Service of Russia according to form 1-VAT. URL: [https://www.nalog.gov.ru/rn77/related\\_activities/statistics\\_and\\_analytics/forms/](https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/) (accessed on 17.07.2025).

federal budget regardless of the region where the company is based in Russia. Other benefits also show a positive trend in terms of demand, although it should be noted that a small number of taxpayers use them. We believe that the reasons for this lie not in the benefits themselves, but rather in the difficulties associated with documenting eligibility for benefits and the resulting tax risks.

The criteria for a comparative assessment of the effectiveness of innovative tax incentives, as well as their contribution to the overall outcome, include both the number of beneficiaries and the average reduction in state budget revenue per user of the incentive. The cumulative impact of these incentives can be measured by the growth rate of companies' spending on research in priority areas.

According to tax accounting data, R&D (research and development) expenses of companies increased from 75.3 billion rubles in 2020 to 112.2 billion rubles in 2025. During this time, the share of R&D spending in the total amount spent on scientific research by businesses increased significantly, with a growth rate of 1.5. This was due to the fact that these expenses were prioritized and carried out in accordance with the list approved by the government of the Russian

Federation, as shown in *Fig. 1*. These findings indicate the effectiveness of tax incentives aimed at promoting innovation. Starting from 2025, the growth coefficient has been further increased to 2.

Indirect tax benefits have proven to be less effective at stimulating innovation compared to direct tax preferences, as shown in *Fig. 2*. As a result, the number of taxpayers taking advantage of VAT exemptions for research and development<sup>12</sup> has decreased by almost 15% between 2020 and 2024. At the same time, the amount of shortfall in state budget revenue has remained approximately the same.

The goal of these privileges was not only to free up funds for innovation, but also to encourage collaboration between research customers and educational and scientific institutions. It would seem more effective to achieve this through direct tax incentives, especially for corporate income tax. These suggestions are discussed in the final section of the article.

In addition to tax incentives for companies investing their own funds in scientific research, Russian tax legislation also provides

<sup>12</sup> The Tax Code of the Russian Federation, part 2, paragraphs 16, paragraph 3, Article 149. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/c8ebcedc9ddce9d959d6c520c3b0d602f71e8e12/](https://www.consultant.ru/document/cons_doc_LAW_28165/c8ebcedc9ddce9d959d6c520c3b0d602f71e8e12/) (accessed on 17.07.2025).

fiscal incentives for consumers of domestic innovative products. These incentives include an increasing coefficient of 2 for tax accounting of expenses for the purchase of Russian software, databases, hardware and software complexes listed in a relevant registry.<sup>13</sup>

Moreover, the same coefficient applies to the initial cost of radioelectronic products purchased and high-tech equipment recognized as fixed assets and included in special registers.<sup>14</sup> This rule in the tax legislation allows the buyer to double their expenses in tax accounting through depreciation charges, significantly reducing the corporate income tax base.

The coefficient was increased from 1.5 to 2 starting from January 1, 2025. The use of this benefit denies the taxpayer the opportunity to claim the federal investment deduction, which is completely justified. In 2024, 23 organizations benefited from these preferences, reducing their tax liabilities by a total of 130.6 million rubles.<sup>15</sup>

## CONCLUSIONS

The analysis showed that many of the innovative tax preferences in the Russian legislation are in demand and have a positive impact on business spending on research and development. Currently, these benefits mainly apply to taxpayers who spend money

on scientific research and purchase high-tech equipment and software that are included in lists approved by the government. It would be beneficial to include manufacturers of high-tech products based on their own patented developments within the scope of these benefits. A financial incentive for creating and selling such products could be a reduced corporate income tax rate of 10%, which would reflect a balance between the interests of users and the state budget. However, the implementation of this proposal would require separate accounting at the company level.

In order to encourage research and educational organizations to participate in the development of innovative domestic products, it may be beneficial to increase the coefficient for R&D expenses to 3 for companies that utilize their services. This increase in the coefficient would be beneficial for taxpayers, as it would reduce their corporate income tax liability to a greater extent than the costs of similar research conducted by the company itself, even in priority areas.

Additionally, to enhance the competitiveness of Russian high-tech products, it would be advantageous to expand the range of goods that qualify for an increased coefficient in tax accounting for acquisition costs. This would make Russian high-tech products more attractive to consumers in the presence of foreign alternatives.

Furthermore, to promote innovation in the Russian economy, direct tax incentives may be an effective fiscal instrument, as they have proven successful in the past. Indirect incentives, on the other hand, may not be as effective.

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<sup>13</sup> The Tax Code of the Russian Federation, part 2, paragraphs 26, paragraph 1, Article 264. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/3fdee9a04c76f1af1e084502759523cd77da7d16/](https://www.consultant.ru/document/cons_doc_LAW_28165/3fdee9a04c76f1af1e084502759523cd77da7d16/) (accessed on 17.07.2025).

<sup>14</sup> Tax Code of the Russian Federation, Part 2, paragraph 1, Article 257. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_28165/cf1a9426ba878faee9824672bca283c1420a2b1e/](https://www.consultant.ru/document/cons_doc_LAW_28165/cf1a9426ba878faee9824672bca283c1420a2b1e/) (accessed on 17.07.2025).

<sup>15</sup> Data from the Federal Tax Service of Russia on Form 5-P. URL: [https://www.nalog.gov.ru/rn77/related\\_activities/statistics\\_and\\_analytics/forms/](https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/) (accessed on 17.07.2025).



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**M. E. Kosov** — setting the goals and objectives of the study, developing the article's hypothesis, and confirming it based on the obtained data.

**E. V. Golubtsova** — analyzing and describing the obtained results from the perspective of the effectiveness of tax incentives for R&D.

**E. S. Novikova** — review of literature on the subject, analysis of current macroeconomic problems and tasks from the perspective of fiscal policy affecting the level of innovation in the Russian economy in comparison with the world's leading innovative economies.

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# Tax Incentives for Intellectual Transformation of Companies

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## ABSTRACT

The subject of this study is the tax incentives that promote the intellectual transformation of Russian companies. The objective of the article is to assess the role of stimulating tax policy in ensuring the intellectual transformation of business. Research methods include qualitative analysis of tax incentives, correlation and regression analysis (including assessment of autocorrelation, multicollinearity, and heteroscedasticity), structural analysis, analysis of dynamic time series, tabular, and graphical methods of data visualization. The study conducted an inventory and systematization of tax incentives that promote the intellectual transformation of companies. Three groups of tax incentives were identified: (1) incentives aimed at supporting the infrastructure for the intellectual transformation of a company; (2) innovation incentives, and (3) investment-oriented tax incentives. Within the framework of the analysis of the theoretical aspects of the influence of tax incentives on the intellectual transformation of companies, four areas of such influence have been identified. The impact of tax incentives on the intellectual transformation of business through direct and indirect channels has been assessed. A positive indirect (peripheral) impact of taxes on digital transformation through the development of the information and telecommunication technology sector has been revealed, while the direct impact of fiscal incentives on business digitalization processes has not been proved statistically. The scientific novelty of this study lies in the development and testing of the author's methodology for assessing the direct and indirect impact of tax incentives on the intellectual transformation of companies, based on the use of correlation and regression analysis.

**Keywords:** tax incentives; innovation benefits; investment benefits; regression analysis; correlation; business digitalization; benefit effectiveness; depreciation; investment tax deductions

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## INTRODUCTION

The global development of the digital economy is accelerating, which is crucial for the reshaping of universal factors of production [1], the restructuring of the global economic system and the changing competitive landscape. Achieving technological independence through the use of advanced digital production technologies is a top priority for the Russian Federation. This is reflected in the country's legislation. In particular, digital transformation of the economy has been identified as one of the key national goals in the Unified Plan for achieving the national development goals of the Russian Federation until 2030, and beyond that, until 2036. The Strategy of Scientific and Technological Development of the Russian Federation (approved by Decree of the President of the Russian Federation dated 28.02.2024 No. 145) highlights the transition to advanced technologies based on the use of intelligent manufacturing solutions, robotic and high-performance computing systems, the results of processing large amounts of data, machine learning technologies and artificial intelligence as priority areas. Thus, the intellectual transformation of Russian companies appears to be essential in the context of ensuring the technological sovereignty of the Russian Federation. In this study, this concept is understood as a structured business investment initiative that involves human-machine interaction and the integration of hardware and software. Therefore, the intellectual transformation of companies can be seen as synonymous with digital transformation.

The transformation of the digital economy within enterprises involves optimizing production processes and monitoring various aspects of procurement, production, inventory, capital, energy consumption, and equipment condition. This allows enterprises to solve complex problems and improve product quality through innovation [2]. However, the transformation

of corporate digital intelligence requires a comprehensive investment strategy that encompasses upgrading technology and equipment, implementing digital management systems, reorganizing human resources, and restructuring business models.

In today's economic climate, the intellectual transformation of businesses requires a significant investment of resources, and it also carries the risk of unsuccessful implementation of digital technologies. Therefore, governments in different countries are using various financial support measures to encourage businesses to digitalize their processes. In scientific research, several tools have been identified as priorities for government support of digital business transformation, including tax incentives, public investment in IT technologies, and institutional support for digitalization [3, 4]. Tax benefits can take various forms, such as exemption from taxation on technology transfer operations and preferential tax rates for technologically advanced companies [5], additional deductions for research and development expenses and accelerated depreciation of fixed assets due to technological advancements and equipment upgrades [6].

In this study, we aim to use the author's methodology to assess the role of tax policy in promoting intellectual business transformation and to identify promising areas for developing the Russian tax system to contribute to the digital transformation of companies. To achieve this goal, we have defined the following set of tasks:

- 1) To inventory and systematize tax benefits that contribute to the intellectual transformation of companies.
- 2) To investigate the theoretical aspects of the impact of tax incentives on the intellectual transformation of businesses.
- 3) To assess the impact of tax incentives on business and propose directions for the development of a modern tax policy in Russia, taking into account the intellectual transformation of companies as a key factor.



## MATERIALS AND METHODS

The impact of tax incentives on the intellectual transformation of a business can occur both directly and indirectly. In this study, we assess the impact indirectly through the development of information and communication technologies (ICT). In particular, we use correlation and regression analysis to assess the relationship between the volume of tax benefits received by each taxpayer and the gross value added (GVA) generated by the ICT sector for each employee in the sector, as well as the share of GVA in gross domestic product (GDP) for the entire ICT sector. Due to the fact that the places of the variables in the regression model do not change, the statistical significance of the relationships (*t*-statistics and *F*-statistics) remains unchanged. In a multifactorial model, tax benefits serve as dependent variables, and indicators of the ICT sector serve as independent variables.

The direct impact of tax benefits is assessed by comparing the volume of benefits received by taxpayers with the gross costs incurred by organizations for the development of the digital economy. This analysis also considers the share of these costs in GDP. Due to the fact that the data presented for the period 2009–2023 are used to assess indirect interactions, the first model is constructed in the form of multiple regression. However, business expenditure indicators for the development of the digital economy are only presented for 7 years (2017–2023), so the assessment of direct impact will be done by constructing two one-factor regression models, based on the requirement of data sufficiency. Since the analysis method used is based on the least squares method (OLS), it is necessary to check each model for compliance with the most important prerequisites of OLS (absence of autocorrelation and heteroscedasticity of residues).

Estimating the value of tax benefits requires a preliminary analysis, as not all

incentives contribute (even indirectly) to the intellectual growth of companies. Current tax incentives can be categorized into three groups:

*The first group* of benefits is aimed at supporting the company's intellectual infrastructure transformation. This includes tax incentives for industries that form the basis of digital business transformation, such as the IT and electronics industries.

*The second group* consists of innovation-oriented incentives, which are applicable to all companies regardless of their type of activity or participation in digital transformation.

The most numerous *group is the third*, which includes investment-oriented benefits that help to grow the sources of financing for companies' digital transformation. These benefits are listed in more detail in *Table 1*.

The systematization of tax incentives has revealed that the Russian tax system currently offers a diverse range of measures to encourage the digital transformation of businesses. These measures vary depending on the type of tax (set at the federal, regional, and local levels), as well as the channels through which they are implemented.

In particular, two types of channels of influence should be considered: direct and indirect. The benefits from the direct channel have a direct impact on the company undergoing transformation. These include, for example, a 2% increase in expenses for the purchase of domestic electronics and software for corporate income tax, as well as federal and regional investment tax deductions. Indirect tax incentives aim to support the infrastructure for digital transformation, as well as R&D activities that can form the basis for this transformation. Given the wide range of benefits and the priority of digitalizing the economy and businesses, it is relevant to assess the impact of fiscal incentives and their role in this process.

The initial data for simulation are presented in *Table 2*.

Table 1

## Tax Incentives to Promote the Intelligent Transformation of Companies

| Benefits group                                     | Tax                    | Benefit                                                                                                                                                                                 | Basis (TC RF)                                    |
|----------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Intellectual transformation infrastructure support | Corporate income tax   | Lower tax rate for IT companies                                                                                                                                                         | PARA. 1.15 art / 284                             |
|                                                    |                        | Reduction of the tax rate for companies operating in the field of radio electronics                                                                                                     | PARA. 1.16 art / 284                             |
|                                                    | Insurance premiums     | Reduced insurance premium rates for IT companies                                                                                                                                        | Subpara. 3 para. 1 art / 427                     |
|                                                    |                        | Reduced insurance premium rates for companies operating in the field of radio electronics                                                                                               | Subpara. 18 para. 1 art / 427                    |
|                                                    | VAT                    | VAT exemption for the sale of domestic software included in the register                                                                                                                | Subpara. 26 para. 2 art / 149                    |
|                                                    | Corporate property tax | Exemption from taxation of property of organizations of the power supply system                                                                                                         | PARA. 21.1 para. 21.2 art / 381                  |
| Innovation support                                 | Corporate income tax   | Reduced rates for small technology companies included in the register                                                                                                                   | PARA. 1.8-5 art / 284                            |
|                                                    |                        | Reduced rates for residents of Skolkovo and science and technology centers                                                                                                              | PARA. 5.1 art / 284                              |
|                                                    |                        | Increased depreciation factor 3 for fixed assets used for R&D                                                                                                                           | PARA. 2 art/ 259.3                               |
|                                                    |                        | Increasing ratio to R&D expenses                                                                                                                                                        | PARA. 7 art / 262 TC / PΦ                        |
|                                                    |                        | Investment tax deduction for expenses as a contribution to an investment partnership, whose activities are aimed at making venture and direct investments in small technology companies | Subpara. 10 para. 2 art/ 286.1                   |
|                                                    |                        | Regional investment tax deduction for R&D expenses                                                                                                                                      | Subpara. 6 para. 2 art/ 286.1                    |
|                                                    | Insurance premiums     | Reduced insurance premium rates for companies of business entities and partnerships whose activities consist in the application of R&D                                                  | Subpara. 1 para. 1 art / 427                     |
|                                                    |                        | Reduced tariffs for residents of Skolkovo and science and technology centers                                                                                                            | Subpara. 10 para. 1 art / 427                    |
|                                                    | VAT                    | Exemption of operations for the realization of intellectual property results                                                                                                            | Subpara. 26.1 и Subpara. 26.2 para. 2            |
|                                                    |                        | Exemption of R&D operations                                                                                                                                                             | Subpara. 16, Subpara. 16.1 para. 3 art / 149     |
|                                                    | Corporate property tax | Liberation of the property of state scientific centers                                                                                                                                  | PARA. 15 art/ 381                                |
|                                                    |                        | Release of property of residents and management companies of Skolkovo and scientific and technological centers                                                                          | PARA. 19, para. 20, para. 27, para. 28 art / 381 |
|                                                    | Personal income tax    | Personal income tax exemption for citizens within the framework of grants (according to the list)                                                                                       | PARA. 6.1 art/ 217                               |
| Investment support                                 | Corporate income tax   | Reduced income tax rates for organizations that are residents of zones with preferential taxation (SEZ, SEZ, TOP, SPIC, RIP)                                                            | Art / 284                                        |
|                                                    |                        | Federal Investment Tax Deduction                                                                                                                                                        | Art / 286.2                                      |
|                                                    |                        | Regional investment tax deduction                                                                                                                                                       | Art / 286.1                                      |
|                                                    |                        | Increasing coefficients to the depreciation rate                                                                                                                                        | PARA. 1 и para. 2 art / 259.3                    |
|                                                    |                        | Depreciation premium                                                                                                                                                                    | PARA. 9 art / 258                                |
|                                                    |                        | An increasing factor of 2 to the cost of purchasing domestic electronic products and software                                                                                           | PARA. 1 art / 257                                |
|                                                    | Insurance premiums     | Reduced insurance premium rates for organizations that are residents of zones with preferential taxation (SEZ, SEZ, TOP, SPIC, RIP)                                                     | Art / 428                                        |
|                                                    | VAT                    | Exemption from VAT on transactions of an investment nature (contributions to the authorized capital, investment partnership, etc.)                                                      | PARA. 2 art / 146                                |
|                                                    | Corporate property tax | Release of property of SEZ residents and management companies                                                                                                                           | PARA. 17 art / 381                               |
|                                                    |                        | Release of property having a high energy efficiency class (according to the list)                                                                                                       | PARA. 21 art / 381                               |

Source: Compiled by the authors.

Table 2

**Initial Data for Modeling the Impact of Taxes on the Digital Transformation of Companies**

| Year | Amount of tax benefits per taxpayer, in thousand rubles | Data for multiple regression (indirect effect assessment)                 |                             | Data for paired regression (direct effect assessment)                         |                                                          |
|------|---------------------------------------------------------|---------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------|----------------------------------------------------------|
|      |                                                         | GVA of the ICT sector per 1 employee of the ICT sector, in million rubles | ICT sector GVA, as % of GDP | Organizations' expenditures on digital economy development, in billion rubles | Expenditures on digital economy development, as % of GDP |
| 2009 | 54.76                                                   | 0.99                                                                      | 3.8                         | –                                                                             | –                                                        |
| 2010 | 67.03                                                   | 1.04                                                                      | 3.4                         | –                                                                             | –                                                        |
| 2011 | 289.57                                                  | 1.22                                                                      | 3.3                         | –                                                                             | –                                                        |
| 2012 | 387.91                                                  | 1.37                                                                      | 3.4                         | –                                                                             | –                                                        |
| 2013 | 344.29                                                  | 1.47                                                                      | 3.4                         | –                                                                             | –                                                        |
| 2014 | 486.43                                                  | 1.65                                                                      | 3.1                         | –                                                                             | –                                                        |
| 2015 | 1745.47                                                 | 1.62                                                                      | 2.6                         | –                                                                             | –                                                        |
| 2016 | 1386.81                                                 | 1.65                                                                      | 2.6                         | –                                                                             | –                                                        |
| 2017 | 1126.82                                                 | 1.8                                                                       | 2.7                         | 1739                                                                          | 3.6                                                      |
| 2018 | 1194.89                                                 | 2.07                                                                      | 2.6                         | 1953                                                                          | 3.6                                                      |
| 2019 | 674.87                                                  | 2.38                                                                      | 2.9                         | 2453                                                                          | 3.7                                                      |
| 2020 | 824.00                                                  | 2.6                                                                       | 3.4                         | 2262                                                                          | 3.8                                                      |
| 2021 | 782.37                                                  | 2.90                                                                      | 3.1                         | 2947                                                                          | 3.6                                                      |
| 2022 | 1694.47                                                 | 3.27                                                                      | 3                           | 3199                                                                          | 3.3                                                      |
| 2023 | 1177.69                                                 | 3.87                                                                      | 3.5                         | 3294                                                                          | 3.2                                                      |

Sources: Compiled by the authors based on the data: 1) Abashkin V.L., Abdrakhmanova G.I., Vishnevsky K.O., Gokhberg L.M. et al. Compiled by the authors based on data from Digital economy: 2024: a brief statistical digest. Moscow: ISSEK HSE; 2024. 124 p.; 2) Abdrakhmanova G.I., Vishnevsky K.O., Gokhberg L.M. et al. Digital economy indicators: 2019: a statistical digest. Moscow: ISSEK HSE; 2019. 248 c.; 3) Abashkin V.L., Abdrakhmanova G.I., Vishnevsky K.O., Gokhberg L.M. et al. Digital economy indicators: 2025: a statistical digest. Moscow: NRU HSE, 2025. 296 p.; 4) statistical reporting forms of the Federal Tax Service of Russia 1-NDS, 5-P, 5-NIO for 2009–2023.

**RESULTS****1. Theoretical Aspects of the Impact of Tax Incentives on the Intellectual Transformation of Companies**

The prospects for using tax incentives in the process of intellectual transformation of companies depend on several factors. Firstly, intellectual transformation requires significant investments, but there is uncertainty about the outcome.

This uncertainty creates risks and can hinder progress. Lack of financing makes it difficult for companies to achieve their goals, including digitalization. Capital market issues make it more expensive to obtain funds from external sources and limit financing.

Tax incentives can help reduce these financial barriers. Taxes are mandatory expenses for businesses, which can lead to

a loss of resources and reduced internal funds. However, tax incentives can increase the funds available to companies without imposing additional conditions on their operations. This can motivate companies to invest in digital transformation

Secondly, according to the principle of preferential financing, it is often more profitable for companies to utilize internal financing due to its lower costs. External financing should only be considered if internal financing proves insufficient. However, when the tax burden becomes excessively high, businesses may be forced to turn to external financing options such as loans or equity issues, which can lead to increased costs [7]. In addition, companies will need to bear the additional financial burden associated with the repayment of the principal amount at maturity and regular interest or dividend payments. These conditions do not support the implementation of transformational activities. Instead, tax incentives allow businesses to access reliable internal financing sources. They reduce financial constraints for enterprises, allowing them to allocate more resources towards transformational areas and accelerate their digital transformation.

Thirdly, tax incentives contribute to the modernization of equipment, demonstrating the willingness of organizations to explore new areas and actively carry out transformations. These incentives play a crucial role in increasing companies' investment costs and reducing the cost of capital for users, leading to a change in investment opportunities. The level of tax benefits directly affects the willingness to invest. Under the current policy, federal and regional investment deductions, accelerated depreciation, and other tax incentives increase efficiency in allocating companies' resources, reducing investment and fund renewal costs, accelerating the frequency of equipment replacement, and promoting technological progress.

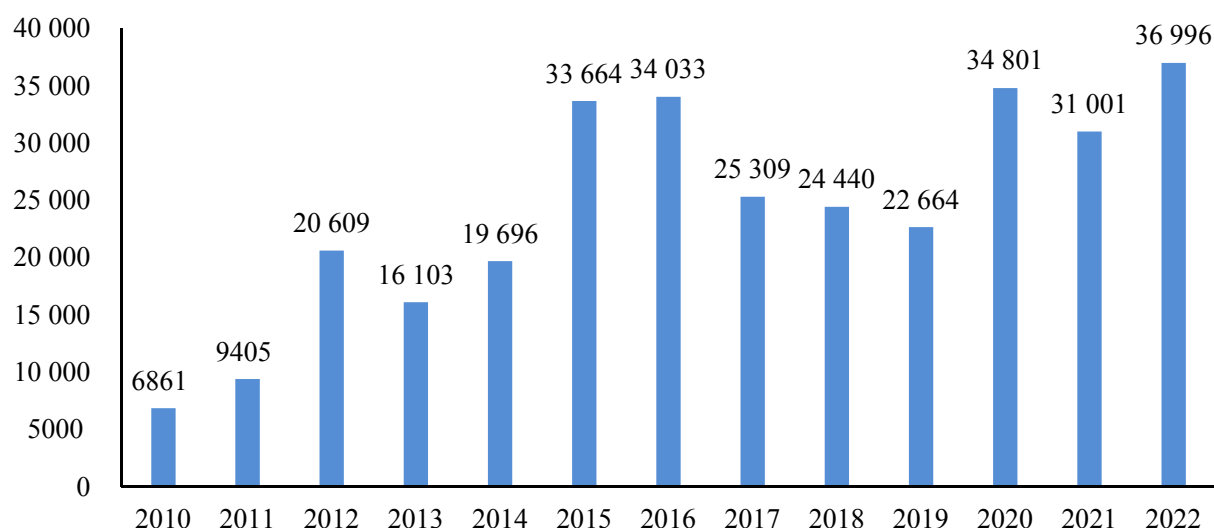
Fourth, increasing the company's digital literacy requires allocating additional resources for innovation. However, innovation

Table 3  
The Results of Modeling the Indirect Dependence Between Tax Incentives and ICT Indicators

| Indicators                                                                             | Meaning                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Symbols                                                                                | $Y$ – The amount of tax benefits per taxpayer is in thousands of rubles.<br>$X_1$ – GVA of the ICT sector per employee of the ICT sector, million rubles.<br>$X_2$ – GVA of the ICT sector, % of GDP |
| Correlation coefficient                                                                | $R = 0.887$                                                                                                                                                                                          |
| Coefficient of determination                                                           | $R^2 = 0.786$                                                                                                                                                                                        |
| The regression equation                                                                | $Y = 3263.44 + 327.01X_1 - 993.42X_2$                                                                                                                                                                |
| Investigation of multicollinearity of factors                                          | $R_{yx_1} = 0.556$<br>$R_{yx_2} = -0.72$<br>$R_{x_1x_2} = -0.08$                                                                                                                                     |
| Significance of the parameters (t-statistics)                                          | $t_0 = 4.802 > t_{tabl} = 2.56$<br>$t_1 = 3.597 > t_{tabl} = 2.56$<br>$t_2 = 4.87 > t_{tabl} = 2.56$                                                                                                 |
| Significance of the equation (The Fisher criterion)                                    | $F = 19.867 > F_{tabl} = 3.89$                                                                                                                                                                       |
| Checking for the absence of heteroscedasticity of residues                             | The Spearman Criterion:<br>$S = 0.69 > S_{tabl} = 2.533$<br>The Goldfeld-Quandt criterion:<br>$G = 1.2 > G_{tabl} = 5.05$                                                                            |
| Checking for the absence of autocorrelation of residuals (The Darbin-Watson criterion) | $2.46 > DW = 2.19 > 1.54$                                                                                                                                                                            |

Source: Author's calculations.

can be risky and uncertain with respect to potential profits, which can reduce the investment motivation of businesses. Tax incentives from the government can help offset the costs of innovation and contribute to expected profits from digital transformation. This encourages businesses to invest more in innovation.



**Fig. 1. Internal Expenditure on Research and Development in the ICT Sector, in Million of Rubles**

Source: Compiled by the authors based on statistical research data from the Higher School of Economics: 1) Abashkin V.L., Abdrakhmanova G.I., Vishnevsky K.O., Gokhberg L.M. et al. Compiled by the authors based on data from Digital economy: 2024: a brief statistical digest. Moscow: ISSEK HSE; 2024. 124 p.; 2) Abdrakhmanova G.I., Vishnevsky K.O., Gokhberg L.M. et al. Digital economy indicators: 2019: a statistical digest. Moscow: ISSEK HSE; 2019. 248 c.; 3) Abashkin V.L., Abdrakhmanova G.I., Vishnevsky K.O., Gokhberg L.M. et al. Digital economy indicators: 2025: a statistical digest. Moscow: NRU HSE, 2025. 296 p.

At the same time, it is important to understand that the policy of tax incentives can have a threshold effect on the digital transformation of enterprises. These policies are often designed and implemented for businesses of a certain size or industry, meaning that there are thresholds for different companies to receive tax benefits. Small businesses and startups may not meet the criteria and conditions for receiving these benefits, and therefore do not receive them. Additionally, the scope and effectiveness of these tax incentives are also limited.

Since digital transformation requires significant investment in areas such as technological research and development, equipment modernization, and human resource training, tax incentives may only cover a small portion of these costs. For projects with large investments, the benefits may be relatively insignificant, creating a threshold effect. Furthermore, the long-term stability of these tax benefits affects companies' decisions about digital transformation. If companies perceive tax benefits as temporary or uncertain, they may be more hesitant to make long-term

investments in intellectual transformation, or they may choose to wait for more stable political conditions.

## 2. Assessment of the Impact of Tax Incentives on the Intellectual Transformation of Business

The results of constructing a model of indirect (peripheral) influence described in the section "Materials and methods" are presented in *Table 3*.

The study of paired correlation coefficients suggests that there is a moderate relationship between tax benefits and the first factor, and a strong relationship with the second factor. There is no multicollinearity between the factors, which suggests the possibility of creating a multiple regression model.

The resulting model is statistically significant and reliable according to the Fisher criterion, with all parameters being significant (based on t-statistics). The necessary conditions for the least squares method have also been met.

1) There is no heteroscedasticity in the residuals of the model (as assessed by the Spearman and Goldfeld-Quandt tests, both of which did not exceed tabular values).



Table 4

**The Results of Modeling the Direct Dependence Between Tax Incentives  
and Companies' Spending on Digital Transformation**

| Indicator                                                                              | Model 1                                                                                                                                                         | Model 2                                                                                                                            |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Symbols                                                                                | $X_1$ – the amount of tax benefits per taxpayer, thousand rubles.<br>$Y$ – the cost of organizations for the development of the digital economy, billion rubles | $X_2$ – the amount of tax benefits per taxpayer, thousand rubles.<br>$Y$ – is the cost of developing the digital economy, % of GDP |
| Correlation coefficient                                                                | $R = 0.2834$                                                                                                                                                    | $R = 0.7165$                                                                                                                       |
| Coefficient of determination                                                           | $R^2 = 0.08031$                                                                                                                                                 | $R^2 = 0.5133$                                                                                                                     |
| The regression equation                                                                | $Y = 2015.82 + 0.5X_1$                                                                                                                                          | $Y = 4.0176 - 0.000445X_2$                                                                                                         |
| Significance of the parameters (t-statistics)                                          | $t_0 = 2.39 < t_{tabl.} = 3.163$<br>$t_1 = 0.661 < t_{tabl.} = 3.163$                                                                                           | $t_0 = 18.612 > t_{tabl.} = 3.163$<br>$t_1 = 2.296 < t_{tabl.} = 3.163$                                                            |
| Significance of the equation (The Fisher criterion)                                    | $F = 0.437 < F_{tabl.} = 6.6079$                                                                                                                                | $F = 5.273 < F_{tabl.} = 6.6079$                                                                                                   |
| Checking for the absence of heteroscedasticity of residues                             | The Spearman Criterion:<br>$S = 1.28 < S_{tabl.} = 3.163$<br>The Goldfeld-Quandt criterion:<br>$G = 3.7 < S_{tabl.} = 19$                                       | The Spearman Criterion:<br>$S = 1.36 < S_{tabl.} = 3.163$<br>The Goldfeld-Quandt criterion:<br>$G = 4.39 < S_{tabl.} = 19$         |
| Checking for the absence of autocorrelation of residuals (The Durbin-Watson criterion) | $1.36 > DW = 0.65$                                                                                                                                              | $1.36 < DW = 1.58 < 2.64$                                                                                                          |

Source: Author's calculations.

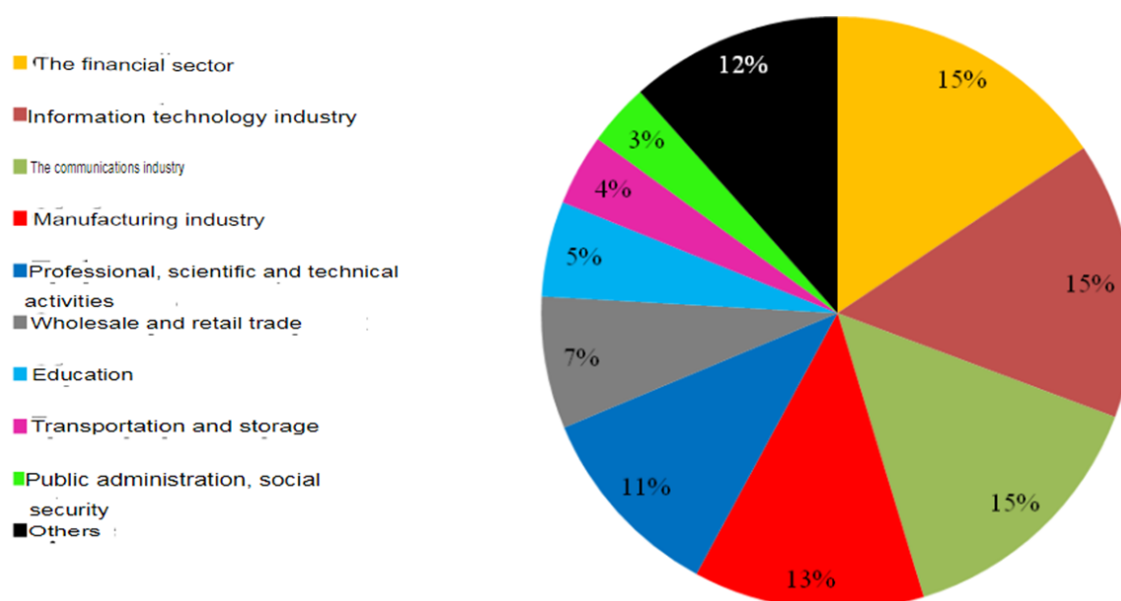
2) There is also no autocorrelation in the residuals (as determined by the Durbin-Watson test, which fell within the range of autocorrelation absence).

The results of building a multiple regression model suggest that there is a strong correlation between tax benefits and indicators of the ICT sector. It was found that, in the studied case, 76.8% of the variability in the total amount of tax benefits is explained by changes in the factors included in the model. At the same time, an increase in tax benefits contributes to the growth of the gross value added (GVA) of the information and communication technology (ICT) sector (and vice versa, a direct link is formed). However, the relationship between tax benefits and the share of the ICT GVA in gross domestic product (GDP) is reversed. This situation (in terms of the feedback between tax benefits and the ICT share in the economy) may be associated

with a high multiplier effect of the sector's influence on other industries, contributing to a reduction in its overall share in GDP.

Indicators of separate determination revealed a stronger relationship between tax benefits and the GVA share of the ICT sector. Similar results were obtained when calculating partial elasticity coefficients: for the GVA per employee indicator of the ICT sector, it was 0.8%, and for the share of ICR GVA, it was 3.8%. The influence of the second factor in the model is greater.

Thus, it has been proved that there is an indirect influence of tax incentives on the intellectual transformation of businesses through the development of the information and communication technology (ICT) sector. This influence manifests itself, among other things, in an increase in the overall internal costs of research and development in the ICT sector (Fig. 1).



**Fig. 2. The Structure of Internal Costs of Organizations for the Creation, Distribution, and Use of Digital Technologies and Related Products and Services, by Type of Economic Activity, in % (2024)**

Source: Compiled by the authors based on data from: Abashkin V.L., Abdrakhmanova G.I., Vishnevsky K.O., Gokhberg L.M. et al. Compiled by the authors based on data from Digital economy: 2024: a brief statistical digest. Moscow: ISSEK HSE; 2024. 124 p.

The data in *Fig. 1* show a general upward trend in research and development costs in the ICT sector. However, this trend is not stable. For example, during the periods 2013–2014, 2017–2019, and 2021, there has been a reduction in these costs (the estimates are given in real prices without taking into account the inflation rate). In addition, statistical studies by HSE show an increase in the share of innovative goods, works and services in the ICT sector from 5.4% in 2010 to 10.8% in 2022.

The results of constructing models of direct influence are presented in *Table 4*.

The construction of paired regression models using indicators of companies' costs for digital transformation led to a negative result. Both equations were found to be statistically insignificant according to the Fisher criterion, as well as the parameters for qualitative variables according to t-statistics. Also, all necessary prerequisites for the least squares method were not met: there was an autocorrelation in residuals in model 1. We found that only 8% of variability in organizations' costs for developing the digital economy and 51% of variability of

digitalization costs in GDP can be explained by tax factors. Therefore, interpretation of model results is not possible, and direct impact of tax incentives on intellectual transformation of companies could not be proven by statistical methods.

Nevertheless, a positive effect has been achieved in this direction. As shown in *Table 1*, over the period from 2017 to 2023, the total costs of organizations for the development of the digital economy increased from 1739 to 3294 billion rubles (almost 2 times) against the background of an increase in the average amount of tax benefits over the same period by only 5%. The positive impact of stimulating government policy is also reflected in how such costs of digitalization are distributed across industries and types of economic activity (*Fig. 2*).

The presented structure shows the distribution of internal costs of organizations for the creation, dissemination and use of digital technologies for various types of economic activity. The main category of digital technology users is the financial sector (16%, the industry is traditionally the leader in this area, due to the high degree of automation of

business processes). Organizations working in the field of information technology and communications share the second and third places (15% each) in terms of the cost of digital solutions. It is important to note that the manufacturing industry stands out among the top five industries (12.6%), which today actively integrates automated production lines, ERP systems and equipment condition monitoring systems.

### DISCUSSION

The results of the study are not definitive, but they do generally align with previous research on a similar subject. There is limited evidence in the academic literature that suggests a positive correlation between tax reduction policies and the intellectual development of companies. This phenomenon can be attributed to the fact that the concept of intelligent production at enterprises is based on unique characteristics of production technologies [11], which makes it challenging to fully understand the underlying impact of preferential tax policies on the digital transformation of businesses [12]. For example, Dye and Chapman use a theoretical model (without testing it on practical data) to study the impact of tax reduction policies on intellectual modernization of production in the context of flexible manufacturing [13]. The authors' research has shown that preferential policies can contribute to intellectual modernization mainly in the short term. However, it is important to remember that excessively rapid tax cuts can limit their effectiveness. Therefore, the state ought to maintain a balance in terms of both the duration of tax benefits and in terms of the speed of their introduction. Similarly, many Russian researchers study digital transformation by examining specific companies [14, 15]. Perhaps the results of this study would be somewhat different if they were based on organizational data rather than aggregated macroeconomic indicators.

Existing research also shows that the impact of tax incentives on digital transformation is not linear and demonstrates threshold effects at which marginal benefits can decrease as soon as companies reach a certain size or technological level [16]. E.E. Panfilova notes that the tax benefits provided to SEZ residents stimulate small companies to the process of reverse engineering, which is an important factor of digitalization for entities of this size [17]. In this regard, in further research, it is possible to differentiate the construction of models by the size of enterprises. Comparing modeling based on data from specific enterprises with the macroeconomic modeling conducted in this article will allow us to correlate the macro- and microeconomic effects of tax benefits in the context of digitalization.

The time threshold effect is revealed in V.G. Panskov's study. The author notes that the significant impact of tax incentives on investment and innovation is only evident in the first two years of implementation, after which it levels off [18].

Other studies in the field of tax policy and corporate behavior show that tax cuts can encourage enterprises to invest in fixed assets [19], promote the development of IT technologies [20], reorganize and improve the quality of their human resources, and expand companies' innovation policies [21]. Studies based on the application of tax incentives in the United States for depreciation of fixed assets show that small enterprises respond to them more actively than large companies [22]. Similarly, the accelerated depreciation policy in China primarily stimulates investments in small enterprises and private organizations, and also significantly affects the efficiency of capital allocation within them [23]. At the same time, international studies emphasize that differences in the market environment, tax systems and corporate culture in different countries and regions can lead to different ways and consequences of tax incentives for digital transformation [24]. In general, the presented

research also demonstrates the growth of business investments in digitalization.

In many ways, these strong differences in the results obtained by the authors can be justified by the fact that, in addition to tax incentives, the factors influencing intellectual and technological modernization are the development of intelligent technologies, technological innovations [26, 27], labor costs [28], environmental regulations, political incentives and demand for market-based and entrepreneurial products based on innovative spirit [29]. The scientific literature notes that factors influencing digital transformation include both internal and external factors. Internal factors include the propensity of business leaders to take risks and the characteristics of their leadership teams. External factors include digital technologies, the competitive environment, tax support, and government intervention.

The digital transformation of an enterprise requires a leadership team that is willing to innovate and willing to take risks. The team must be able to adapt to new technologies and be open to change. They must also be willing to work with other teams and stakeholders to create a culture of collaboration and innovation [30]. Age, gender, work experience in information technology, and a variety of professional skills — all these factors also affect the effectiveness of a company's digital strategy [31]. Market competition in the industry [32], industrial Internet policy and the testing of smart cities [33] also have a significant impact on the intellectual transformation of companies. Similarly, human capital is the most important factor of productivity in business [34]. The main challenge faced by businesses during digital transformation is a lack of digital skills, which is particularly noticeable in smaller organizations. A significant factor determining the strength of a company's human capital is the proportion of employees with a higher level of education and those with unique, high-level skills [35].

## CONCLUSIONS

Within the framework of this study, a scientifically based methodology has been developed to assess the indirect and direct impact of tax benefits on the intellectual transformation of companies. The proposed approach is universal and can be tested using disaggregated data from individual taxpayers. This will allow us to draw more accurate conclusions about the direct impact of tax benefits and identify areas for improvement in individual tax policy instruments.

It is important to understand that benefits alone cannot solve all the problems facing the national economy when it comes to digitalization. A significant portion of the cost of the intellectual transformation is innovation-based, and therefore carries risks. Therefore, during times of crisis, it is understandable for companies to be reluctant to invest in high-risk innovations. In this regard, a comprehensive approach is required, including strengthening the scientific foundation, creating a supportive business environment, and ensuring equal opportunities for all market players.

Despite the proven positive effects of indirect tax benefits on the intellectual transformation of companies through the ICT sector, their significant positive impact on other industries (such as manufacturing and construction) has not been fully demonstrated. This suggests that the use of tax incentives should be accompanied by careful monitoring of the results, regular assessment of the effectiveness of the measures taken and subsequent adjustment of ineffective tax instruments. In this regard, it seems appropriate to increase the responsibility of businesses for the application of tax benefits. This is possible when switching to the equivalent principle of tax incentives, which involves imposing an obligation on the taxpayer to invest in his digital transformation in amounts equivalent to the amount of benefits provided. A similar mechanism is used, for example, when providing reduced insurance premium rates



to residents of industrial clusters (Subpara. 21, para.1, art. 427 of the Tax Code of the Russian Federation). In accordance with para. 16 of art. 427 of the Tax Code of the Russian Federation, reduced insurance premium rates are applied by a participant in an industrial cluster, provided that the volume of investments made for the implementation of an investment project exceeds the amount of the company's saved costs due to the application of a reduced insurance premium rate (both indicators are determined from the beginning of the application of uniform reduced insurance premium rates).

In addition, it would be advisable to systematically evaluate the effectiveness of benefits on an individual level. This approach has already been launched by the Federal Tax Service of Russia using agile methods. The agile methodology allows the Federal Tax Service to evaluate the benefits in relation to specific taxpayers, conducting micro-level analytics. Further development of this approach using data mining tools is a priority for ensuring the digital transformation of Russian companies. Its application will allow determining the most promising directions for tax policy development.

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**A.V. Tikhonova** — statement of the problem, development of the article concept, development of the analysis methodology.

**A.V. Kozharinov** — collection of statistical data, calculations, tabular and graphical presentation of the results.

**N.A. Nazarova** — systematization of tax benefits that contribute to the digital transformation of a company.

**D.I. Ryakhovsky** — description of the results and formation of the research conclusions.

**N.R. Kuzieva** — preparation of the “Discussion” section.

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# Forecasting Business Stability Based on Scenario Approach and Logit-Modeling of Financial Potential

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## ABSTRACT

The relevance of the study stems from the need to improve the accuracy of business sustainability forecasting in a highly turbulent economy. In this regard, the purpose of the research was to create a forecast for business sustainability using an example from the non-ferrous metallurgy industry using an advanced approach with a logit analysis of its financial prospects as a means of assessing key risks, and creating scenarios that could increase the accuracy of forecast estimates. The research methodology included principles, factors, indicators, models of sustainable development, empirical analysis and a risk-factor approach. The selection of factors and indicators for the model characterizing the multidimensionality in financial potential is based on an industry risk analysis, which includes the results of a study of the uncertainty of the business environment. Additionally, correlation analysis and assessment of the statistical significance of various factors were conducted. To build the model, data from 2014 to 2023 was downloaded from the SPARK information system, as well as public industry data. The constructed logit model allows us to assess the probability of the realization of key sustainability risks. The proposed assessment scale allows us to interpret the results as a basis for forecasting of the financial potential of non-ferrous metallurgy companies. The scientific novelty lies in improving the algorithm for forecasting business sustainability. This includes identifying risk factors, selecting indicators based on industry analysis, and developing logit models for financial potential. It also involves developing scenarios, that increase the reliability of forecasts of company sustainability over the short and medium terms. The practical value of the results lies in their potential use in research and development projects, as well as assessing and developing industry strategies at the Ministry of Industry and Trade, and by industry professional, investing funds for industrial development, and in generating reports on the sustainable development of socially and economically important enterprises.

**Keywords:** financial potential; strategy; sustainable development; non-ferrous metallurgy; logit model; risk factor approach; regression analysis; scenario approach

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## INTRODUCTION

Under the conditions of the global sustainable development paradigm, the main priorities of financial management include the predominance of national interests and ensuring the sustainability of financial strength, balance, and growth based on an effective economic model and strategy. The problem of assessing and forecasting indicators in relation to various aspects of sustainable development, levels and institutional parameters of economic systems has been studied by many scientists, including D. E. Sorokin, M. A. Eskindarov, V. V. Maslennikov, S. Y. Glazyev, O. S. Sukharev, S. D. Bodrunov, O. V. Loseva, M. A. Fedotova, I. Ya. Lukasevich [1–5] and others. A critical analysis of multiplicative discriminant analysis techniques and models popular in the twentieth century [6, 7] proves that in a highly turbulent economy and new sustainability criteria, previous approaches do not provide reliable results, which affects the quality of assessment and forecasting, limits the possibility of their application, especially during the period of transformation with high geopolitical and industry risks for business. To select the most appropriate forecasting approaches, we relied on the research of R. Fischer and A. Damodaran<sup>1</sup> and their recommendations on the variability of approaches to predicting future values of indicators, the use of econometric methods and digital modeling of economic processes.

In the 21st century, predictive analytics based on logit modeling, information resources and big data technologies are successfully developing. In financial research, logit models are used to assess the probability of any critical events or the achievement of a set target [7, 8]. According to established practice, in order to accurately predict the long-term viability of a company, it is essential to establish and implement a system of optimal parameters and select methods for assessing their importance

that are appropriate for the forecasting environment. It is crucial that the indicators used are informative and provide a high degree of reliability, based on industry risk analysis [9, 10]. The sustainability of a business depends on its long-term development goals, government priorities, and economic growth. The target aspects and models of economic growth based on the principles of sustainable development are the subject of study by many Russian and foreign scientists, including B. Cornell,<sup>2</sup> Y. M. Tsygalova [11], J. Zhao, J. Tang [12], J. Grewal, E. J. Riedl, G. Serafeim [13], O. V. Efimova [14], O. V. Rozhnova [15], M. V. Melnik [16], who propose using corporate reporting as a source of information about risks in the analysis and forecasts of a company's sustainability.

The aim of this research was to create a forecast for business sustainability using the non-ferrous metallurgical industry as an example. We used an improved approach based on logit analysis to assess the financial potential of the industry as a probability of key risks materializing. Additionally, we created scenarios to enhance the reliability of future projections.

Our hypothesis is that business sustainability, as measured by indicators of financial potential availability and growth trends, is a complex, multidimensional characteristic that takes into account the influence of various components (or sub-potentials) on the company's adequacy, balance, and development. This can be quantified through a logit model that evaluates the likelihood of key risk events occurring.

## RESEARCH METHODOLOGY

Financial potential is a set of resources and opportunities for improving the effectiveness and sustainability of business growth. Assessing and forecasting financial potential helps identify reserves for growth and stability of a company, which is crucial for successful

<sup>1</sup> A. Damodaran's website. URL: <http://pages.stern.nyu.edu/~admodar/> (accessed on 24.02.25).

<sup>2</sup> URL: [https://papers.ssrn.com/sol3/cf\\_dev/AbsByAuth.cfm?per\\_id=16209/](https://papers.ssrn.com/sol3/cf_dev/AbsByAuth.cfm?per_id=16209/) (accessed on 24.02.25).



business. The accuracy and reliability of results depend on the completeness of information about financial potential. A lack of information may lead to inaccurate conclusions and inefficient decisions.

Modern research suggests various methods for assessing both the potential and actual financial potential, as well as analysis methods that take into account its different components [17].

The principles of studying a company's financial potential involve considering its consistency, interactions, and mutual influences of identified structural components. Our research relies on methods such as financial analysis, regulatory compliance analysis, statistical and analytical materials, as well as various methods for assessing a company's financial potential. We also utilize methods of generalization, induction, deduction, and prediction. When selecting forecasting methods, we take into account their specific features and ability to provide reliable results. For example, extrapolation methods are employed when a company's performance remains stable and there are no significant changes in the external economic environment. Factor forecasting enables us to consider the influence of key factors on a company's financial prospects. The Holt's method has better forecasting accuracy, as it adjusts the forecast model to reflect changes in a number of data based on the amount of error in the previous period. This method is useful for forecasting individual factors in the medium term, whose dynamics depend not only on economic conditions. However, it may not be suitable for conditions of high uncertainty, as the scenario method is more appropriate for such situations. The scenario method involves constructing several possible scenarios for the future development of events, which can help to better understand the potential outcomes and make informed decisions.

As a result, a more effective approach to predicting business sustainability has been developed, based on an analysis of the financial potential and development of

industrial companies, using logit to assess the likelihood of key risks. This approach was tested using non-ferrous metallurgy as an example (*Fig. 1*).

The approach focuses on grouping the components of financial potential based on existing risk factors identified through industry analysis. Indicators of subpotential are selected based on correlation analysis and an assessment of their statistical significance. Industry analysis includes external risk factors for the business, based on expert assessments and forecasts for industry development contained in scientific research and the "Strategy for the Development of the Metallurgical Industry of the Russian Federation" for the period until 2030.<sup>3</sup> To build the model, data for 2014–2023 was used, downloaded from the SPARK<sup>4</sup> information system for 236 companies with the type of activity 24.42 "Aluminum Production", as well as industry data on the official websites of the Bank of Russia and Rosstat.

### THE RESULTS OF THE STUDY

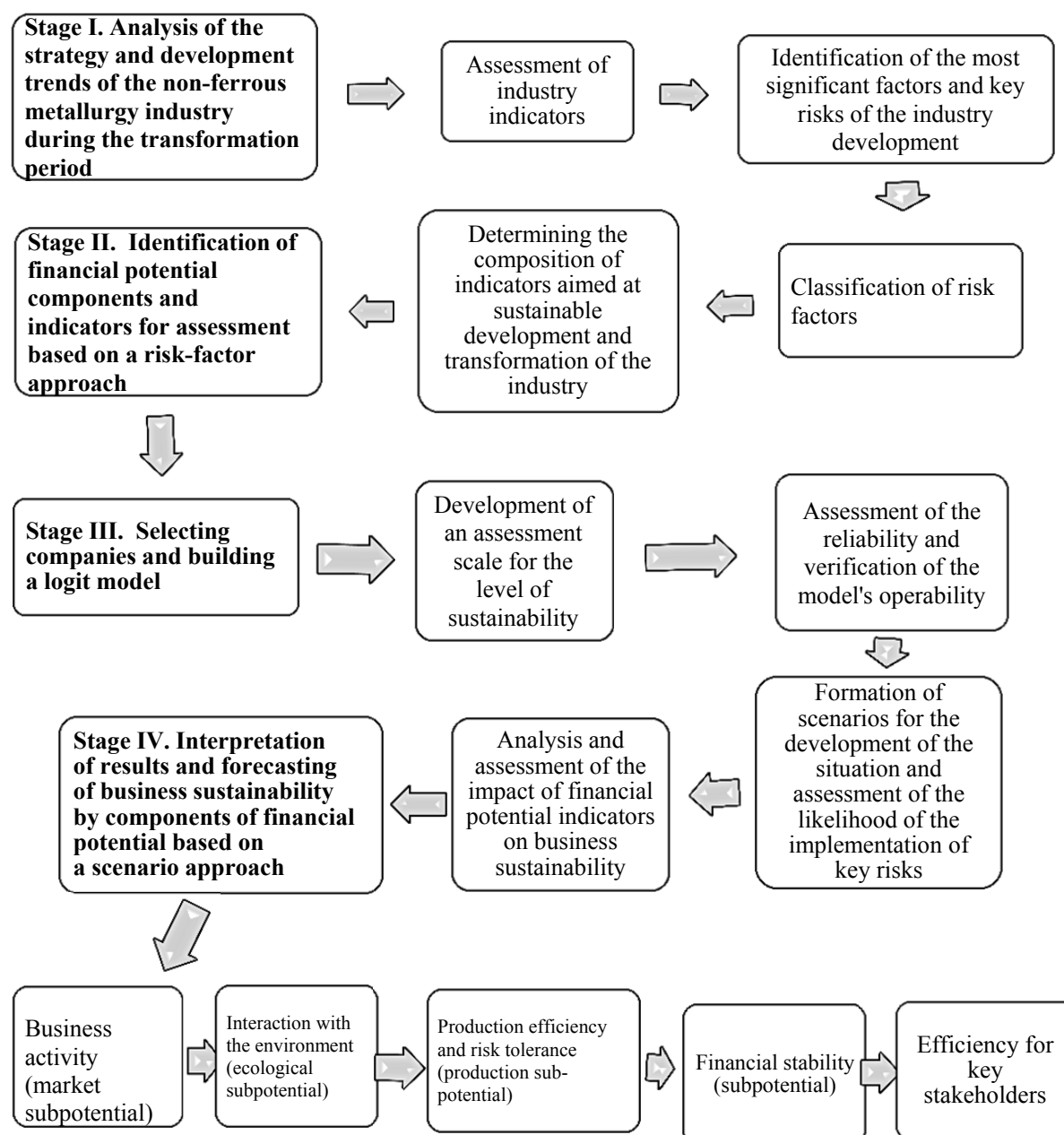
#### Analysis of the Strategy and Development Trends of the Industry, Identification of Key Risks

Industry analysis provides an assessment of the qualitative and quantitative characteristics of the financial potential of industry companies, which affects the level of business sustainability. The strategy for the development of the metallurgical industry includes areas to ensure sustainable growth by increasing the consumption of its products on the domestic market, as well as improving the level of metal processing and producing high-quality products. It is planned to increase the share of added-value products in non-ferrous metallurgy to 75%.

With the easing of sanctions and favorable conditions in foreign markets, accelerated

<sup>3</sup> Strategy for the development of the metallurgical industry of the Russian Federation for the period up to 2030. URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_436470/d6e2df61d984370a0cfca24921215118c4c8c9eb/](https://www.consultant.ru/document/cons_doc_LAW_436470/d6e2df61d984370a0cfca24921215118c4c8c9eb/) (accessed on 22.12.2024).

<sup>4</sup> The SPARK-Interfax information system. URL: <https://spark-interfax.ru/> (accessed on 22.08.2024).



**Fig. 1. An Algorithm for Assessing the Business Sustainability Prospects Based on the Analysis of Financial Potential Sufficiency, Balance and Development Using the Example of the Non-Ferrous Metallurgy Industry**

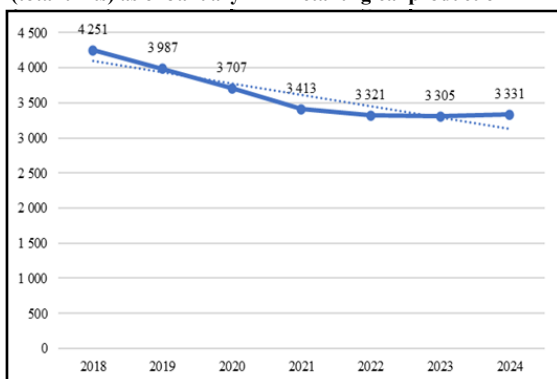
Source: Compiled by the authors.

export growth is expected. Considering projected growth in global aluminum consumption to 104 million tons per year by 2025 and 121 million tons by 2030, trends in aluminum consumption are expected to shift towards increased demand for recycled metal, due to the need for recycling in a closed-loop economy.

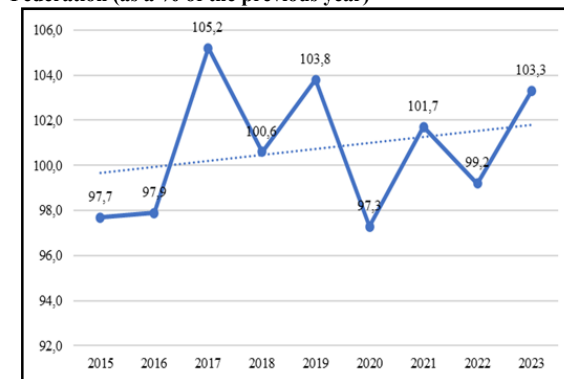
Among the priorities of the metallurgical industry are:

- Increased exports of products with increased processing depth;
- Development of an import substitution program;
- Stricter requirements for product quality, improvement of the product range and competitiveness;
- Resource conservation and energy efficiency, reducing negative environmental impact.

Number of organizations according to state registration (total units) as of January 1 in metallurgical production



Dynamics of the metallurgical production index of the Russian Federation (as a % of the previous year)



Average number of employees in metallurgical production

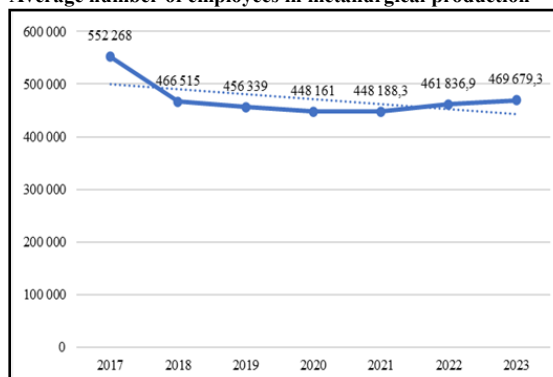


Fig. 2. Statistical Data of Metallurgical Production of the Russian Federation

Source: Compiled by the authors.

According to Rosstat,<sup>5</sup> the production index increased by 3.3% in 2023 (Fig. 2).

According to a study by the Higher School of Economics [18], according to the assessment of the uncertainty of the business environment, metallurgical production is among the nine types of activity with a low index of uncertainty of the business environment. As domestic demand has increased in the economy, there is an increase in investment activity, since investments in production are the only possible scenario for business development due to the lack of reserve production capacity. Investments increased by 9.8% in 2023 and by 6.7% in 2022. Main investment areas: equipment and intellectual property, construction.

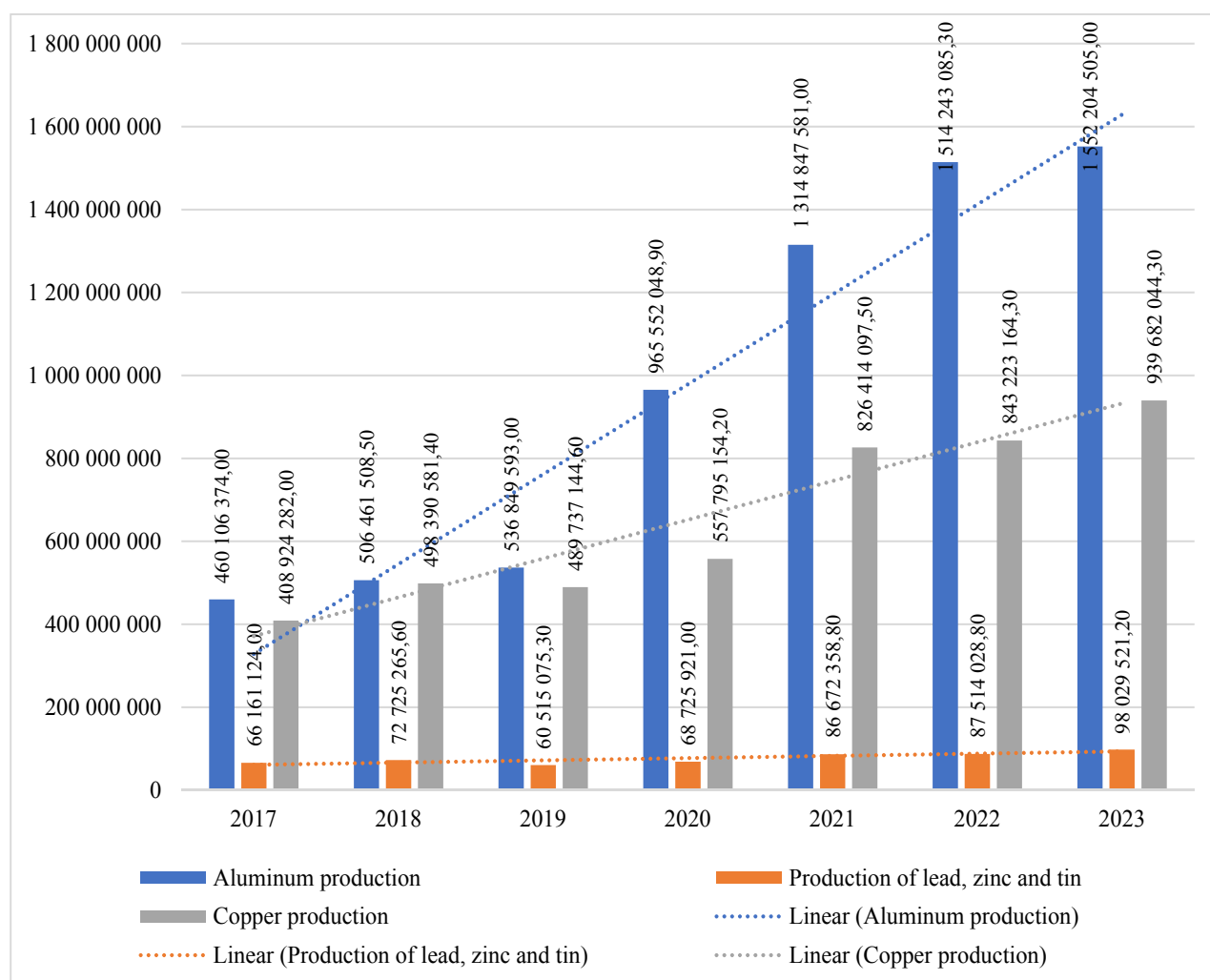
<sup>5</sup> Industrial production. Federal State Statistics Service. URL: [https://rosstat.gov.ru/enterprise\\_industrial](https://rosstat.gov.ru/enterprise_industrial) (accessed on 06.08.2024).

In addition, there has been an increase in patent activity and assessments of the investment climate have been improving. The most significant trend identified was the outpacing growth of high-value-added industries. According to Rosstat, industrial production increased by 3.6%, with processing being the main driver, providing a 7.5% increase in output.

In August 2024, companies' production expectations were positive and the Bank of Russia's business climate indicator showed a positive trend, with a score of 7.0 points compared to 6.2 points<sup>6</sup> in August 2023, indicating continued growth in economic activity.

According to the World Bank, Russia's share in global exports of non-ferrous metals

<sup>6</sup> Enterprise monitoring: estimates, expectations, comments. The Bank of Russia. URL: <https://www.cbr.ru/analytics/dkp/monitoring/0824/> (accessed on 21.12.2024).



**Fig. 3. The Dynamics of the Volume of Shipped Non-Ferrous Metallurgy Goods for 2017–2023 (in Thousands of Rubles, in the Russian Federation)**

Source: Compiled by the authors.

is approximately 16%. The majority of non-ferrous metal products are supplied to the global market in the form of raw materials for the production of other non-ferrous metals. Fig. 3 illustrates the dynamics of shipments of non-ferrous metal products based on data from the Unified Interagency Information and Statistical System (EMISS).<sup>7</sup>

The development of non-ferrous metallurgy in the Russian Federation is affected by several factors, including geopolitical considerations, demand and prices for raw materials. Trends for

different types of production vary, but overall, there has been positive growth in some areas and decline in others.

For example, aluminum production has seen an increase throughout the period under review, while production of copper, lead, zinc, and tin has decreased in 2022. This can be attributed to the geopolitical situation and corresponding decline in demand for Russian products. However, in 2023 there is resurgence, with production exceeding levels from 2021 due to improvements in supply chains, payment systems, and expansion into new markets in the East.

From January to October, the share of Russian aluminum in China's imports increased by 12.7%, reaching 23.4%. Nickel imports also saw an increase of 1.4%, while copper imports

<sup>7</sup> Goods of its own production have been shipped, works and services performed on its own (excluding VAT, excise taxes and similar mandatory payments) for "clean" activities since 2017. EMISS. URL: <https://fedstat.ru/indicator/57716> (accessed on 06.08.2024).

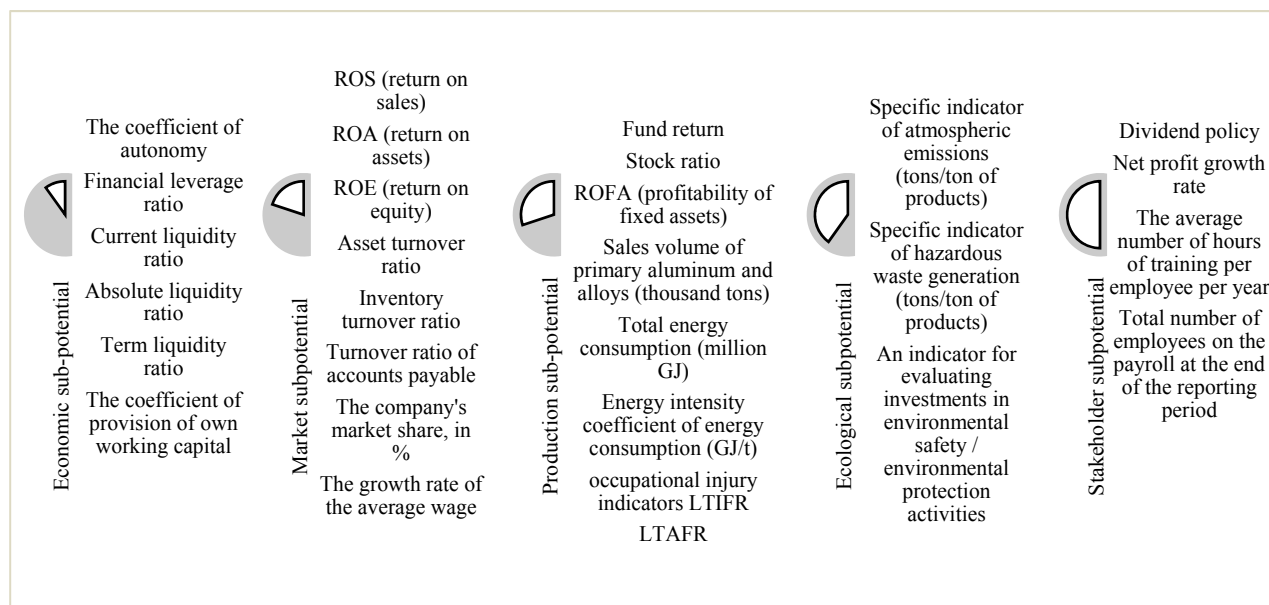


Fig. 4. Composition of Indicators Characterizing the Financial Potential of Non-Ferrous Metallurgy Goods

Source: Compiled by the authors.

increased by only 1%. Physical volumes of copper and nickel supplies increased by 18% and 29% respectively, while aluminum exports increased by 3.4 and 2.6 times compared to the same period in 2021.<sup>8</sup> These changes indicate a transition towards a more efficient economic model, with a focus on forming a national strategy for economic growth and reducing capital outflows from the country.

In terms of aluminum production, Russia is among the top ten countries producing bauxite (the raw material base is approximately 1.4 billion tons). However, there are several key risk factors that could affect the sustainability of the industry:

- Sanctions pressure, including the suspension of operations and nationalization of the Mykolaiv Alumina Plant and the cessation of raw material supplies from Australia, as well as the loss of some sales markets;
- Increased logistics costs due to changes in the flow of goods from the European market to Asia, leading to longer transport distances,

higher costs, and problems with cargo insurance and mutual settlements;

- Turbulence in the national economy, such as rising inflation and an increase in interest rates;
- Volatility in product prices;
- Dependence on imported equipment;
- Environmental risks, including production waste and the prospect of depleting deposits.

#### Identification of the Components of the Financial Potential for Sustainable Development in Non-ferrous Metallurgy

Based on industry analysis, several key factors have been identified that contribute to the availability and development of the financial potential for non-ferrous metallurgical companies. These factors include:

- **Internal operational efficiency:** This refers to the efficiency of a company's internal operations, such as production processes, supply chain management, and financial management.
- **Market position:** The position of a company in the market, including its market share, customer base, and brand recognition, is an important factor for its financial potential.

<sup>8</sup> Preliminary results of Russia's foreign trade in 2023. Trade turnover with China. Monitoring the economic situation in Russia. December 21, 2023 Gaidar Institute of Economic Policy. URL: <https://www.iep.ru/ru/monitoring/predvaritelnye-itogi-vneshney-torgovli-rossii-v-2023-godu-tovarooborot-s-kitaem.html> (accessed on 06.08.2024).



Table 1

**System of Indicators-Factors Characterizing the Financial Potential of Companies in the Metallurgical Industry for the Production of Aluminum (Indicators Included in the Model)**

| Year | Absolute liquidity ratio ( $K_1$ ) | Inventory turnover ratio ( $K_2$ ) | Autonomy ratio ( $K_3$ ) | Return on assets) ( $K_4$ ) | Return on equity) ( $K_5$ ) | Aluminum prices ( $K_6$ ) | Metallurgical production index ( $K_7$ ) |
|------|------------------------------------|------------------------------------|--------------------------|-----------------------------|-----------------------------|---------------------------|------------------------------------------|
| 2014 | 0.06                               | 5.76                               | 0.15                     | 2.08                        | 21.42                       | 1866                      | 100.6                                    |
| 2015 | 0.07                               | 8.41                               | 0.16                     | 3.71                        | 21.04                       | 1671                      | 97.7                                     |
| 2016 | 0.06                               | 9.37                               | 0.19                     | 3.23                        | 25.6                        | 1605                      | 97.9                                     |
| 2017 | 0.05                               | 6.53                               | 0.2                      | 3.21                        | 22.53                       | 1935                      | 105.2                                    |
| 2018 | 0.08                               | 10.25                              | 0.2                      | 4.27                        | 27.02                       | 2087                      | 100.6                                    |
| 2019 | 0.11                               | 11.65                              | 0.23                     | 3.45                        | 17.47                       | 1805                      | 103.8                                    |
| 2020 | 0.1                                | 7.76                               | 0.22                     | 4.89                        | 21.25                       | 1736                      | 97.3                                     |
| 2021 | 0.07                               | 11.09                              | 0.24                     | 5.12                        | 30.29                       | 2505                      | 101.7                                    |
| 2022 | 0.09                               | 11.62                              | 0.27                     | 3.5                         | 21.93                       | 2491                      | 99.2                                     |
| 2023 | 0.1                                | 6.96                               | 0.28                     | 5.11                        | 27.83                       | 2245                      | 103.3                                    |

Source: Compiled by the authors.

- **Productivity and technological support:** The use of advanced technologies and efficient production methods can help companies to increase their productivity and reduce costs, thereby enhancing their financial potential.

- **Social and reputational capital:** A company's reputation and social standing can influence its ability to attract investors and secure financing, thus contributing to its financial potential.

- **Negative environmental externalities:** Companies that take steps to reduce their negative environmental impact, such as implementing environmental management systems or investing in renewable energy, can enhance their reputation and attract socially conscious investors.

- **Human capital:** The skills, knowledge, and experience of employees can be a valuable asset for a company, contributing to its productivity and financial success.

Based on these factors, a system of financial potential indicators has been developed to provide

a comprehensive assessment of a company's available resources and potential for sustainable development (Fig. 4). These indicators include:

- **Business activity (market sub-potential):** The company's market share, revenue, and growth potential.

- **Production efficiency and risk tolerance (production sub-potential):** Measures of a company's efficiency in production processes and its ability to manage risks.

- **Financial stability (economic sub-potential):** Indicators of a company's financial health, including debt levels, liquidity, and profitability.

- **Efficiency for key stakeholders (stakeholder sub-potential):** How well a company meets the needs and expectations of its stakeholders, such as employees, investors, and customers.

- **Interaction with the environment (ecological sub-potential):** A company's efforts to minimize its environmental impact and contribute to sustainable development.

By analyzing these indicators, companies can identify areas where they can improve their performance and enhance their financial potential, leading to greater success and sustainability [19].

The selection of indicators was carried out in such a way as to assess the level of business stability comprehensively for all components in the form of the influence of independent indicators on the resulting indicator – the likelihood of the realization of key risks of reducing financial potential. To develop a regression model, a medium-term period from 2024 to 2026 was set and retrospective data for 10 years (2014–2023) for organizations with the main activity of OKVED 24.42 “Aluminum Production” was uploaded from the Spark-Interfax information system. The upload included information on 236 companies. Data on external factors were taken from the official websites of the Bank of Russia<sup>9</sup> and Rosstat.<sup>10</sup> Using the functionality and built-in functions of the Excel package, correlation analysis was performed and multicollinearity between the indicators-factors was eliminated.

As a result, the complex characteristic of financial potential includes seven statistically significant indicators, which were included in the constructed model (Table 1): absolute liquidity ratio ( $K_1$ ), inventory turnover ratio ( $K_2$ ), autonomy coefficient ( $K_3$ ), ROA (return on assets, %) ( $K_4$ ), ROE (return on equity, %) ( $K_5$ ), aluminum prices (USD) ( $K_6$ ), metallurgical production index, % ( $K_7$ ).

After standardization and regression analysis, regression coefficients were determined. The calculated coefficient of determination of the model ( $R$ -squared), equal to 85.03%, proves the sufficient statistical significance of the constructed model according to the  $F$ -criterion. In a standardized form, the model looks like this:

<sup>9</sup> Statistics. The Bank of Russia. URL: <https://www.cbr.ru/statistics/> (accessed on 19.11.2024). National accounts. URL: <https://rosstat.gov.ru/statistics/accounts> (accessed on 19.11.2024).

<sup>10</sup> National accounts URL: <https://rosstat.gov.ru/statistics/accounts> (accessed on 19.11.2024); Industrial production. URL: [https://rosstat.gov.ru/enterprise\\_industrial](https://rosstat.gov.ru/enterprise_industrial) (accessed on 19.11.2024).

Table 2

## Result Rating Scale

| The Likelihood of Negative Risk Factors Reducing Financial Potential | Characteristics of the Company's Sustainability Level |
|----------------------------------------------------------------------|-------------------------------------------------------|
| 0.625–1                                                              | Low                                                   |
| 0.375–0.625                                                          | Medium                                                |
| 0–0.375                                                              | High                                                  |

Source: Compiled by the authors.

$$P = \frac{1}{1 + e^{-\left( \begin{matrix} 0,5 - 0,1204 \times K_1 + 0,0058 \times K_2 - 0,2410 K_3 - \\ -0,1567 K_4 + 0,1853 K_5 - 0,1359 K_6 + 0,0355 K_7 \end{matrix} \right)}} \quad (1)$$

The coefficients for each independent factor are calculated for each variable and represent the strength and type of relationship between the independent variable and the dependent one. The coefficient of autonomy has the greatest impact on the performance indicator, which is typical for Russian companies.

The low impact of inventory turnover can be explained by the fact that there is not always a direct correlation between a company's performance and its inventory turnover. For example, in 2020, many companies increased their inventories due to the COVID-19 pandemic, which caused a slowdown in trade.

The negative impact of aluminum prices may be because not all companies in the industry engage in export activities, and an increase in domestic prices may lead to a decrease in demand for the product.

To construct the evaluation scale, we used the ROC analysis method, which is used to assess the effectiveness of models based on two indicators: sensitivity and specificity. Depending on their ratio, a cut-off point is determined, which determines the level of sustainability of the company. The benchmarks for evaluation are taken from the study by A. Damodaran<sup>11</sup> (see Table 2).

<sup>11</sup> Damodaran Online. URL: <https://pages.stern.nyu.edu/~adamodar/> (accessed on 06.10.2024).

Table 3

## Characteristics of Forecast Scenarios

| Scenario type         | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Basic scenario        | The company's operations are carried out under the conditions of expected continuation of geopolitical tensions, assuming that the acute phase of the crisis has been resolved. There is a gradual easing of the sanctions regime and/or restructuring of supply chains to other countries. Measures are being taken to support the national economy, especially with regard to production dependent on imported components                                                                                                                                                           |
| Conservative scenario | The company operates in the context of a deteriorating geopolitical situation and ongoing sanctions. New restrictions continue to be imposed on Russian goods in world markets, and there has been no significant restructuring of supply chains or expansion of trade with other countries. The national economy has seen a significant deterioration in investment climate, leading to a decrease in business activity and production. This is due to reduced imports and structural problems within the economy [20], which have had a negative impact on the company's operations |
| Target scenario       | The company operates in a context of a relatively fast recovery from the current geopolitical crisis, with partial lifting of sanctions. As a result, some restoration of supply chains and economic stability can be expected, as well as improvement of the investment climate. Considering that such a recovery won't happen overnight, there will be an increase in economic relations with other countries, particularly in the Asian region                                                                                                                                     |

Source: Compiled by the authors.

Table 4

## The Forecast of Independent Factor Indicators

| Year                  | Absolute liquidity ratio ( $K_1$ ) | Inventory turnover ratio ( $K_2$ ) | Autonomy ratio ( $K_3$ ) | Return on assets ( $K_4$ ) | Return on equity ( $K_5$ ) | Aluminum prices ( $K_6$ ), (USD) | Metallurgical production index ( $K_7$ ) |
|-----------------------|------------------------------------|------------------------------------|--------------------------|----------------------------|----------------------------|----------------------------------|------------------------------------------|
| Target scenario       |                                    |                                    |                          |                            |                            |                                  |                                          |
| 2024                  | 0.12                               | 10.53                              | 0.3                      | 6.15                       | 29.82                      | 3096.25                          | 103.9                                    |
| 2025                  | 0.13                               | 11.51                              | 0.32                     | 7.20                       | 31.8                       | 2882.33                          | 103.1                                    |
| 2026                  | 0.13                               | 12.49                              | 0.33                     | 8.24                       | 33.79                      | 2695.25                          | 103.1                                    |
| Baseline scenario     |                                    |                                    |                          |                            |                            |                                  |                                          |
| 2024                  | 0.1                                | 9.42                               | 0.29                     | 5.57                       | 29.04                      | 2815                             | 103.9                                    |
| 2025                  | 0.11                               | 10.33                              | 0.3                      | 6.28                       | 30.26                      | 2760                             | 102.5                                    |
| 2026                  | 0.11                               | 11.24                              | 0.31                     | 6.99                       | 31.47                      | 2890                             | 102.4                                    |
| Conservative scenario |                                    |                                    |                          |                            |                            |                                  |                                          |
| 2024                  | 0.09                               | 8.34                               | 0.27                     | 5.11                       | 28.65                      | 2300                             | 103.8                                    |
| 2025                  | 0.09                               | 9.43                               | 0.27                     | 4.58                       | 26.41                      | 2400                             | 102.3                                    |
| 2026                  | 0.09                               | 8.61                               | 0.27                     | 4.75                       | 26.88                      | 2300                             | 102.1                                    |

Source: Compiled by the authors.

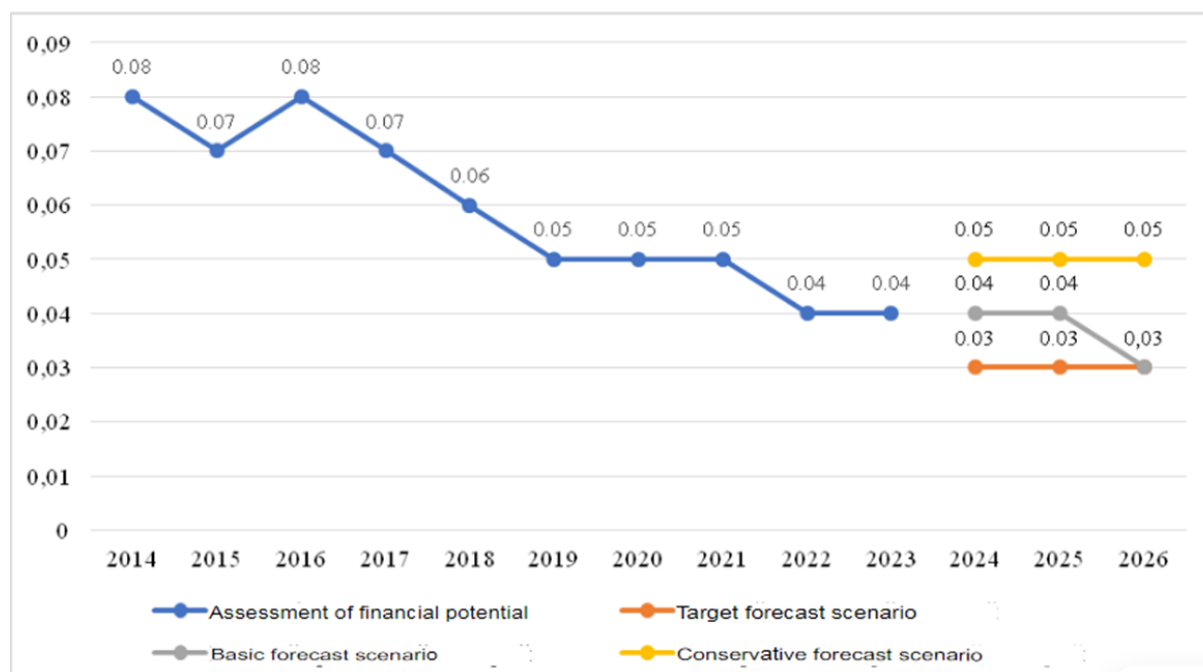


Fig. 5. Assessment of the Likelihood of Key Risks and Forecast of Financial Potential of UC RUSAL IPJSC

Source: Compiled by the authors.

A low level of sustainability is characterized by negative or zero profitability, low aluminum prices, slow production growth, and negative trends in turnover and liquidity. This level of sustainability also indicates a lack of financial independence.

The average level of stability demonstrates optimal values for a number of industry benchmarks. While some parameters may have low values, they are balanced by other factors that have high values. The coefficients are within or equal to the benchmarks.

A high level of sustainability, on the other hand, is characterized by positive profitability, high aluminum prices, increasing production, high turnover, strong liquidity, and strong financial independence. These factors all comply with industry benchmarks and contribute to a healthy and sustainable business.

The performance of the model was tested by MCPAO OK RUSAL,<sup>12</sup> a vertically integrated company with its own resource base that carries out the full cycle of aluminum

production, from mining to finished product manufacturing, ensuring maximum quality control. Since 2022, the company has faced sanctions from Australia, including a ban on the supply of alumina. Then, Ukraine nationalized the company's sole asset on its territory, the Mykolaiv Alumina Plant, and starting in 2023, the United States imposed a 200% tariff on aluminum imports from Russia, threatening to halt exports. Additionally, the Swiss trader Glencore has refused to renew its contract with the company worth \$ 16 billion.

To forecast the financial potential of the company, we used a scenario approach and developed basic, conservative, and target scenarios (see Table 3). This method was chosen because it is optimal for making a forecast in the current conditions of high uncertainty, and it is widely used in strategic planning at the state level. For example, the "Forecast of Socio-Economic Development of the Russian Federation" for the period until 2024 developed by the Ministry of Economic Development presents basic, conservative, and target development scenarios. Similarly, the "Strategy for the Development of the Metallurgical Industry" for the same period, approved by

<sup>12</sup> RUSAL. The official website. URL: <https://rusal.ru/> (accessed on 06.08.2024).

the Government of Russia, includes basic and conservative scenarios.

To build scenario forecasts for assessing the financial potential of a company, we first need to build them for the corresponding independent indicators — the factors that were determined earlier (see *Table 4*). It is worth noting here that the forecast values of the macroeconomic indicators used in the model (aluminum prices in US dollars and the metallurgical production index) were obtained through expert ratings.

To forecast aluminum prices, forecasts from the International Monetary Fund<sup>13</sup> and Fitch Ratings<sup>14</sup> were used, while for the metallurgical production index, we used the medium-term forecast of the VEB<sup>15</sup> Institute for the Russian economy, as well as the Forecast of Socio-Economic Development for 2024 and the planning period of 2025–2026 provided by the Ministry of Economic Development of the Russian Federation.<sup>16</sup> The forecast of the remaining indicators was based on two computational methods: the Holt method, which was chosen due to its high accuracy and ability to adjust for over- and underestimation of trends, and the moving average method, which is used for its simplicity of calculation and accuracy in medium-term forecasting, as well as its ability to smooth out pronounced trends with fluctuations.

*Figure 5* presents the dynamics of estimates of the financial potential of MCPAO UC RUSAL,

calculated using the logit model. It also shows forecast scenarios for business sustainability, which are based on the probability of key risks materializing. The validation of the logistics model allowed us to assess the company's stability as high, as the likelihood of negative risk factors reducing the financial potential is low (see *Table 2*).

During times of crisis, the assessment indicator may deteriorate slightly, but it still ranges from the target to the conservative scenario. Positive trends are ensured in the forecast period by the availability of alternative sources of raw materials, materials, and spare parts, as well as by purchasing machinery and equipment from “friendly” countries and establishing new export routes. Additionally, aluminum prices are expected to increase on the global market due to growing production in China and increasing demand for aluminum in industries such as automotive, green energy,<sup>17</sup> packaging, and construction. The adequacy of the model has also been confirmed based on retrospective data, with the calculated values of the company's financial potential corresponding to its actual financial situation as measured by the considered indicators.

## CONCLUSIONS

The theoretical significance of this study lies in the improved approach to grouping and assessing financial potential parameters, taking into account risk factors and stakeholder risks. This approach serves as a navigator for predicting business sustainability levels.

The logit model that was developed and the assessment scale have practical value, allowing for quantifying and qualitatively assessing the likelihood of key risks. This information can be used to select scenarios for the development of situations in the short and medium terms in conditions of high uncertainty.

<sup>13</sup> Aluminum Price Forecast: 2021, 2022 and Long Term to 2035. Knoema. URL: <https://ru.knoema.com/infographics/ffzioof/aluminum-price-forecast-2021-2022-and-long-term-to-2035> (accessed on 02.06.2024).

<sup>14</sup> Fitch Ratings Raises Several Global Metals and Mining Price Assumptions. Fitch Ratings. URL: <https://www.fitchratings.com/research/corporate-finance/fitch-ratings-raises-several-global-metals-mining-price-assumptions-14-03-2024> (accessed on 02.06.2024).

<sup>15</sup> Medium-term forecast of the development of the Russian economy (updated version, April 2024). The VEB Institute. URL: [https://inveb-docs.ru/attachments/article/2024\\_04/Srednesrochnyi-prognoz-04-2024.pdf](https://inveb-docs.ru/attachments/article/2024_04/Srednesrochnyi-prognoz-04-2024.pdf) (accessed on 02.06.2024).

<sup>16</sup> The forecast of socio-economic development of the Russian Federation for 2024 and for the planned period of 2025 and 2026 (developed by the Ministry of Economic Development of Russia). URL: [https://www.consultant.ru/document/cons\\_doc\\_LAW\\_457874/](https://www.consultant.ru/document/cons_doc_LAW_457874/) (accessed on 02.06.2024).

<sup>17</sup> Green Metals: Solving Aluminium's Climate Paradox. Goldman Sachs. URL: <https://www.goldmansachs.com/intelligence/pages/solving-aluminiums-climate-paradox.html> (accessed on 05.12.2024).



Comprehensive analytical tools enhance the reliability of forecasts and help meet the needs of stakeholders who are interested in assessing business sustainability.

The relevance of the research results is supported by the adequacy, statistical significance, and sample size of the selected indicators. The results of approbation also confirm the validity of the findings. The proposed approach can be applied in research

and projects to assess and develop industry strategies within the Ministry of Industry and Trade, as well as professional associations and investment funds for industrial development. It can also be used in the preparation of reports on the sustainability of socially and economically significant enterprises.

Future research will focus on expanding variable approaches to business sustainability prediction, including stress testing.

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# The Impact of Earnings Management and Tax Avoidance on the Cost of Debt in Vietnamese Listed Firms

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## ABSTRACT

In the context of Vietnam, as an emerging economy characterized by limited financial transparency, this study aims to clarify how the credit market responds to financial management behaviors. It also examines the roles of audit quality and listing status in this relationship. The topic holds both practical and academic significance, particularly in shaping policies related to credit risk control and enhancing financial market discipline. This paper investigates the impact of earnings management and corporate income tax avoidance on the cost of debt among firms listed on the Vietnamese stock exchange during the period from 2016 to 2024. A quantitative research approach is employed using panel data regression models with firm and year fixed effects. The primary independent variables include proxies for earnings management and tax avoidance, while the dependent variable is the cost of debt. Control variables such as profitability, firm size, financial leverage, and foreign ownership are also included to ensure robustness. Further analysis is conducted by dividing the sample based on audit firm type (Big4 vs. non-Big4) and listing status (listed vs. unlisted) to investigate the heterogeneity in audit quality and market visibility. The findings indicate that earnings management has a statistically significant negative impact on the cost of debt, particularly among firms audited by Big4 and listed companies. In contrast, the effect of tax avoidance on the cost of debt is positive but relatively weak and inconsistent across groups. These results underscore the crucial role of audit quality and financial transparency in shaping credit risk responses in emerging markets.

**Keywords:** audit quality; the cost of debt; tax avoidance; earnings management; information asymmetry; Viet Nam; moderating role; capital structure theory

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## INTRODUCTION

In the context of Vietnam's increasingly deep integration into the global financial system, access to debt capital has become a critical factor for firms to maintain and expand their business operations. The cost of debt, defined as the interest rate or financial expenses incurred when borrowing, reflects creditors' trust in a firm's financial information and debt repayment capacity. Consequently, factors affecting the cost of debt are of primary concern to financial managers, investors, and policymakers.

In corporate accounting and finance, earnings management (EM) and income tax avoidance are two common financial behaviors that may distort the quality of financial reporting. EM refers to the adjustment of accounting items to achieve specific profit targets, often with the intent of signaling performance or fulfilling financial covenants [1–3]. Meanwhile, income tax avoidance involves the use of legal or potentially risky strategies to minimize a firm's actual tax liabilities [4].

Although EM and tax avoidance may generate short-term benefits for firms, both behaviors can

exacerbate information asymmetry between firms and external stakeholders such as investors, regulators, and particularly creditors. In credit assessment, creditors rely heavily on financial statements to evaluate a firm's risk profile and repayment ability. As such, financial information distorted by EM or tax avoidance practices may prompt creditors to demand higher interest rates as compensation for the increased information risk [5].

In developed economies, the relationships among earnings management, tax avoidance, and the cost of debt have been extensively studied. For instance, [6] found that firms engaging in aggressive tax avoidance strategies tend to face higher borrowing costs due to perceived legal risks. Similarly, (Bharath et al., 2008) [7] demonstrated that financial reporting quality often affected by EM, has a significant impact on firms' cost of debt. Recent studies have also begun to explore the interaction between EM and tax avoidance and the moderating effects of oversight mechanisms such as auditing, ownership structure, and the legal environment [8].

The quality of tax enforcement by the government plays a critical role in curbing corporate tax avoidance.

When the tax administration system operates effectively, with transparency and the ability to promptly detect and penalize violations, both the motivation and opportunity for firms to engage in tax avoidance are significantly constrained. Conversely, weaknesses in oversight, a lack of transparency in audit procedures, or limited professional capacity may increase the risk of tax avoidance especially as firms increasingly adopt sophisticated accounting techniques to minimize tax liabilities. Therefore, the quality of tax control not only directly influences corporate tax compliance behavior but also serves as a fundamental factor in ensuring fiscal equity and maintaining market discipline. Within the scope of this study, tax avoidance is defined as the use of legal strategies by firms to exploit loopholes in the tax system in order to reduce their tax liabilities, as opposed to tax evasion, which involves illegal practices. The research does not focus on firms that have been detected and penalized for tax evasion. Rather, it analyzes the factors that drive or constrain tax avoidance within the boundaries of existing legal frameworks. This approach allows for a clearer understanding of the motivations behind this behavior and its economic implications for corporate debt costs and managerial decision-making.

However, in Vietnam, the institutional setting and corporate monitoring environment differ substantially from those in developed markets. The legal frameworks related to accounting, taxation, and auditing are still in the process of being refined. Information disclosure is relatively opaque, institutional investor participation is limited, and market monitoring mechanisms are underdeveloped. These characteristics may allow EM and tax avoidance practices to occur more frequently and be harder to detect, thereby exerting a more complex influence on the cost of debt. Weak legal enforcement and low financial transparency are likely to amplify the adverse effects of tax avoidance on borrowing costs [9].

The novelty and primary contribution of this study lie in its analysis of the simultaneous effects of EM and corporate income tax avoidance on the cost of debt within the distinctive context of Vietnam. Unlike previous studies that typically examine each behavior in isolation, this research investigates the interaction between these two financial behaviors and the role of monitoring mechanisms, specifically audit quality and listing status. This approach aims to provide a more comprehensive

understanding of how manipulated financial information influences creditors' lending decisions.

A key innovation in this study is the analysis of how audit quality and listing status moderate the relationship among EM, tax avoidance, and the cost of debt. While prior literature has separately examined the impact of audit quality or market status on cost of capital [5], few studies have incorporated both factors into a unified analytical framework especially in emerging markets such as Vietnam. Firms that are audited by Big 4 auditors typically receive higher-quality audit services due to their expertise, global standards, and greater independence compared to domestic audit firms [10]. Consequently, Big 4 auditors are more capable of detecting and constraining excessive EM and tax avoidance, thereby enhancing the reliability of financial reports and reducing the cost of debt [5]. This study divides its sample into two groups, Big 4 firms and non-Big 4 firms to investigate whether the quality of the audit mitigates the negative relationship between financial transparency and borrowing costs.

Second, the study extends its analysis by separating the sample into listed and unlisted firms. Listed firms are subject to stricter disclosure requirements and greater regulatory and investor scrutiny, which can help constrain EM and tax avoidance behaviors [11]. In contrast, unlisted firms may face less pressure to maintain transparency and be more prone to short-term managerial incentives, thereby increasing credit risk and borrowing costs.

The combination of these two dimensions creates a unique analytical framework capable of shedding light on the complex interplay between financial behavior, audit quality, and firm-level institutional characteristics. This is particularly relevant to emerging economies such as Vietnam, where market monitoring mechanisms are still evolving [12]. Therefore, this study contributes not only to the theoretical literature on emerging markets and the cost of capital, but also provides important policy implications for improving audit quality and information transparency in order to enhance the corporate financial environment.

## THEORETICAL FRAMEWORK

### Asymmetric Information Theory

Asymmetric information theory posits that in financial transactions, internal decision-makers such as corporate managers often have superior



information regarding the firm's operations compared to investors or lenders [13]. Within this context, EM and tax avoidance can be viewed as mechanisms to obscure the true state of corporate affairs, thereby exacerbating information asymmetry. When creditors are unable to fully assess the reliability of financial statements, they tend to perceive a higher risk and consequently demand a risk premium in the form of higher interest rates [1]. EM is therefore considered a factor contributing to increased debt costs. Similarly, tax avoidance, particularly under conditions of low financial transparency can elevate the perceived risk of legal non-compliance and latent tax obligations, thus raising borrowing costs [4]. S. Lee [8] applied the asymmetric information theory to demonstrate that tax avoidance behavior leads to higher debt costs in environments characterized by opaque financial reporting. Likewise, (Francis et al., 2005) [5] showed that EM reduces the credibility of financial information, increasing lenders' risk and thereby the cost of debt.

#### Agency Theory

Agency theory, proposed by (Jensen & Meckling, 1976) [14], highlights conflicts of interest among stakeholders within a firm, particularly between shareholders and managers, as well as between shareholders and creditors. EM and tax avoidance may be interpreted as manifestations of such conflicts, where managers seek to maximize their personal utility at the expense of other stakeholders' long-term interests. From a debt cost perspective, agency-driven behavior, such as EM, raises concerns among creditors regarding the transparency and objectives of management, which in turn results in higher interest rate demands. Tax avoidance can also be regarded as an agency issue, especially when complex tax strategies are employed without adequate disclosure, thereby increasing creditors' monitoring costs and legal risks. (Hanlon & Heitzman, 2010) [4] argued that tax avoidance embodies potential conflicts between managers and creditors, which may result in lender losses. (Liu & Lu, 2007) [15] applied agency theory to Chinese firms and found that high levels of EM are associated with increased borrowing costs due to elevated moral hazard.

#### Signaling Theory

Signaling theory (Spence, 1973) [16], posits that under conditions of incomplete information, firms

may emit signals to convey their financial strength and operational performance. However, when such signals are distorted by opaque financial practices such as EM or tax avoidance, their effectiveness may be weakened or even counterproductive. For instance, aggressive tax avoidance strategies may be perceived by lenders as negative signals indicating poor risk management and a lack of transparency. Similarly, "window-dressing" financial statements through EM may trigger skepticism about the sustainability of reported performance, thereby increasing the cost of debt. (Orazalin & Akhmetzhanov, 2019) [17] employed signaling theory to analyze the mitigating role of high-quality audits on the adverse effects of EM on borrowing costs. Their findings suggest that firms audited by the Big Four firms are better able to issue credible signals of transparency, thereby reducing the negative impact of EM on the cost of debt.

The three theories collectively provide a robust foundation for examining the relationship between EM, tax avoidance, and the cost of debt. Asymmetric information theory underscores the importance of financial information quality in assessing credit risk. Agency theory offers insights into the behavioral motivations underlying EM and its implications for lenders. Signaling theory highlights the role of mediating mechanisms such as auditing in conveying transparent information to the market. The integration of these theories creates a comprehensive and nuanced analytical framework, which not only clarifies causal mechanisms but also supports the development of empirical models.

#### Capital Structure Theory: Past, Present, Future

The study by (Brusov & Filatova, 2023) [18] a comprehensive reassessment of capital structure theory by incorporating time value and non-static conditions into firm valuation models. Their dynamic trade-off framework extends traditional capital structure theories by emphasizing how financing decisions, including tax-related strategies, impact the cost of capital over time. This perspective is highly relevant to the current research, as it highlights the interplay between earnings management, tax avoidance, and the cost of debt under evolving financial conditions. By integrating dynamic capital structure insights, the study enriches the theoretical foundation for analyzing how tax-related behaviors influence firms' debt financing costs.



## LITERATURE REVIEW AND RESEARCH HYPOTHESES

### The Impact of Earnings Management on the Cost of Debt

When a company engages in EM, particularly practices that inflate reported earnings or smooth earnings volatility, it exacerbates information asymmetry between corporate managers and potential creditors [17, 19]. Financial statements become less transparent and less reflective of the firm's actual performance and financial health [20]. This lack of clarity increases the information risk faced by creditors (Sánchez-Ballesta & Yagüe, 2023) [21], meaning a heightened risk of making lending decisions based on incomplete or misleading information. Moreover, EM may also be perceived as a form of managerial opportunism arising from the separation of ownership and control [12, 22]. Managers may use EM to pursue personal objectives such as bonuses, job security, or avoiding covenant violations [17, 19]. Such behavior increases agency costs, as it signals that managers may not act in the best interests of creditors [22].

Due to increased information asymmetry, information risk, and agency costs, creditors perceive a greater risk of default or inadequate loan recovery [21]. To compensate for this heightened risk, lenders demand higher yields on their loans. These higher yields translate into an increased cost of debt for the firm, as reflected in interest rates or credit spreads [23–25]. Empirical studies provide support for this positive relationship. For instance, research on mining firms in Indonesia finds that accrual-based EM has a significantly positive impact on the cost of debt [19]. This aligns with the argument that creditors require higher interest rates when earnings quality is diminished by EM.

**H1:** *Earnings management has a positive effect on the cost of debt.*

### The Impact of Tax Avoidance on the Cost of Debt

Tax avoidance is generally seen as a cost-optimization strategy, but it carries significant risks. According to (Hanlon & Heitzman, 2010) [4], high levels of tax avoidance may raise concerns about corporate transparency and introduce legal risks if the strategies employed are noncompliant with existing tax regulations. (Dyreng et al., 2008) [9] suggest that long-term tax avoidance can result in higher debt costs if lenders perceive heightened compliance risk. The

relationship between tax avoidance and cost of debt can be explained by two opposing channels.

### The Tax Saving Effect and Debt Substitution

Tax avoidance reduces a firm's tax liabilities, thereby increasing post-tax cash flows [12, 21, 26]. These increased cash flows may be used to fund operations without external debt or to improve repayment capacity [27]. Firms with better repayment ability are perceived as less likely to default by creditors, leading to lower required interest rates and thus a reduced cost of debt [21]. Empirical evidence supporting this inverse relationship has been found in Malaysia [27], Germany [24], Spain [21], and France [23].

### The Risk Exposure Effect

Although tax avoidance can enhance cash flow, it may also heighten risk for both the firm and its creditors. Complex tax avoidance strategies may lead to information asymmetry between management and creditors, reducing financial transparency and complicating accurate assessments of financial health [12, 26]. Additionally, tax avoidance may be seen as managerial opportunism or may increase agency costs [12, 22]. More importantly, it introduces tax risk, i.e., the risk of audits, penalties, or legal disputes that can result in unexpected future tax payments or legal costs [23, 24]. This elevated risk leads creditors to demand higher risk premiums, thereby increasing the firm's cost of debt [26]. Several studies report a positive relationship between tax avoidance and the cost of debt, including evidence from Indonesia (Masri & Martani, 2014) [28] and in high-tax-risk contexts such as France (Guedrib & Hamdi, 2025) [23] and Germany [24]. Research in China further shows that this relationship can shift from negative to positive following new bond issuance regulations, highlighting the role of external governance [29]. However, empirical results regarding the direct relationship between tax avoidance and the cost of debt are mixed [28]. Some studies find no statistically significant relationship, such as in Vietnam (Minh Ha et al., 2022) [12] or specific samples in Indonesia [19]. These findings suggest that in certain markets, lenders may prioritize factors such as firm performance or management efficiency over tax avoidance strategies or ownership structure [12]. The conflicting evidence may depend on national

context, industry characteristics, firm attributes (e.g., size, profitability, ownership type such as state-owned or family businesses) [24, 28], the level of tax risk associated with avoidance activities [23], and the quality of corporate governance and audit [21]. Based on the argument that tax avoidance increases both information and tax-related risks for creditors, who then demand higher compensation, the following hypothesis is proposed:

**H2:** *Tax avoidance has a positive effect on the cost of debt.*

### The Moderating Role of Audit Quality and Listing Status in the Relationship between Earnings Management, Tax Avoidance, and the Cost of Debt

Large auditing firms (Big4) are typically regarded as providers of higher-quality audit services. Higher audit quality can mitigate information asymmetry and enhance the reliability of financial reporting [17]. In the context of tax avoidance, high-quality auditing may reduce the information risk associated with complex tax strategies or limit the ability to obscure tax-related risks. One study on SMEs found that the negative effect of tax avoidance on debt costs was significant only for firms receiving unqualified audit opinions [21]. High-quality audits are also expected to constrain earnings management [17].

Listed companies are often subjected to stricter scrutiny by the public, investors, and regulators than their unlisted counterparts [29]. This stronger external governance environment may influence how creditors perceive tax avoidance and EM practices. A study in China found that tax avoidance tends to be negatively associated with the cost of debt for listed firms but positively associated for private firms. This could be attributed to greater transparency and governance in listed firms, which reduces the information risk accompanying tax avoidance. However, there is a lack of direct evidence on the moderating role of listing status in the EM — the cost of debt relationship.

Another gap in the literature is the underexplored role of audit quality and listing status in shaping the relationship between these financial behaviors and the cost of debt. The classification of firms based on their audit quality (Big4 vs. non-Big4) and their listing status (listed vs. unlisted) can provide deeper insights into the role of transparent accounting information and institutional oversight in financial decision-making.

This study aims to fill this gap by testing a model that integrates both financial behavior, earnings management and tax avoidance in relation to cost of debt, while examining the moderating roles of audit quality and listing status in various contexts. This approach is both integrative and reflective of real-world financial practices, especially in transitioning economies like Vietnam. Based on the preceding discussion, we develop the following hypotheses:

**H3a:** *The impact of earnings management on the cost of debt differs across firms with different audit quality (audited by Big4 vs. non-Big4).*

**H3b:** *The impact of tax avoidance on the cost of debt differs across firms with different audit quality (audited by Big4 vs. non-Big4).*

**H4a:** *The impact of earnings management on the cost of debt differs between listed and unlisted firms.*

**H4b:** *The impact of tax avoidance on the cost of debt differs between listed and unlisted firms.*

## RESEARCH METHODOLOGY

To test the research hypotheses regarding the effects of EM, tax avoidance, and the cost of debt in the context of audit quality and the listing status of firms in the Vietnamese stock market, this study employs a quantitative method using panel data and multivariate linear regression models. This approach allows for controlling unobserved heterogeneity across firms while simultaneously evaluating the impact of several independent variables on a dependent variable [30].

### Research Models

Model 1: Examining the impact of earnings management on cost of debt.

$$COD_{it} = \beta_0 + \beta_1 EM_{it} + \alpha Control_{it} + \varepsilon_{it} \quad (1)$$

Model 2: Examining the impact of earnings management and tax avoidance on the cost of debt, considering the roles of audit quality and listing status:

$$COD_{it} = \beta_0 + \beta_1 EM_{it} + \beta_2 ETR_{it} + \alpha Control_{it} + \varepsilon_{it} \quad (2)$$

where  $COD_{it}$  — the cost of debt for firm  $i$  at time  $t$ , measured by interest expenses over the average total liabilities during the year;  $EM_{it}$  — degree of earnings management. In this study, EM is measured using four models: the Jones [31] model, the Modified Jones

model (Dechow et al., 1995) [32], the (Kothari et al., 2005) [33] model, and the (Kasznik, 1999) [34] model.

$$\frac{TAC_{it}}{A_{it-1}} = a_1 \frac{1}{A_{it-1}} + a_2 \frac{\Delta REV_{it}}{A_{it-1}} + a_3 \frac{PPE_{it}}{A_{it-1}} + \varepsilon_{it}, \quad (3.1)$$

$$\begin{aligned} \frac{TAC_{it}}{A_{it-1}} = & a_1 \frac{1}{A_{it-1}} + a_2 \frac{\Delta REV_{it} - \Delta REC_{it}}{A_{it-1}} + \\ & + a_3 \frac{PPE_{it}}{A_{it-1}} + \varepsilon_{it}, \end{aligned} \quad (3.2)$$

$$\begin{aligned} \frac{TAC_{it}}{A_{it-1}} = & \alpha_1 \frac{1}{A_{it-1}} + \alpha_2 \frac{\Delta REV_{it} - \Delta REC_{it}}{A_{it-1}} + \\ & + \alpha_3 \frac{PPE_{it}}{A_{it-1}} + \alpha_4 ROA_{it-1} + \varepsilon_{it}, \end{aligned} \quad (3.3)$$

$$\begin{aligned} \frac{TAC_{it}}{A_{it-1}} = & \alpha_1 \frac{1}{A_{it-1}} + \alpha_2 \frac{\Delta REV_{it} - \Delta REC_{it}}{A_{it-1}} + \\ & + \alpha_3 \frac{PPE_{it}}{A_{it-1}} + \alpha_4 \frac{\Delta CFO_{it}}{A_{it-1}} + \varepsilon_{it}, \end{aligned} \quad (3.4)$$

where  $TAC_{it}$  represents the total accruals of firm  $i$  in year  $t$ , calculated as:

$$TAC_{it} = \Delta CA_{it} - \Delta Cash_{it} - \Delta CL_{it} - \Delta DCL_{it} - DEP_{it}, \Delta CA_{it}$$

is the change in current assets,  $\Delta Cash_{it}$  is the change in cash and cash equivalents,  $\Delta CL_{it}$  is the change in current liabilities,  $\Delta DCL_{it}$  is the change in short-term debt, and  $DEP_{it}$  is depreciation expense.  $\Delta REV_{it}$  refers to the change in revenue,  $\Delta REC_{it}$  is the change in net receivables,  $PPE_{it}$  is the total fixed assets,  $\Delta CFO_{it}$  is the change in cash flows from operating activities,  $A_{it-1}$  is total assets at the beginning of the year ( $t-1$ ), and  $ROA_{it-1}$  is return on assets in year  $t-1$ .

Equations (3.1), (3.2), (3.3), and (3.4) are estimated cross-sectionally by industry and by year, requiring at least 10 firms in each industry group per year. The absolute value of the residuals from these equations is used as a proxy for EM magnitude.

$ETR_{it}$ : Tax avoidance behavior, measured as current income tax expense divided by accounting pre-tax income.

$Control_{it}$ : Control variables include foreign ownership (FO), state ownership (SO), firm size (SIZE, measured by the natural logarithm of total assets), financial leverage (LEV), measured as total liabilities over total assets, and profitability (ROA, calculated as net income after tax over total assets).

**Audit Quality:** Firms are categorized into two groups, those audited by Big 4 audit firms and those audited by non-Big 4 firms.

**Listing Status:** A dummy variable is equal to 1 if the firm is listed and 0 otherwise.

### Data Description

The study uses a panel dataset consisting of 8,315 firm-year observations, derived from financial statements and audit reports of Vietnamese firms over the period 2016–2024. The data are classified into 10 industry groups based on the international standard industrial classification system, including: Industrials, Information Technology, Pharmaceuticals & Healthcare, Oil & Gas, Consumer Services, Consumer Goods, Materials, Utilities, and Telecommunications. The Industrials sector comprises the largest portion of the sample, with 3,534 observations, accounting for 43% of the total. This is followed by Consumer Goods (18%) and Materials (14%). Sectors such as Oil & Gas and Telecommunication each represent approximately 1% of the sample.

The diverse sectoral distribution enables the study to control for industry-specific characteristics that may influence the cost of debt, earnings management, or tax avoidance behaviors [4]. Data were collected from publicly available sources, including FiinPro and Vietstock.vn, ensuring objectivity and reliability. Firms operating in the financial and banking sectors were excluded due to the distinctive nature of their financial structure and accounting standards, which could bias the empirical analysis. A nine-year data collection period enhances temporal coverage and provides stability for the subsequent analyses (see *Appendix*).

## RESULTS AND DISCUSSION

### Baseline Model

*Table 1* presents the descriptive statistics of 8,315 observations, reflecting the distributional characteristics of the variables used in the model. The dependent variable, the cost of debt (COD), has an average value of 2.53%, with a standard deviation of 2.28%, ranging from 0 to a maximum of 10%. This level of cost of debt is relatively consistent with the characteristics of the Vietnamese capital market, where borrowing costs remain high due to asymmetric information risks and significant monitoring costs.

The four earnings management variables (EM1 to EM4), derived from accrual-based models including

[31–34], have mean values ranging from 7.27% to 9.40%. The tax avoidance variable (ETR) has an average value of 16.85%, which is lower than the statutory corporate tax rate of 20%, indicating signs of tax avoidance behavior within the sample (Hanlon & Heitzman, 2010).

The control variables include foreign ownership (FO), state ownership (SO), return on assets (ROA), financial leverage (LEV), a loss dummy variable (LOSS), and firm size (SIZE). These variables exhibit distributions generally consistent with theoretical expectations. The ROA variable has a positive meaning (4.07%), but it also has a large negative minimum value (−6.10%), suggesting substantial performance heterogeneity across firms. The average leverage (LEV) is 55.2%, with a large standard deviation of 77.6%, aligning with previous findings that many Vietnamese firms heavily rely on debt financing.

Overall, the descriptive statistics support the appropriateness of using multivariate linear regression models to test the research hypotheses.

Table 2 presents a Pearson correlation matrix, illustrating the relationships among the independent variables, the dependent variable, and the control variables in the model. The results indicate that the cost of debt (COD) is positively and statistically significantly correlated with all earnings management variables (EM1–EM4); however, the correlation coefficients are relatively low (ranging from 0.0103 to 0.0284), suggesting that while there is a relationship between EM and the cost of capital, it is relatively weak, consistent with findings from emerging markets where financial transparency and information symmetry are limited.

Notably, COD exhibits the strongest positive correlations with firm size ( $SIZE = 0.2177$ ), return on assets ( $ROA = 0.1283$ ), and leverage ( $LEV = 0.0864$ ). These results imply that larger firms with better profitability and higher leverage tend to incur higher borrowing costs. This contrasts with findings from developed markets, where firm size is often associated with a lower cost of capital due to reputation effects and greater creditworthiness [35]. Such results may reflect specific characteristics of the Vietnamese market, where large firms often operate in riskier industries or have histories of high debt levels. Correlations among the earnings management indicators are particularly high, especially between EM2 and EM3 ( $r = 0.9815$ ), as well as between EM1 and both EM2 and EM3 (above

0.93). This suggests a high degree of multicollinearity if these variables are included simultaneously in the regression model. These findings are consistent with the observations of [32], who noted strong movements among various discretionary accrual measures. Additionally, ROA and LOSS are negatively correlated with LEV and SIZE, suggesting that firms with lower efficiency or losses tend to be smaller and more highly leveraged. This aligns with the conclusions regarding capital structure decisions under financial distress.

Table 3 presents the estimation results, indicating that all earnings management indicators (EM1 to EM4) exhibit negative and statistically significant coefficients at the 5% level, implying an inverse relationship between EM and the cost of debt. This suggests that when firms engage in EM in a positive manner (i.e., adjusting earnings towards greater transparency and stability), the cost of borrowing tends to decline. This finding is consistent with signaling theory in finance, which posits that accounting practices aimed at enhancing the credibility of financial information are positively perceived by lenders, potentially resulting in more favorable interest rates [36]. Similarly, (Francis et al., 2005) [5] found that firms with higher earnings quality are subject to lower capital costs. However, this finding contrasts with the studies of [19, 20], while aligning with the conclusions of [17]. Thus, the present study reveals a negative association between EM and the cost of debt, contrary to the initial hypothesis. This counterintuitive outcome may be interpreted as follows: (i) certain forms of EM, particularly those that increase reported earnings, may be perceived by creditors as signals of stable cash flows and short-term financial soundness. When firms demonstrate stable and favorable performance even through accounting adjustments, banks and credit institutions may assess them as lower risk and consequently offer lower borrowing rates. (ii) In markets like Vietnam, where financial disclosure is limited and information asymmetry is high, creditors may find it difficult to accurately detect EM practices [37]. Hence, if EM goes undetected or remains within acceptable bounds, the cost of debt may not rise and may even decline due to artificially positive signals. (iii) Some firms may utilize EM as a temporary financial adjustment tool during challenging periods, while maintaining credibility through long-standing banking relationships and strong internal control systems. In these cases, creditors may not react negatively to EM, resulting in lower debt costs [38].



Table 1

## Descriptive Statistics

| Variable | Obs   | Mean    | Std. dev. | Min      | Max     |
|----------|-------|---------|-----------|----------|---------|
| COD      | 8,315 | 0.02529 | 0.0228    | 0        | 0.10007 |
| EM1      | 8,315 | 0.09282 | 0.08996   | 0.00214  | 0.55742 |
| EM2      | 8,315 | 0.09404 | 0.09095   | 0.00217  | 0.54704 |
| EM3      | 8,315 | 0.09342 | 0.09036   | 0.00217  | 0.54704 |
| EM4      | 8,315 | 0.07267 | 0.07131   | 0.00105  | 0.48669 |
| ETR      | 8,315 | 0.16846 | 0.13495   | -0.2201  | 0.89959 |
| FO       | 8,315 | 0.05657 | 0.12254   | 0        | 0.99    |
| SO       | 8,315 | 0.28377 | 0.30005   | 0        | 1       |
| ROA      | 8,315 | 0.04068 | 0.13142   | -6.10454 | 1.03446 |
| LEV      | 8,315 | 0.55201 | 0.77614   | 0.00021  | 23.2562 |
| LOSS     | 8,315 | 0.12123 | 0.32641   | 0        | 1       |
| SIZE     | 8,315 | 27.2191 | 1.58326   | 19.2594  | 33.0449 |

Source: Compiled by the author.

Regarding the control variables, foreign ownership (FO) is negatively and significantly associated with the cost of debt, indicating that firms with substantial foreign ownership tend to face lower borrowing costs. This may stem from the effective monitoring role of foreign investors, which reduces the perceived risk for creditors [39]. In contrast, state ownership (SO) is statistically insignificant, suggesting that the presence of state shareholders does not meaningfully impact the cost of debt in the context of this study.

Return on assets (ROA) exhibits a negative and significant coefficient at the 5% level, implying that more profitable firms tend to enjoy lower borrowing costs. This aligns with traditional financial theories (Modigliani & Miller, 1958) [40] and empirical studies (Hung et al., 2022) [41], which argue that more efficient firms have a greater debt-servicing capacity, thereby reducing credit risk. Conversely, the LOSS variable has a positive and significant coefficient, indicating that loss-making firms incur higher debt costs, as lenders often view losses as signals of elevated risk. This result is consistent with [7, 42], who demonstrate that financial risk and reporting losses significantly increase the cost of capital.

Firm size (SIZE) is positively and significantly associated with the cost of debt, a noteworthy finding that runs counter to much of the literature from developed markets, where larger firms typically benefit from better negotiation power with lenders [35]. This may reflect a local context in Vietnam, where some large firms operate in high-risk sectors or borrow heavily, resulting in higher interest expenses.

Finally, the R-squared values range from approximately 0.047 to 0.048, indicating that the models explain around 4.7–4.8% of the variation in the cost of debt. Although this explanatory power is modest, it is acceptable given the nature of large panel data and the influence of many unobservable qualitative factors on the dependent variable.

In summary, the findings confirm the role of earnings management in reducing firm's borrowing costs. This suggests that improving the quality of accounting information and promoting financial transparency can serve as effective tools for firms to enhance access to capital at reasonable costs. Moreover, the monitoring role of major shareholders and profitability emerge as key factors in reinforcing a firm's financial credibility in the eyes of lenders.

## EXTENDED MODEL

### Analysis and Discussion of Extended Research Results

The study further examines the relationship between EM and the cost of debt (Table 4) by incorporating the variable measuring the firm's level of tax avoidance (ETR). The regression results across all four models (EM1 to EM4) demonstrate that the relationship between earnings management and the cost of debt remains consistent in terms of direction and statistical significance, while also revealing the additional impact of tax avoidance behavior on the cost of capital. All earnings management variables (EM1 to EM4) have negative statistically significant coefficients at the 5% level, consistent with the baseline model results.



Table 2

Correlation Matrix

| Variable | COD     | EM1     | EM2     | EM3     | EM4     | ETR     | FO      | SO       | ROA      | LEV      | LOSS     | SIZE |
|----------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|------|
| COD      | 1       |         |         |         |         |         |         |          |          |          |          |      |
| EM1      | 0.0284* | 1       |         |         |         |         |         |          |          |          |          |      |
| EM2      | 0.0116  | 0.9447* | 1       |         |         |         |         |          |          |          |          |      |
| EM3      | 0.0156  | 0.9334* | 0.9815* | 1       |         |         |         |          |          |          |          |      |
| EM4      | 0.0103  | 0.5500* | 0.5686* | 0.5663* | 1       |         |         |          |          |          |          |      |
| ETR      | 0.0577* | 0.0445* | 0.0423* | 0.0409* | 0.0994* | 1       |         |          |          |          |          |      |
| FO       | 0.0584* | 0.0592* | 0.0567* | 0.0546* | 0.0683* | 0.0248* | 1       |          |          |          |          |      |
| SO       | 0.1181* | 0.0851* | 0.0889* | 0.0897* | 0.1005* | 0.0423* | 0.1723* | 1        |          |          |          |      |
| ROA      | 0.1283* | 0.1313* | 0.1496* | 0.1218* | 0.1671* | 0.1378* | 0.0879* | 0.0503*  | 1        |          |          |      |
| LEV      | 0.0864* | 0.1045* | 0.1153* | 0.1091* | 0.1509* | 0.0840* | 0.0573* | -0.0333* | -0.3693* | 1        |          |      |
| LOSS     | 0.0900* | 0.0887* | 0.0971* | 0.0959* | 0.1719* | 0.5051* | 0.0491* | -0.0739* | -0.4779* | 0.2420*  | 1        |      |
| SIZE     | 0.2177* | 0.1298* | 0.1186* | 0.1177* | 0.1356* | 0.0914* | 0.2444* | -0.0206  | 0.1383*  | -0.0482* | -0.1716* | 1    |

Source: Compiled by the author.

Note: \*p < 0.1.

Table 3

Regression Results of Model 1

| Variable          | COD        | COD        | COD        | COD        |
|-------------------|------------|------------|------------|------------|
| EM1               | -0.00509** |            |            |            |
|                   | [-2.30]    |            |            |            |
| EM2               |            | -0.00563** |            |            |
|                   |            | [-2.44]    |            |            |
| EM3               |            |            | -0.00511** |            |
|                   |            |            | [-2.22]    |            |
| EM4               |            |            |            | -0.00771** |
|                   |            |            |            | [-2.41]    |
| FO                | -0.0124*** | -0.0124*** | -0.0124*** | -0.0125*** |
|                   | [-3.86]    | [-3.87]    | [-3.86]    | [-3.89]    |
| SO                | -0.000503  | -0.000535  | -0.000517  | -0.00048   |
|                   | [-0.28]    | [-0.30]    | [-0.29]    | [-0.27]    |
| ROA               | -0.00775** | -0.00781** | -0.00764*  | -0.00769*  |
|                   | [-1.97]    | [-1.98]    | [-1.94]    | [-1.95]    |
| LEV               | 0.000544   | 0.000537   | 0.000528   | 0.00052    |
|                   | [1.11]     | [1.11]     | [1.09]     | [1.07]     |
| LOSS              | 0.00413*** | 0.00414*** | 0.00415*** | 0.00422*** |
|                   | [3.94]     | [3.94]     | [3.96]     | [4.02]     |
| SIZE              | 0.00540*** | 0.00541*** | 0.00541*** | 0.00539*** |
|                   | [6.43]     | [6.45]     | [6.45]     | [6.45]     |
| _cons             | -0.120***  | -0.120***  | -0.120***  | -0.120***  |
|                   | [-5.27]    | [-5.28]    | [-5.28]    | [-5.28]    |
| Firm fixed effect | Yes        | Yes        | Yes        | Yes        |
| Year fixed effect | Yes        | Yes        | Yes        | Yes        |
| Observations      | 8315       | 8315       | 8315       | 8315       |
| R-squared         | 0.047      | 0.047      | 0.047      | 0.048      |

Source: Compiled by the author.

Note: \*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01.

Table 4

## Regression Results of Model 2

| Variable          | COD        | COD        | COD        | COD        |
|-------------------|------------|------------|------------|------------|
| EM1               | -0.00507** |            |            |            |
|                   | [-2.29]    |            |            |            |
| EM2               |            | -0.00560** |            |            |
|                   |            | [-2.43]    |            |            |
| EM3               |            |            | -0.00509** |            |
|                   |            |            | [-2.22]    |            |
| EM4               |            |            |            | -0.00766** |
|                   |            |            |            | [-2.40]    |
| ETR               | 0.00331*   | 0.00331*   | 0.00332*   | 0.00329*   |
|                   | [1.72]     | [1.72]     | [1.73]     | [1.72]     |
| FO                | -0.0124*** | -0.0124*** | -0.0124*** | -0.0125*** |
|                   | [-3.87]    | [-3.87]    | [-3.87]    | [-3.89]    |
| SO                | -0.000623  | -0.000655  | -0.000638  | -0.000598  |
|                   | [-0.35]    | [-0.37]    | [-0.36]    | [-0.34]    |
| ROA               | -0.00743*  | -0.00749*  | -0.00732*  | -0.00738*  |
|                   | [-1.92]    | [-1.93]    | [-1.89]    | [-1.91]    |
| LEV               | 0.000552   | 0.000545   | 0.000537   | 0.000526   |
|                   | [1.13]     | [1.12]     | [1.10]     | [1.08]     |
| LOSS              | 0.00483*** | 0.00484*** | 0.00486*** | 0.00492*** |
|                   | [4.31]     | [4.32]     | [4.34]     | [4.39]     |
| SIZE              | 0.00535*** | 0.00537*** | 0.00537*** | 0.00535*** |
|                   | [6.39]     | [6.41]     | [6.40]     | [6.41]     |
| _cons             | -0.119***  | -0.120***  | -0.120***  | -0.119***  |
|                   | [-5.26]    | [-5.27]    | [-5.27]    | [-5.26]    |
| Firm fixed effect | Yes        | Yes        | Yes        | Yes        |
| Year fixed effect | Yes        | Yes        | Yes        | Yes        |
| Observations      | 8315       | 8315       | 8315       | 8315       |
| R-squared         | 0.048      | 0.048      | 0.048      | 0.048      |

Source: Compiled by the author.

Note: \*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01.

These findings further confirm that firms with lower levels of earnings management (i.e., those reporting more transparent earnings) tend to incur lower borrowing costs. This can be explained by asymmetric information theory (Spence, 1973) [16], which suggests that high-quality earnings reports send positive signals to external stakeholders such as banks or bondholders, thereby reducing perceived credit risk and resulting in lower interest rates [5, 36]. This result aligns with studies in emerging economies with improving transparency, such as Vietnam, where firms increasingly recognize the long-term benefits of financial transparency for accessing capital at reasonable costs [43].

#### The Impact of Corporate Income Tax Avoidance on Cost of Debt

The regression results indicate that the coefficient of ETR is positive and statistically significant at the 10%

level across all four models. This positive coefficient implies that a higher level of tax avoidance (i.e., a lower ETR) reduces the cost of debt financing. This can be explained by the fact that tax avoidance helps firms retain more cash flow, thereby increasing their repayment capacity and reducing perceived credit risk from the lenders' perspective. This finding is consistent with the study of (Graham & Tucker, 2006) [6], which shows that tax avoidance improves cash flow and can lead to short-term financial benefits for firms. The result also aligns with those of [23, 24, 28], thus supporting hypothesis H2. The R-squared value slightly increases from 0.047 to 0.048 after including the ETR variable, indicating a small but meaningful contribution of tax avoidance in explaining the variation in the corporate cost of debt. This positive signal suggests that further exploration of the ETR variable in financial models within developing economies is warranted.

The extended model results incorporating the tax avoidance variable demonstrate that accounting behavior affects the cost of debt not only through EM but also through tax strategies. Firms should consider maintaining effective tax policies that do not pose excessive risks while ensuring transparency in financial reporting, to enhance their access to low-cost capital. Regulatory authorities should develop more effective tax avoidance oversight frameworks balancing the goals of encouraging corporate cash flow and maintaining tax fairness, while continuing to promote improvements in financial information quality as an indirect support channel for financial markets.

#### Analysis and Discussion of Results by the Big4 and Non-Big4 Audit Groups

The study further analyzes the relationship between EM, tax avoidance, and the cost of debt by splitting the sample into two groups based on audit quality: firms audited by Big4 audit firms ( $n = 1,749$ ) and the remaining firms ( $n = 6,566$ ). The aim is to clarify the role of audit quality in the relationship between accounting behavior and the cost of capital. The regression results (*Table 5*) show that the variables representing earnings management (EM1, EM2, EM3) have negative coefficients that are statistically significant at the 5% level within the Big4-audited group. This indicates that in firms audited by Big4 often characterized by higher reliability and transparency of information EM has a clear negative effect on borrowing costs. This finding aligns with previous research suggesting that high audit quality enhances the reliability of financial information, making financial report signals more influential in lenders' decision-making [5, 10].

Conversely, in the non-Big4 group, EM1, EM2, and EM3 variables also have negative coefficients but with lower statistical significance. This suggests that while the negative relationship between EM and the cost of capital persists, but its strength and consistency are weaker compared to the Big4 group. This implies that for firms with lower audit quality, their EM behaviors may not be clearly identified by the market or lending institutions, resulting in less effective signaling from financial reports. This is consistent with (Krishnan, 2003) [44] argument that high-quality auditors contribute to enhancing financial reporting quality and mitigating asymmetric information risks.

Notably, within the non-Big4 group, the tax avoidance variable (ETR) has a significant positive coefficient at the 10% level across all models, suggesting that tax avoidance may be perceived by the market as beneficial by helping firms reduce cash outflows and increase liquidity. However, this may also reflect ineffective monitoring of potentially risky behaviors such as tax avoidance in firms with low-quality auditing. Therefore, hypotheses H3a and H3b are accepted.

Overall, the results highlight the clear role of Big4 audits: the negative relationship between EM and the cost of capital is stronger in the Big4 group. This reinforces the hypothesis regarding the mediating role of audit quality in reducing information asymmetry and enhancing the credibility of accounting signals [17]. From a policy perspective, these findings suggest that improving audit quality, especially strengthening the oversight role of independent auditors, is crucial for helping firms access capital more efficiently. Investors and creditors should pay particular attention to audit quality when assessing corporate financial risk. Additionally, the ROA variable exhibits a negative and statistically significant coefficient, and foreign ownership (FO) also shows a clearly negative coefficient, further reflecting the supervisory role of both operational efficiency and major shareholders in reducing the cost of capital.

#### Analysis and Discussion of Research Results by Listed and Unlisted Firms

As presented in *Table 6*, the variables representing earnings management (EM1 to EM4) in the group of unlisted firms are all statistically insignificant, with t-statistics below conventional thresholds to conclude any meaningful difference. This indicates that in unlisted firms, EM does not have a clear impact on the cost of debt. This phenomenon can be explained by the limited information transparency and weaker market supervision in unlisted firms, which makes it difficult for creditors to detect or accurately quantify accounting behaviors [45].

In contrast, the results for the listed firms show significant differences. All variables representing earnings management (EM1 to EM4) have negative coefficients that are statistically significant at the 1% level. These results clearly demonstrate that in listed firms where financial information must comply with higher standards and is closely monitored by the

Table 5

## Regression Results under Different Audit Quality Contexts

| Variable          | COD        | COD        | COD        | COD        | COD        | COD        | COD        | COD        |
|-------------------|------------|------------|------------|------------|------------|------------|------------|------------|
| EM1               | -0.0121**  |            |            |            | -0.00392   |            |            |            |
|                   | [-2.34]    |            |            |            | [-1.59]    |            |            |            |
| EM2               |            | -0.0105**  |            |            |            | -0.00507*  |            |            |
|                   |            | [-2.08]    |            |            |            | [-1.94]    |            |            |
| EM3               |            |            | -0.0103**  |            |            |            | -0.00444*  |            |
|                   |            |            | [-2.07]    |            |            |            | [-1.70]    |            |
| EM4               |            |            |            | -0.0109    |            |            |            | -0.00712*  |
|                   |            |            |            | [-1.60]    |            |            |            | [-1.96]    |
| ETR               | -0.002     | -0.0018    | -0.00167   | -0.00137   | 0.00360*   | 0.00358*   | 0.00359*   | 0.00352*   |
|                   | [-0.43]    | [-0.38]    | [-0.35]    | [-0.29]    | [1.69]     | [1.67]     | [1.68]     | [1.65]     |
| FO                | -0.0112*** | -0.0111**  | -0.0111**  | -0.0114*** | -0.0126**  | -0.0127**  | -0.0126**  | -0.0126**  |
|                   | [-2.60]    | [-2.58]    | [-2.58]    | [-2.67]    | [-2.53]    | [-2.53]    | [-2.53]    | [-2.52]    |
| SO                | 0.00126    | 0.00119    | 0.00118    | 0.00129    | -0.000689  | -0.000723  | -0.000704  | -0.000678  |
|                   | [0.34]     | [0.32]     | [0.32]     | [0.35]     | [-0.34]    | [-0.36]    | [-0.35]    | [-0.34]    |
| ROA               | -0.0309*** | -0.0316*** | -0.0312*** | -0.0296*** | -0.00609*  | -0.00616*  | -0.00600*  | -0.00612*  |
|                   | [-2.73]    | [-2.78]    | [-2.76]    | [-2.60]    | [-1.76]    | [-1.77]    | [-1.73]    | [-1.75]    |
| LEV               | 0.00188    | 0.00174    | 0.00184    | 0.00128    | 0.00042    | 0.00042    | 0.000411   | 0.000405   |
|                   | [0.34]     | [0.32]     | [0.34]     | [0.23]     | [0.87]     | [0.88]     | [0.86]     | [0.85]     |
| LOSS              | 0.000528   | 0.000572   | 0.000618   | 0.00105    | 0.00499*** | 0.00500*** | 0.00502*** | 0.00506*** |
|                   | [0.17]     | [0.18]     | [0.20]     | [0.33]     | [4.39]     | [4.39]     | [4.40]     | [4.43]     |
| SIZE              | 0.00661*** | 0.00664*** | 0.00661*** | 0.00652*** | 0.00493*** | 0.00494*** | 0.00494*** | 0.00493*** |
|                   | [2.90]     | [2.92]     | [2.90]     | [2.87]     | [5.46]     | [5.47]     | [5.47]     | [5.48]     |
| _cons             | -0.159**   | -0.160**   | -0.159**   | -0.157**   | -0.106***  | -0.106***  | -0.107***  | -0.106***  |
|                   | [-2.54]    | [-2.55]    | [-2.54]    | [-2.51]    | [-4.39]    | [-4.39]    | [-4.39]    | [-4.39]    |
| Firm fixed effect | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        |
| Year fixed effect | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        |
| Observations      | 1749       | 1749       | 1749       | 1749       | 6566       | 6566       | 6566       | 6566       |
| R-squared         | 0.086      | 0.086      | 0.086      | 0.084      | 0.041      | 0.042      | 0.042      | 0.042      |

Source: Compiled by the author.

Note: \*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01.

market, EM has a strong negative effect on the cost of debt. This is consistent with prior studies, such as Francis et al. (2005), who argue that lower earnings increase borrowing costs due to heightened information risk and potential mispricing.

Based on the regression results, the variable representing tax avoidance behavior (ETR) shows no statistically significant effect on the cost of debt (COD) in the overall sample and or in the unlisted firms group (UPCOM). However and it is statistically significant at the 10% level in the listed firms group (with a coefficient of around 0.0046 and a t-value of near 1.69). This suggests that the positive relationship between tax avoidance and the cost of debt is more

clearly observed among listed firms. These results align with signaling theory and information risk theory in capital markets, and thus hypotheses H4a and H4b are accepted. Specifically, firms with higher tax avoidance are often perceived by creditors as having lower financial transparency and a greater likelihood of using financial reports to conceal risks [29, 46]. Consequently, banks and other credit institutions may demand higher interest rates to compensate for the potential risk. However, among unlisted firms, poor information disclosure and weak monitoring systems make it difficult for creditors to clearly assess tax avoidance behavior, thereby weakening the relationship between ETR and the cost of debt.

Table 6

## Regression Results by Listed Company Status

| Variable          | COD                  | COD                  | COD                  | COD                  | COD                    | COD                   | COD                   | COD                   |
|-------------------|----------------------|----------------------|----------------------|----------------------|------------------------|-----------------------|-----------------------|-----------------------|
| EM1               | -0.00136<br>[-0.43]  |                      |                      |                      | -0.00933***<br>[-2.99] |                       |                       |                       |
| EM2               |                      | -0.00167<br>[-0.52]  |                      |                      |                        | -0.0102***<br>[-3.12] |                       |                       |
| EM3               |                      |                      | -0.00081<br>[-0.25]  |                      |                        |                       | -0.0103***<br>[-3.15] |                       |
| EM4               |                      |                      |                      | -0.00279<br>[-0.64]  |                        |                       |                       | -0.0124***<br>[-2.67] |
| ETR               | 0.00083<br>[0.31]    | 0.00083<br>[0.31]    | 0.00084<br>[0.31]    | 0.00084<br>[0.32]    | 0.00458*<br>[1.69]     | 0.00458*<br>[1.69]    | 0.00458*<br>[1.69]    | 0.00454*<br>[1.68]    |
| FO                | -0.0129**<br>[-2.10] | -0.0129**<br>[-2.10] | -0.0129**<br>[-2.10] | -0.0130**<br>[-2.11] | -0.0105***<br>[-2.81]  | -0.0106***<br>[-2.82] | -0.0106***<br>[-2.82] | -0.0105***<br>[-2.82] |
| SO                | 1E-04<br>[0.05]      | 9E-05<br>[0.04]      | 0.00011<br>[0.05]    | 0.0001<br>[0.05]     | -0.00162<br>[-0.52]    | -0.00168<br>[-0.54]   | -0.00168<br>[-0.54]   | -0.0015<br>[-0.48]    |
| ROA               | -0.00489<br>[-1.54]  | -0.00492<br>[-1.54]  | -0.00485<br>[-1.53]  | -0.00494<br>[-1.54]  | -0.0288***<br>[-4.09]  | -0.0289***<br>[-4.11] | -0.0288***<br>[-4.10] | -0.0271***<br>[-3.86] |
| LEV               | 0.000932*<br>[1.77]  | 0.000933*<br>[1.77]  | 0.000925*<br>[1.76]  | 0.000927*<br>[1.77]  | 0.00403<br>[1.00]      | 0.00391<br>[0.97]     | 0.00395<br>[0.98]     | 0.00386<br>[0.96]     |
| LOSS              | 0.00471***<br>[3.80] | 0.00471***<br>[3.80] | 0.00471***<br>[3.80] | 0.00474***<br>[3.82] | 0.00203<br>[1.09]      | 0.0021<br>[1.12]      | 0.00209<br>[1.12]     | 0.00247<br>[1.31]     |
| SIZE              | 0.00694***<br>[5.53] | 0.00695***<br>[5.51] | 0.00694***<br>[5.50] | 0.00694***<br>[5.54] | 0.00217**<br>[2.03]    | 0.00217**<br>[2.03]   | 0.00215**<br>[2.02]   | 0.00220**<br>[2.07]   |
| _cons             | -0.161***<br>[-4.80] | -0.161***<br>[-4.80] | -0.161***<br>[-4.79] | -0.161***<br>[-4.81] | -0.0331<br>[-1.15]     | -0.0328<br>[-1.14]    | -0.0324<br>[-1.13]    | -0.0339<br>[-1.18]    |
| Firm fixed effect | Yes                  | Yes                  | Yes                  | Yes                  | Yes                    | Yes                   | Yes                   | Yes                   |
| Year fixed effect | Yes                  | Yes                  | Yes                  | Yes                  | Yes                    | Yes                   | Yes                   | Yes                   |
| Observations      | 4449                 | 4449                 | 4449                 | 4449                 | 3866                   | 3866                  | 3866                  | 3866                  |
| R-squared         | 0.06                 | 0.06                 | 0.06                 | 0.06                 | 0.053                  | 0.053                 | 0.054                 | 0.052                 |

Source: Compiled by the author.

Note: \*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01.

## CONCLUSION AND RECOMMENDATIONS

## Conclusion

This study examined the impact of EM and tax avoidance on the cost of debt financing in the context of Vietnamese firms, while also analyzing the roles of audit quality (Big4) and listing status (officially listed and UPCOM). Using fixed-effects regression analysis on panel data comprising over 8,315 observations from non-financial firms, the study provides clear evidence of the negative effect of EM on the cost of debt, particularly in firms with higher transparency levels.

First, the results indicate that variables representing earnings management behavior (EM1 to EM4) have

a negative and statistically significant effect on the cost of debt in the subsamples of firms audited by Big4 and those listed on the stock exchange. This implies that lower quality accounting information, as reflected in earnings management, leads creditors to demand higher risk premiums when lending [5, 7]. Conversely, for firms audited by non-Big4 auditors or unlisted firms, this effect is not statistically significant, reflecting limitations in using accounting information to assess credit risk in firms with lower levels of information disclosure [45].

Second, the study finds that tax avoidance behavior, measured by the Effective Tax Rate (ETR), is positively but inconsistently related to the cost of



debt. This relationship reflects creditors' perspectives on potential information risk and managerial opportunism. According to [4], tax avoidance can signal efficient financial management, but it may also indicate the risks of opacity and fraud, resulting in higher capital costs due to an increased perceived risk for creditors.

Third, the study confirms the critical role of supervisory mechanisms and audit quality. Firms audited by the Big4, known for their high audit quality and relative independence from client influence, exhibit a clear relationship between EM and cost of debt, indicating that more reliable financial information helps creditors respond appropriately to accounting behavior [47, 48]. Similarly, in listed firms under public and regulatory scrutiny, the relationship between EM and the cost of debt is stronger.

Fourth, to mitigate risks associated with tax avoidance behavior, banks often establish stringent credit assessment procedures. These include evaluating the quality of financial statements, the level of information transparency, and the firm's compliance with tax obligations. Banks may also implement credit scoring mechanisms that are linked to the degree of tax compliance. This directly influences interest rates and access to credit. This creates an economic incentive for firms to enhance transparency and fulfill their tax obligations in order to improve borrowing conditions and reduce the cost of debt.

### Contributions to Theory and Practice

Theoretically, this study contributes to the literature on financial reporting quality and earnings management by clarifying the effect of such behavior on the cost of debt in the emerging market context of Vietnam. The results support agency theory and asymmetric information theory, arguing that distorted accounting information leads creditors to demand higher risk premiums to compensate for uncertainty [49].

Furthermore, the findings reinforce and extend signaling theory [16], and agency theory [14], Capital Structure Theory [18], where tax avoidance is seen as a negative signal of conflicts between shareholders and creditors. In emerging markets like Vietnam, where accounting standards and oversight are still developing, tax avoidance can increase borrowing costs due to lenders' diminished trust. Additionally, the study corroborates prior research that audit

quality and information transparency moderates the relationship between accounting behavior and debt market reactions [5, 50].

Practically, the study provides important evidence for investors and credit institutions in evaluating corporate credit risk. Detecting EM should be considered a negative indicator of financial risk, especially for firms with high transparency. Policymakers may infer that enhancing audit quality and promoting listing can improve transparency and reduce firms' cost of capital. Managerially, the study warns firms to carefully weigh the short-term benefits of tax reduction against the long-term risk of higher debt costs. Policymakers should also strengthen transparency and supervision of tax avoidance behaviors to enhance market trust.

### Recommendations

*For firms:* Improve the quality of financial information and minimize earnings management, as this effect investor confidence and increases the cost of debt. Collaborating with reputable audit firms like Big4 can affect enhance the reliability of financial reports.

*For policymakers:* Implement mechanisms to encourage transparency and standardize financial disclosure requirements, especially for unlisted and UPCOM-listed firms. Consider raising audit standards for non-Big4 firms to ensure more uniform financial supervision quality.

*For credit institutions:* Actively utilize accounting information in risk assessment and differentiate the reliability of financial reports based on the audit firms and listing status. Incorporate EM behavior into credit scoring models as a risk-enhancing factor.

### Limitations and Future Research Directions

This study has several limitations that need to be addressed in future research. First, earnings management measurement relies mainly on accounting models (EM1 to EM4), which may be affected by model errors or industry characteristics. Future studies could integrate non-financial data (e.g., delivery times, accounting staff turnover) or machine learning techniques to detect abnormal accounting behaviors more accurately [51]. Second, this research focuses solely on the cost of debt, while the cost of equity, a significant component of capital structure, remains unexamined. Future research could expand the model to analyze the impact of

EM on overall capital costs (WACC). Third, the study context is limited to Vietnam, an emerging economy, so the results may not fully generalize to developed economies. Subsequent research might broaden

the scope by comparing countries or economic regions to assess institutional and legal roles in the relationships between EM, tax avoidance, and capital costs.

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Appendix

### Research Data

| Industry                       | Year |      |      |      |      |      |      |      |      | Total |      |
|--------------------------------|------|------|------|------|------|------|------|------|------|-------|------|
|                                | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | N     | %    |
| Industry                       | 342  | 371  | 387  | 394  | 396  | 409  | 407  | 406  | 422  | 3,534 | 43%  |
| Information Technology         | 17   | 18   | 21   | 14   | 18   | 15   | 16   | 17   | 14   | 150   | 2%   |
| Pharmaceuticals and Healthcare | 36   | 27   | 36   | 43   | 46   | 44   | 46   | 47   | 47   | 372   | 4%   |
| Oil and gas                    | 9    | 11   | 10   | 9    | 7    | 11   | 9    | 10   | 9    | 85    | 1%   |
| Consumer Services              | 57   | 70   | 71   | 80   | 85   | 47   | 86   | 85   | 80   | 661   | 8%   |
| Consumer Goods                 | 139  | 149  | 152  | 164  | 172  | 176  | 176  | 170  | 170  | 1,468 | 18%  |
| Raw Materials                  | 110  | 121  | 124  | 127  | 126  | 137  | 129  | 128  | 124  | 1,126 | 14%  |
| Community Utilities            | 77   | 92   | 92   | 92   | 97   | 102  | 104  | 104  | 101  | 861   | 10%  |
| Telecommunications             | 7    | 6    | 5    | 6    | 7    | 6    | 7    | 7    | 7    | 58    | 1%   |
| Total                          | 794  | 865  | 898  | 929  | 954  | 947  | 980  | 974  | 974  | 8,315 | 100% |

Source: Compiled by the author.

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# The Development of a Method for Forecasting the Business Valuation of Public Companies Within the Framework of the Comparative Approach Using Artificial Intelligence

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## ABSTRACT

The article focuses on the study of issues related to assessing the business value of publicly traded companies using artificial intelligence. **The purpose of the study** is to develop a model for predicting the business value of publicly traded companies within the framework of a comparative approach. The relevance of this work is that in times of uncertainty, it can be difficult to justify the market value of the business of public companies due to the fact that historical transaction prices, which are used as the basic information for calculating market value in the framework of the capital market method, may not reflect the company's future prospects. **The scientific novelty** of the research consists in developing a method for predicting the business value of publicly traded companies using the main section of artificial intelligence – machine learning. The authors used the following **methods** in their scientific research, including logical and statistical methods (correlation analysis) and machine learning techniques such as linear regression, decision tree, tree ensembles, and recurrent neural network. The developed method consists of six stages which integrate the main steps of machine learning with the classical stages of data cost estimation. Based on the results of testing the method, eleven models of extra-random decision trees have been developed. These Trees allow us to predict the direction of movement of industry indexes Moscow Exchange depending on exogenous and technical indicators. It can be **concluded** that the developed models have a high level of accuracy (based on the test data  $R^2$  of 0.99 and MAPE below 1%) of forecasting industry indices and the suitability of the method for solving the problem of predicting the share price of a single public company within the context of the capital market method. **The prospect of further research** relates to the development of predictive models for all public companies, taking into account their financial characteristics and behavioral factors. This article will be beneficial for practicing appraisers in their evaluation of businesses in this field and for investors.

**Keywords:** methods of value assessment; comparative approach; industry indices; valuation factors; machine learning models

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## INTRODUCTION

Forecasting the business value of public companies is an essential part of investment decision-making, risk assessment, and strategic planning. For a long time, traditional valuation methods such as revenue, cost, and comparison with similar companies have been the basis for analysts and investors in determining the value of a company.

The comparative approach is based on the principle that the value of a company can be determined by comparing it with similar companies whose market value is known. This method is widely used because of its simplicity and interpretability.

However, a significant disadvantage of the comparative approach is the retrospective nature of transaction prices with analog companies, which are the basis for calculating multipliers. It turns out that the calculated multiplier value does not reflect the prospects of a similar business in any way, which makes this approach indicative and not applicable in conditions of external uncertainty.

With the development of artificial intelligence (AI) and big data technologies, it has become possible to improve the comparative approach (the capital market method, since sufficient data is available for modeling), increasing its accuracy by predicting the share prices of analog companies.

The purpose of the study is to develop a method for predicting the business value of public companies within the framework of a comparative approach based on AI algorithms. Taking into account the objectives of the study, the tasks are defined:

1. To study key areas of artificial intelligence and their practical application in the financial sector and business valuation.
2. Identify the factors and available cost indicators that affect stock prices and the market value of the business of public companies.
3. To determine the main stages of the method of forecasting the business value of

public companies within the framework of the market-capital method of a comparative approach using AI algorithms.

4. To test the proposed method using the example of industry indices of the Moscow Stock Exchange.

## METHODS

In the study by K.-Y. Leong et al. [1], “which is devoted to the valuation of business shares in developed countries, it is noted that the best result in valuation is provided by a comparative approach (capital market method, P/E multiplier). However, the capital market method is not applicable in conditions of high volatility of stock prices” [2]. It seems that AI technology will eliminate this disadvantage of the comparative approach.

AI is an end-to-end technology capable of implementing functionality previously available only to humans. As an end-to-end technology, AI combines classical programming, data and feature engineering, and mathematical algorithms. These directions allow you to solve problems of different classes and with different types of data. The task of teaching a machine to work with numerical, textual, graphical and other information is solved using the main section of AI — machine learning. Machine learning is divided into surface learning (based on a certain class of models based on well-known mathematics: linear and logical regression, nuclear methods — the method of support vectors, decision trees, ensembles of trees — random and extra-random forests, gradient boosting on trees) and deep learning (neural networks: fully connected, recurrent, transformers, pre-trained tracers and generative neural networks).

The AI industry is actively developing all over the world. Over the past 10 years, global private investment in this area has increased 30-fold and reached \$ 154 billion in 2023.<sup>1</sup>

<sup>1</sup> Artificial intelligence statistics. INKLIENT. 2024. URL: <https://incliient.ru/ai-stats/> (accessed on 05.10.2024).

The technology is becoming widespread in “transport and logistics, retail, mining, IT, and consumer goods production.”<sup>2</sup> AI is also actively used in the financial and banking industries. Its main section, machine learning, has been used since the 2010s. with the democratization of technologies, Python libraries, and the emergence of new algorithms based on decision trees, which surpassed kernel methods (the most famous SVM method is the support vector method proposed by Vladimir Vapnik and Corinna Cortez in 1995 [3]) and neural networks in the architecture of those years. However, the emergence of new neural network architectures in 2021 brought them back to the attention of the scientific community.

In the financial sector, work on the application of individual AI algorithms did not appear synchronously with the advent of new algorithms. In order to study the degree of elaboration of the topic to the database of scientific publications dimensions.ai<sup>3</sup> a request was made: “artificial intelligence in business value assessment.” As a result, 104 publications were received. Using the Bert Topic<sup>4</sup> toolkit, the statistics of keywords in the annotation of the found articles were calculated. Among the most frequently mentioned words are the following: prediction, forecasting, stocks, machine learning, market and models. Based on the text analysis, the publications that are most suitable for the research topic have been selected. The publications are structured into four thematic areas:

1. Using social media and news to forecast the stock market. Studies by M. Choi et al. [4], V.K. Abinanda, F.N. Sabiyath [5], L.T. Vu et al. [6], C. Huang et al. [7], R. Kaur, A. Sharma [8, 9] show that signals from social media and analysis of news tonality can be used to

predict stock market movements. L.T. Vu et al. [6] conclude that the impact of news on stock price changes is negligible. The use of machine learning methods such as neural networks improves the accuracy of predictions.

2. Machine learning models for stock forecasting in stock market trading (technical approach).

The works of P.R. Low, E. Sakk [10], B. Gülmez [11], Q. Li et al. [12], L. Hang, et al. [13], C. Chen et al. [14], A. Shet et al. [15], [16], [17] are devoted to the use of neural networks with memory effect (LSTM) and recurrent neural networks (RNN) for predicting stock prices of foreign companies. Some works (M. Sarkar, et al. [18], A.I. Ali et al. [19], C. Karthikeyan et al. [20]) use time series models and moving averages. Some domestic publications devoted to forecasting stock prices of Russian companies also use autoregressive models such as ARIMA and SARIMA [21]. However, this approach may not always be suitable, as it does not allow for the establishment of causal relationships between indicators. A separate area of research involves the creation of neural network-based trading agents for algorithmic trading over short periods of time [22].

According to the author of this study, the use of neural networks does not allow for interpretability of forecasts. Historical stock prices do not reflect all the influencing factors and are not sufficient to predict future trends.

3. The impact of the company’s financial performance on the price and profitability of shares.

In the works of J. Prastika et al. [23], E. Hendawy et al. [24], V. Jeevan et al. [25] it was noted that financial indicators significantly affect the profitability of stocks. The research concluded that long-term predictability of profitability can be achieved using accounting, technical and macroeconomic factors. Memory-enabled neural networks also help analyze historical data to predict future prices.

4. Machine learning for predicting financial performance and estimating business value.

<sup>2</sup> Artificial intelligence in Russia — 2023: trends and prospects. Yakov and Partners. Yandex. 2023. URL: [https://yakovpartners.ru/upload/iblock/c5e/c8t1wrkdne5y9a4nqlideralwny7xh4/20231218\\_AI\\_future.pdf](https://yakovpartners.ru/upload/iblock/c5e/c8t1wrkdne5y9a4nqlideralwny7xh4/20231218_AI_future.pdf) (accessed on 05.10.2024).

<sup>3</sup> An open platform for scientific and technological information. URL: <https://app.dimensions.ai/> (accessed on 14.11.2024).

<sup>4</sup> The repository of the BERTopic library. GITHUB. URL: <https://github.com/MaartenGr/BERTopic?ysclid=m3is73su7397642569> (accessed on 14.11.2024).

In the studies of P.S. Koklev [26], X. Chen et al. [27], U.G. Pinar, N.U. Seyma [28], P. Geertsema, H. Lu [29], R. Zhang et al. [30], B.V. Sonja, J. Katunar [31], S. Budennyy et al. [32, 33] machine learning methods are used (neural networks, trees solutions, gradient boosting, and others) to assess the financial performance of companies and determine the value of the business. The team of authors [34] uses regression to forecast the value of shares of PJSC Transcontainer depending on the dollar exchange rate and oil prices, which is clearly insufficient in the context of modern economic conditions in Russia. Sopelnik and L.V. Fedoseeva [35] compare the technical and fundamental indicators of American companies and conclude that it is advisable to combine them to improve the accuracy of the forecast.

The models presented in scientific publications are applicable to foreign companies (since they were developed on samples from other countries that are characterized by different market specifics) and are not widely available. Only the work of I.N. Galkin [36] includes Russian companies in its sample for the development of the model. However, the cost calculation is based on retrospective reporting, which does not reflect future prospects and does not take into account exogenous factors.

As a result of the analysis of scientific papers, it is advisable to conclude that the issues of the influence of exogenous factors on stock prices and the value of Russian business have not been sufficiently studied. Problems remain related to the volatile nature of the Russian stock market, the macroeconomic situation, and the influence of various behavioral factors on price movements. These aspects must be taken into account when forming a motivated judgment about the value of a business within the framework of a comparative approach.

It is also worth noting that out of all the variety of machine learning models, it is difficult to make a choice to achieve the research objectives. Decision trees are

characterized by their relative simplicity, interpretability, and computational savings compared to neural networks. To make a final decision in favor of any model, it is necessary to conduct an experiment on a specific data set.

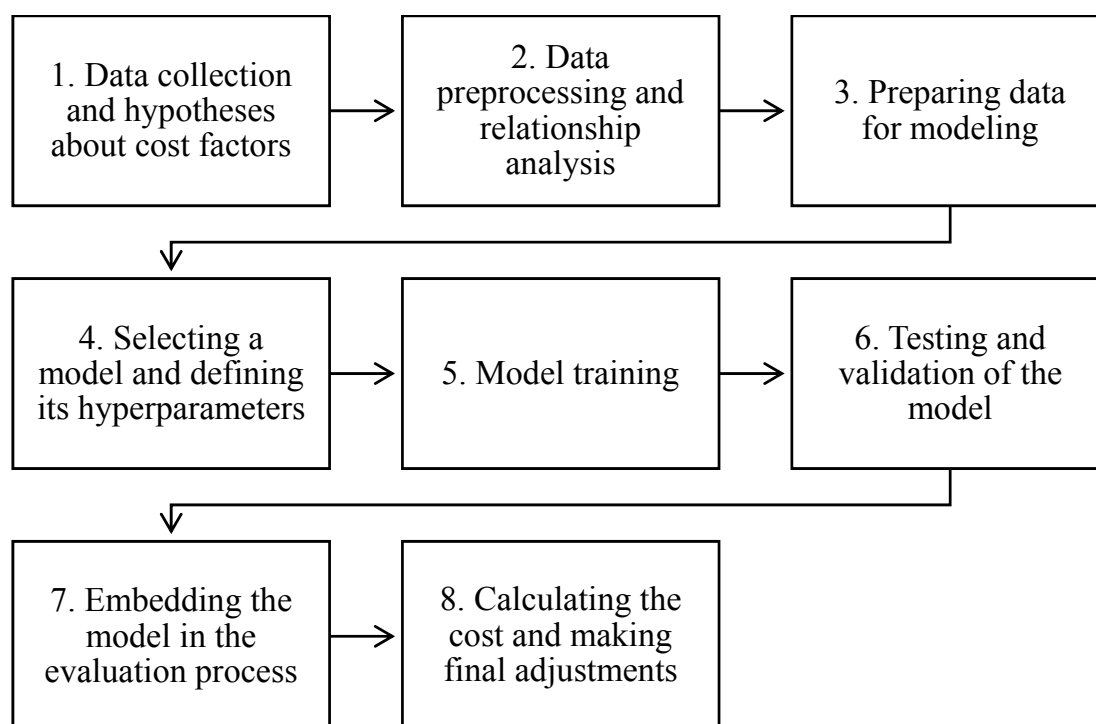
## RESULTS AND PROSPECTS

The concepts of price and value are clearly distinguished in the valuation process. Prices reflect historical market transactions and serve as the basis for determining value, considering goals, objectives, and prerequisites. Value, on the other hand, is believed to have a probabilistic nature, due to the various effects of factors that are characterized by their fundamental essence, based on a company's long-term ability to generate cash flows in the future. These factors take into account both the inherent risks and the impact of the external environment. The stock price can be influenced by supply, demand, behavioral and exogenous factors. Accordingly, prices may fluctuate significantly in the short term.

When using the capital market approach to the comparative method, appraisers rely on historical stock transaction prices, which is both an advantage and a disadvantage of this method. However, this disadvantage is offset by calculating the average stock price over a specific observation period (typically a month). Nevertheless, the multipliers obtained in this way may lose their relevance the very next day after the calculations are performed. Therefore, methods are required to estimate the projected stock prices of companies.

The main stages of the business value forecasting method using AI algorithms are shown in *Fig. 1*.

- In the first stage, it is essential to analyze the various factors and identify the indicators that influence the final outcome.
- In the second stage, the data is cleaned (removal of omissions and outliers, checking for anomalies and correcting them), and the formation of a feature space. Another important step is to study the relationship



**Fig. 1. The Main Stages of the Business Value Forecasting Method Using AI Algorithms**

Source: Developed by the author.

of variables with the resulting indicator and select the most significant ones.

- In the third stage, the data is split into training and testing sets. This is usually done in a 70/30 or 80/20 ratio. They are then normalized and scaled to bring the data to a single scale for correct model training.

- In the fourth stage, a machine learning algorithm is chosen.

- In the fifth stage, different models are trained on training data (setting up hyperparameters, using cross-validation methods to prevent overfitting). The performance of the model is evaluated. Based on the results of the stage implementation, it is necessary to choose the best model.

- In the sixth stage, the best model is tested on data that is not available to it during training.

- In the seventh stage, solutions are being developed to automate the process of data collection and updating. The model is being integrated into existing tools and processes.

- In the eighth stage, the model is applied as part of an appropriate cost estimation approach.

#### **Approbation of the method using the example of forecasting industry indices (the steps of developing the model using the example of IMOEX are described below)**

Stock prices are more susceptible to the ratio of supply and demand for securities in the market, the situation in macroeconomics, debt and money markets. The value of a business is less volatile and depends on cash flows, current and future growth rates, and the risks associated with obtaining them. However, a significant part of the external factors also affect the expected cash flows of the business. According to T. Copeland [37], the cost of a business' equity, determined by the results of a profitable approach, should be close to the cost determined based on the share price. Copeland [37] calls this a "cost perception gap" and makes recommendations for minimizing it through a set of measures to improve the operational efficiency of the business and the strategy of management interaction with the market.

Thus, it can be argued about a single basic set of indicators that must be considered



when assessing the value of the underlying asset — the company's business, which is capable of creating cash flows. The difference between the cost of a business's equity and the share price lies in the composition of rights (ordinary and preferred shares that grant different sets of rights to their owner), the degree of control, the terms of the transaction, objectives, assumptions, and limitations of the valuation process.

Within the framework of the target system of indicators for forecasting the value of a business, the following should be highlighted:

1. Financial information according to official reports (frequency: quarterly, semiannual, annual).

2. Fundamental macroeconomic and sectoral indicators (frequency: daily, monthly, quarterly, annually).

3. Non-financial reporting — ESG (annual basis).

4. News background (the frequency is daily, but there is no sufficient archive of news in the public domain).

However, not all indicators of the target system are suitable for practical testing of the business value forecasting method due to the difference in the frequency of their updates.

Of course, the operational, financial and non-financial indicators of the company are important. However, they are not comparable in terms of step with the available indicators and stock prices, which makes their use impossible at this stage and must be addressed in future studies.

It is important to keep in mind some of the features of behavioral valuation. They consist in analyzing the emotional background of events and its impact on the cost [38]. The basic prototype of the model for assessing the general news background in Russia was developed by the author, but a sufficient array of news on companies has not yet been collected to mark them up [39].

Among a fairly large set of macroeconomic and industry indicators, predictors

comparable in daily increments have been selected, for which there are forecasts of contributors (*Table 1*). Technical indicators are characteristic only of the stock market and do not reflect causal relationships, but they are an important indicator of the market and indicate the direction of price movement [40].

Each of the indicators presented in *Table 1* reflects important aspects of the economic environment and financial conditions that directly affect the operating activities of companies, their profitability and valuation.

The Moscow Exchange Composite Index (IMOEX) and 10 industry variables were selected as target variables: “oil and gas (MOEXOG), electric power (MOEXEU), telecommunications (MOEXTL), metals and mining (MOEXMM), finance (MOEXFN), consumer sector (MOEXCN), chemistry and petrochemistry (MOEXCH), information technology (MOEXIT), construction companies (MOEXRE), transport (MOEXTN)”.<sup>5</sup>

The whole process is implemented in the Python software environment and using its main libraries: pandas, numpy, matplotlib, sklearn, phik, tensorflow, keras.

The statistics on the presented indicators were uploaded from the sources cbonds.ru and finam.ru for 10 years (2014–2024), a longer period includes information about events that are no longer relevant to the current market situation, which may mislead the model.

The total size of the combined data array for all indicators and target variables was 2,372 rows. No missing values or duplicates were found in the data array.

In order to study the quantitative characteristics of the relationship between variables, the Pearson correlation coefficient and the Phik method were used. The Pearson coefficient measures only a linear relationship. If the relationship between the variables is non-linear, the Pearson coefficient may be close to zero even with a strong dependence. Also, significant emissions can significantly

<sup>5</sup> Moscow Stock Exchange industry indexes: what they are, what they are, and how to use them. URL: <https://journal.tinkoff.ru/news/industry-index/> (accessed on 05.10.2024).



Table 1

## Indicators Affecting Industry Indices and Stock Prices

| No.                         | Name of the indicator                                                                                            | Unit of measure    | Rationale                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------------------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>External fundamental</b> |                                                                                                                  |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1                           | Gold exchange rate                                                                                               | rub/gram           | <ul style="list-style-type: none"> <li>– Rising gold prices indicate instability in the global economy, which can lead to lower investments in risky assets, including stocks.</li> <li>– For companies engaged in gold mining and processing, changes in prices for this metal directly affect their income and profitability. An increase in the gold exchange rate increases the revenue of such companies, which can have a positive impact on the value of their shares.</li> <li>– Rising gold prices may indicate expectations of higher inflation, which affects the value of companies' cash flows and, consequently, the valuation of their shares by investors</li> </ul>                                                                                                                                               |
| 2                           | The exchange rate of a foreign currency is the US dollar against the ruble                                       | rub.               | <ul style="list-style-type: none"> <li>– A weak ruble (high dollar exchange rate) makes Russian exports more competitive on world markets, increasing the profits of export-oriented companies, which can lead to an increase in their shares. However, importers face increased costs for the purchase of foreign goods and raw materials, which can reduce their profitability and negatively affect share prices.</li> <li>– Companies with debt in foreign currency, with a weakening ruble, face an increase in debt in ruble terms, which can reduce their financial stability and negatively affect the value of shares.</li> <li>– Exchange rate fluctuations can influence the inflow or outflow of foreign capital from friendly countries, which directly impacts the demand for shares in Russian companies</li> </ul> |
| 3                           | The price of Brent crude oil is                                                                                  | dollars per barrel | <ul style="list-style-type: none"> <li>– Many Russian companies are involved in oil production and export. Rising oil prices increase their revenue and profits, which contributes to higher prices for their shares.</li> <li>– Oil revenues make up a significant part of the state budget. High oil prices improve the economic situation in the country, increase confidence and can lead to an overall increase in the stock market.</li> <li>– Oil prices affect the foreign exchange market. Rising oil prices may strengthen the ruble, which in turn affects other sectors of the economy and companies</li> </ul>                                                                                                                                                                                                        |
| 4                           | The yield on Russian government bonds in rubles for a period of 10 years (the value of the point on the G-Curve) | %                  | <ul style="list-style-type: none"> <li>– Government bonds are considered low-risk instruments. An increase in their yield makes bonds more attractive compared to stocks, which can lead to a redistribution of capital from the stock market to the debt market, reducing demand for stocks and their prices.</li> <li>– Rising bond yields may signal future interest rate increases or inflation expectations, which negatively affects the assessment of future earnings of companies and their shares.</li> <li>– Higher yields on debt instruments can increase the cost of borrowing for companies, especially if they attract financing through bond issuance, which reduces their profits and may negatively affect stock prices</li> </ul>                                                                               |

Table 1 (continued)

| No.              | Name of the indicator                                                                  | Unit of measure | Rationale                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|----------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5                | RUONIA 1M (the average rate at which banks lend to each other for a period of one day) | %               | <ul style="list-style-type: none"> <li>– The change in RUONIA reflects the cost of short-term borrowings for banks and, indirectly, for companies. An increase in the rate increases the cost of companies servicing short-term loans, which can reduce their profitability and negatively affect stock prices.</li> <li>– This is an indicator of liquidity in the banking system and may signal the actions of the Central Bank to change monetary policy. Tightening policy (rising interest rates) may lead to a decrease in economic activity and negatively affect the stock market.</li> <li>– Investors can switch between money market instruments and stocks depending on the rate level. The rise of RUONIA makes money market instruments more attractive, which may reduce demand for stocks</li> </ul> |
| <b>Technical</b> |                                                                                        |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 6                | Moving averages of the industry index over 50 and 200 days                             | rub.            | <ul style="list-style-type: none"> <li>– The intersection of moving averages can serve as a signal to open or close positions. For example, when the 50-day moving average crosses the 200-day moving average from the bottom up (the “golden cross”), this may indicate the beginning of an uptrend. A reverse intersection (“dead cross”) may signal a downtrend</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                        |

Source: Developed by the author.

Table 2

**Correlation of Indicators with the Moscow Exchange Index Based on Pearson's Coefficient and Phik**

| No. | Indicator                                                                                                        | Designation     | Pearson's coefficient | Phik |
|-----|------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------|------|
| 1   | 200-day moving average                                                                                           | SMA_200         | 0.96                  | 0.92 |
| 2   | 50-day moving average                                                                                            | SMA_50          | 0.82                  | 0.97 |
| 3   | Gold exchange rate                                                                                               | Gold            | 0.68                  | 0.86 |
| 4   | The exchange rate of the foreign currency – the dollar against the ruble                                         | USD/RUB         | 0.55                  | 0.80 |
| 5   | RUONIA 1M (the average rate at which banks lend to each other for a period of one day)                           | RUONIA 1M       | –0.47                 | 0.83 |
| 6   | The yield on Russian government bonds in rubles for a period of 10 years (the value of the point on the G-Curve) | Yield Curve 10Y | –0.31                 | 0.80 |
| 7   | The price of Brent crude oil                                                                                     | Brent           | 0.29                  | 0.71 |

Source: Calculated by the author using Python.

Table 3

**The Quality Metrics of Models (on a Validation Sample) for Forecasting the Moscow Stock Exchange Index Created Using Machine Learning**

| Model             | MAE, in units of the target attribute | MSE       | RMSE   | MAPE, % |
|-------------------|---------------------------------------|-----------|--------|---------|
| Linear regression | 86.60                                 | 15103.17  | 122.89 | 3.58    |
| ElasticNet        | 193.35                                | 64567.72  | 254.10 | 7.69    |
| Random Forest     | 26.61                                 | 1930.49   | 43.94  | 1.11    |
| Extra Trees       | 20.31                                 | 1173.32   | 34.25  | 0.86    |
| CatBoost          | 28.36                                 | 1820.58   | 42.67  | 1.20    |
| Lightgbm          | 31.64                                 | 4119.49   | 64.18  | 1.32    |
| LSTM              | 534.08                                | 421646.38 | 649.34 | 22.38   |

Source: Calculated by the author using Python.

affect the value of this coefficient. Phik is a correlation metric designed to identify more complex and non-linear relationships between variables.

The calculation results are presented in Table 2. After analyzing them, we can conclude that moving averages (especially over 200 days) are the most significant indicators demonstrating a strong relationship, both linear and general. The gold exchange rate and the exchange rate also play a significant role.

The Phik method confirms the presence of significant nonlinear dependencies.

Next, the sample was divided into a training sample (1,412 observational objects), a validation sample (456 observational objects), and a test sample (305). After calculating the technical indicators, the sample size changed slightly from the gaps that had to be deleted.

The next step was to scale or normalize the indicators. Normalization of indicators [27] is aimed at bringing various features to a single scale or distribution, which can significantly increase the efficiency and accuracy of machine learning models. Due to the fact that the distribution of the studied features cannot be considered normal, we will use the RobustScaler method based on median and

quartile range (IQR). The formula underlying RobustScaler is presented below [41]:

$$X_{scaled} = \frac{X - X_{median}}{IQR}, \quad (1)$$

where  $X_{scaled}$  — the normalized value of the feature;  $X$  — the initial value of the feature;  $X_{median}$  — median of the attribute value;  $IQR$  — the quartile range. Represents the difference between the third and first quartiles.  $Q3 - Q1$ .

The method centers the data by subtracting the median and scales the data by dividing by the quartile range. This method is more resistant to outliers in the data, as it uses the median and IQR.

After scaling, the following models were trained: linear regression, ElasticNet, Random Forest, Extra Trees, CatBoost (a framework for gradient boosting on trees from Yandex), Lightgbm (Light Gradient Boosting Machine, a framework for implementing gradient boosting from Microsoft), LSTM (Long Short-Term Memory) neural network. The metrics known for regression tasks were used as “indicators of model quality in the validation sample”:

- MAE (Mean absolute error — the average of the absolute differences between the predicted and actual values);

```

# ExtraTreesRegressor model training
model_et_3 = ExtraTreesRegressor(n_estimators=100,
random_state=42)

model_et_3.fit(features_train, target_train)

# Evaluating the accuracy of the model based on the validation sample
predictions = model_et_3.predict(features_valid)

# Calculation of quality metrics on a validation sample
mae = mean_absolute_error(target_valid, predictions)
mse = mean_squared_error(target_valid, predictions)
rmse = np.sqrt(mse)
mape = np.mean(np.abs((target_valid - predictions) / target_valid)) * 100
# As a percentage

# Output of results
print("MAE models 'Extra Trees': {:.2f}'.format(mae))
print("MSE of the 'Extra Trees' model: {:.2f}'.format(mse))
print("RMSE of the 'Extra Trees' model: {:.2f}'.format(rmse))
print("MAPE models 'Extra Trees': {:.2f}%'.format(mape))

MAE of the "Extra Trees" model: 20.31
MSE of the "Extra Trees" model: 1173.32
RMSE of the "Extra Trees" model: 34.25

BRAND of the "Extra Trees" model: 0.86%

## Testing the model
predictions_test_ = model_et_3.predict(features_test)

mae_et = mean_absolute_error(target_test,
model_et_3.predict(features_test))

mape = np.mean(np.abs((target_test - predictions_test_) /
target_test)) * 100

print("MAE of the 'ET' model in the test sample:", mae_et)
print("MAPE models 'ET' in the test sample:", mape)

USING the 'ET' model in the test sample: 19.426519344262346

The BRAND of the 'ET' model in the test sample:
0.7981173886945636

# Calculation of R2 for predicted values and true values
r2_predictions = r2_score(target_test, predictions_test_)
print("R2 for predicted values: ", r2_predictions)

R2 for predicted values: 0.9979873225849911

```

Fig. 2. Code in Python Extra Trees Model

Source: Compiled by the author using the Python library.

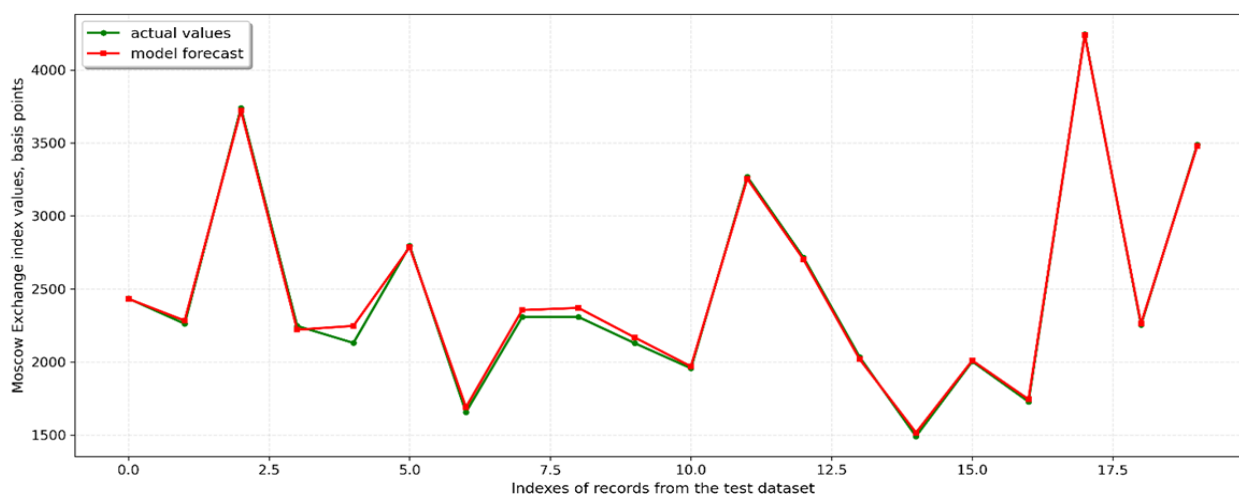


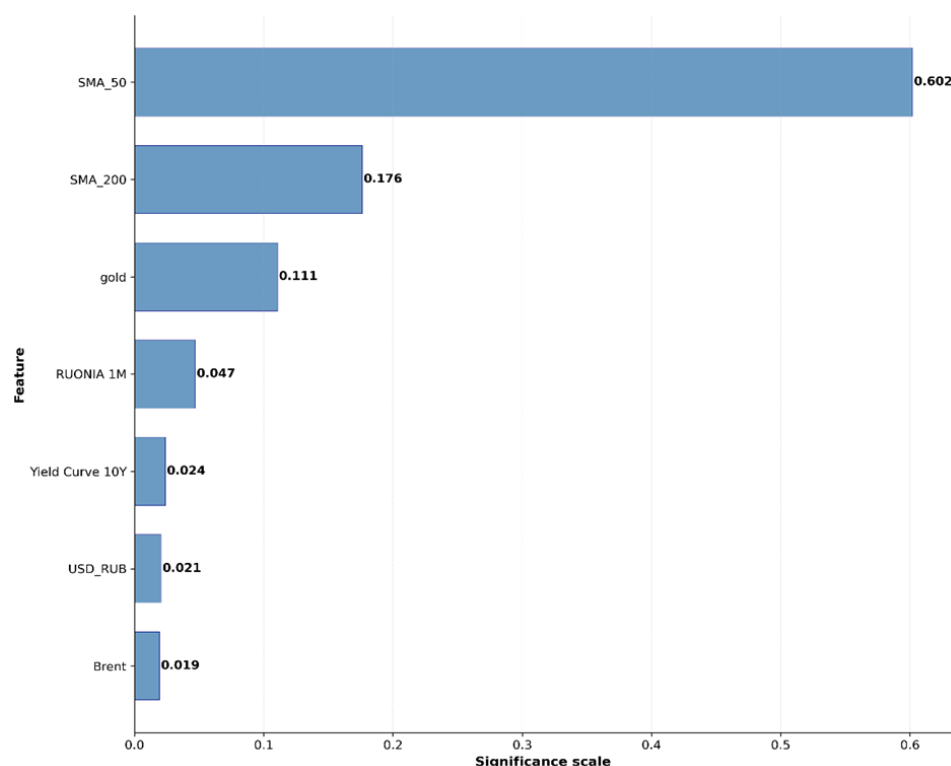
Fig. 3. Chart of Actual Values and Predictions by the Moscow Stock Exchange Index Model

Source: Calculated by the author using Python.

- MSE (Mean square error — the average of the squared differences between the predicted and actual values);
- RMSE (Root mean square error — the square root of the RMS error);
- MAPE (Mean absolute percentage error — the average of absolute percentage errors between predicted and actual values)” [42].

The quality metrics obtained from the results of training models where the Moscow Stock Exchange index was used as the target metric are presented in *Table 3*.

Based on the results of training and validation, it is advisable to conclude that ensemble models on trees (Extra Trees, Random Forest, Catboost, Lightgbm)



**Fig. 4. Feature significance scale in the Extra Trees Model**

Source: Calculated by the author using Python.

```
def get_prediction(USD_RUB, Brent, gold, Yield_Curve_10Y, RUONIA_1M, SMA_50, SMA_200):
    # Creating an array with input data
    features = np.array([[USD_RUB, Brent, gold, Yield_Curve_10Y, RUONIA_1M, SMA_50, SMA_200]])

    # Scaling 6 input data
    scaled_features = robust_scaler.transform(features)

    # Getting the prediction of the model
    prediction = model_et_3.predict(scaled_features)
    return prediction

# Example of using a function to get a prediction
USD_RUB = float(input("Enter the value of USD/RUB: "))
Brent = float(input("Enter the Brent value: "))
gold = float(input("Enter the value of gold: "))
Yield_Curve_10Y = float(input("Enter the value of Yield Curve 10Y: "))
RUONIA_1M = float(input("Enter the value of RUONIA 1M: "))
SMA_50 = float(input("Enter the SMA value 50: "))
SMA_200 = float(input("Enter the SMA 200 value: "))

prediction_result = get_prediction(USD_RUB, Brent, gold, Yield_Curve_10Y, RUONIA_1M, SMA_50, SMA_200)
print("Predicted value:", prediction_result)

Enter the value of USD/RUB: 90.4
Enter the Brent value: 82
Enter the gold value: 7790
Enter the Yield Curve value 10Y: 16.5
Enter the value of RUONIA 1M: 18.8
Enter the SMA value 50: 2796.0134
Enter the SMA 200 value: 3136.39810
Predicted value: [2507.5184]
```

**Fig. 5. Python Function for Applying Extra Trees Models**

Source: Compiled by the author using Python.



Table 4

Forecast Values of Indicators and Industry Indices According to the Developed Models  
(Compiled by the Author Based on Data as of the End of September 2024)

| Ticker | Branch                          | Index value on<br>27.09.2024 | Industry Index<br>Forecast for the End<br>of 2024 | Change, % | SMA200 | SMA50  | Gold<br>Price | Dollar<br>to ruble<br>exchange<br>rate | RUONIA<br>1M | Yield<br>Curve<br>10Y | Brent |
|--------|---------------------------------|------------------------------|---------------------------------------------------|-----------|--------|--------|---------------|----------------------------------------|--------------|-----------------------|-------|
| IMOEX  | Moscow Exchange<br>Index        | 2858                         | 2 507                                             | -14       | 3 136  | 2 796  | 7 790         | 90.4                                   | 18.8         | 16.5                  | 82    |
| MOEXOG | Oil and gas                     | 7 904                        | 6 336                                             | -25       | 8 591  | 7 586  |               |                                        |              |                       |       |
| MOEXEU | Electric power<br>industry      | 1 645                        | 1 439                                             | -14       | 1 899  | 1 658  |               |                                        |              |                       |       |
| MOEXTL | Telecommunications              | 1 669                        | 1 553                                             | -7.5      | 1 993  | 1 702  |               |                                        |              |                       |       |
| MOEXMM | Metals and mining               | 6 627                        | 6 268                                             | -5.7      | 7 839  | 6 633  |               |                                        |              |                       |       |
| MOEXFN | Finance                         | 9 424                        | 7 376                                             | -27.7     | 10 335 | 9 566  |               |                                        |              |                       |       |
| MOEXCN | Consumer sector                 | 7 648                        | 6 114                                             | -25       | 8 539  | 7 600  |               |                                        |              |                       |       |
| MOEXCH | Chemistry and<br>petrochemistry | 29 371                       | 32 788                                            | +11.6     | 33 459 | 29 076 |               |                                        |              |                       |       |
| MOEXIT | Information<br>technology       | 3 155                        | 2 000                                             | -57       | -      | 3 243  |               |                                        |              |                       |       |
| MOEXRE | Construction                    | 7 356                        | 7 315                                             | -0.56     | -      | 7 985  |               |                                        |              |                       |       |
| MOEXTN | Transport                       | 1 594                        | 1 509                                             | -5.6      | 1 831  | 1 599  |               |                                        |              |                       |       |

Source: Calculated by the author based on Finam data.

demonstrate the best results in terms of quality metrics. The best result was demonstrated by the Extra Trees model.

The program code of the Extra Trees model is shown in *Fig. 2*.

The model creates a set of decision trees on random subsets of data and features, which makes it resistant to noise and outliers, and can effectively use the interaction between features. For the recurrent neural network LSTM, which has a rather complex architecture, there may not be enough data for training.

The best Extra Trees model was tested on test data (to assess the model's ability to generalize new, previously unseen data) using the R2 metric, which takes values from 0 to 1, where 1 indicates that the model perfectly matches the data, and 0 means that the model does not explain the variation better than a simple average value. As a result, the R2 for the predicted values was 0.997.

The graph of predictions and actual values of the Moscow Exchange index, shown in *Fig. 3*, also indicates the high quality of the model obtained.

The significance of the features of the Extra Trees model is shown in *Fig. 4*. The most significant signs were technical indicators and fundamental ones — the gold exchange rate and the RUONIA-1M rate.

The forecast of the Moscow Stock Exchange index in accordance with the developed model seems to be the most effective over a time horizon of up to 1 year in accordance with those forecast indicators that are available at the valuation date. An important aspect of the application of the model is the availability of reasonable forecasts for the indicators that are used in the model.

The results of a macroeconomic survey conducted by the Bank of Russia<sup>6</sup> are used as the source of the forecast for the ruble-dollar exchange rate and Brent crude oil. The projected values for the ruble-dollar exchange

rate at the end of 2024 amounted to 90.4 rubles, and Brent crude oil — 82. The gold exchange rate in the base scenario until the end of 2024 in the amount of 7790 rubles was taken according to forecasts of the analytical department of SberCI B.<sup>7</sup>

BKS-express<sup>8</sup> data of 16.5% and 18.8%, respectively, were used as the source of the forecast of the yield curve of 10-year OFZ and RUONIA 1M for the end of 2024. Technical indicators are calculated for the end of September (27.09.2024): SMA50–2796.01 bp, SMA200–3136.39. With the specified parameters, the Moscow Stock Exchange index will reach a level of 2507 bp. The forecast is probabilistic, and the aggravation of the geopolitical situation may lead to significant deviations from the expected results.

To apply the model, a function has been developed in Python, shown in *Fig. 5*. Using the function, you can enter parameter values and get a forecast of the model.

Based on the calculations performed, it can be concluded that the proposed method is effective and gives reliable results.

In the course of further work, 10 Extra Trees models were created to predict the industry indices of the Moscow Stock Exchange based on data from the last ten years. A total of 23,710 observations were analyzed for all indexes from 2014 to 2024. The developed models showed excellent results on test data: the coefficient of determination (R2) is at least 0.9, the average absolute percentage error (MAPE) is less than 1%. Based on the created models, a forecast of the values of industry indices is made, which is presented in *Table 4*.

In the current macroeconomic situation, according to the basic forecast indicators,

<sup>6</sup> The macroeconomic survey of the Bank of Russia. URL: [https://cbr.ru/statistics/ddkp/mo\\_br/](https://cbr.ru/statistics/ddkp/mo_br/) (accessed on 05.10.2024).

<sup>7</sup> The forecast of gold prices until the end of 2024 and in the long term. SberCI B. URL: <https://sberci.ru/publication/prognostsen-na-zoloto-do-kontsa-2024-goda-i-v-dolgosrochnoi-perspektive> (accessed on 05.10.2024).

<sup>8</sup> The OFZ and foreign currency bond market. Forecast for the fourth quarter of 2024. BKS Express. URL: <https://bcs-express.ru/novosti-i-analitika/rynok-ofz-i-valiutnykh-obligatsii-prognost-na-iv-kvartal?ysclid=m1tg18noqj200285787> (accessed on 05.10.2024).

most industries expect a correction by the end of 2024 compared to September.

The largest decrease is expected in IT (MOEXIT) – 57%, finance (MOEXFN) – 27.7%, oil and gas (MOEXOG) and consumer sector (MOEXCN) – 25%. The IT sector is limited in the ability to scale the demand for its products only by the domestic market. In the financial sector, high interest rates in the economy will negatively affect lending activity and borrowing costs, which will slow down the growth of the banking business. In the oil and gas sector, despite the growth of oil and gas revenues, there are price uncertainties, large capital expenditures for the reorientation of exports (especially for gas), rising costs due to an increase in the share of hard-to-recover oil, and a significant tax burden. In the consumer segment, rising prices can reduce consumers' purchasing power.

Chemistry and petrochemistry (MOEXCH) is the only industry expected to grow by 11.6% due to stable demand for chemical products.

The indicators taken into account in the model make it possible to explain the projected changes in the Russian stock market indices and correlate with the general situation in the industry.

## CONCLUSIONS

The integration of modern machine learning techniques and big data analysis provides a deeper understanding of market trends

and factors affecting business value. The practical testing of the method of forecasting the business value of public companies based on exogenous and technical indicators using machine learning gives grounds to conclude that it is sound.

The proposed method allows us to quickly substantiate the prospects of the industry in the context of expected macroeconomic parameters and build a motivated judgment about the expected share price of analogues of the evaluated company using the market-capital method of the comparative approach, within the framework of the cash flow discounting method of the revenue approach when calculating the terminal value through a multiplier or forecasting the expected market profitability within the framework of calculating the discount rate according to the U. Sharpe's [43].

The use of AI algorithms has the potential to significantly improve the accuracy and efficiency of stock price forecasting for public companies. This method can significantly reduce the labor costs associated with external appraisals and contribute to more informed investment decisions, leading to increased competitiveness in the financial market.

Further research plans include developing a model to forecast the share price of each public company listed on the Moscow Stock Exchange, taking into account a broader range of financial and behavioural factors.

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# The Impact of Financial Literacy on the Scale of Fraud

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## ABSTRACT

The topic of financial fraud is often raised in various publications due to its significance. Increasing the level of financial literacy among the population is frequently suggested as a way to reduce the prevalence of financial fraud. However, there is a lack of research on the impact of financial literacy on financial fraud, and the studies that do exist are based only on logical arguments derived from economic theory. The purpose of this article is to examine the impact of financial literacy on financial fraud in Russia. We used data from the Ministry of Internal Affairs on crime rates in the country, as well as estimates of financial literacy levels among Russians published by the NAFI (National Agency for Financial Research) between 2008 and 2023. Given the ongoing link between financial fraud and the use of cash in money laundering the database of analyzed parameters includes data from the Central Bank of Russia on the dynamics of cash inflows. The study used correlation analyses. The article suggests that financial literacy has limited usefulness in protecting the population from financial fraud. The strong positive correlation between the number of fraud cases and the average level of financial literacy suggests that, as people acquire certain financial knowledge, they become more interested in various financial products and are more likely to fall victim to financial fraud. While financial knowledge alone may not be enough to deter fraudsters who exploit the trust of citizens, increased efforts to develop behavioral skills among the public, such as through the “Hang Up the Phone” campaign, seem to be a promising approach to strengthening the population’s ability to protect themselves against financial fraud. However, a more effective approach would be to strengthen the financial system’s protective measures, particularly for banks, in order to identify and halt suspicious transactions of customers who may have fallen victim to fraud.

**Keywords:** financial literacy; financial fraud; correlation matrix; cash; Crime latency; modular theory of society; financial literacy index; “Hang Up the Phone”

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## INTRODUCTION

Many publications are devoted to the state of crime in the field of financial fraud and its growing number. Most of them provide various pieces of information about the situation with financial fraud, arguments about the reasons for its explosive growth, as well as ideas on how to combat it. The reason for this increase is the development of financial technologies [1] and the involvement of organized criminal groups in financial fraud, which show an increased interest in any large turnover of money [2]. It is proposed to counteract this by using machine learning technologies embedded in computer programs that carry out transactions [3, 4], and by increasing the level of financial literacy [5, 6].

Both areas of counteraction are being investigated separately, but in reality they are working towards the same goal. It is believed that financial literacy has a deterrent effect on citizens' decision to comply with the conditions of fraudsters, but in cases where the influence of fraudsters turned out to be stronger than financial literacy; machine learning technologies should stand in the way of questionable transactions. However, the question of the degree of importance of different forms of deterrence remains unexplored.

Here it is necessary to define the conceptual framework. Among the various interpretations of "financial fraud," the definition proposed by V.A. Galanov and A.V. Galanova appears both comprehensive and concise. They suggest understanding financial fraud as "a way of organizing financial relations aimed at appropriating the monetary incomes of other citizens, in which a voluntary and outwardly beneficial form of giving money by a citizen hides a deal that is obviously unprofitable for him" [6, p. 162].

As a definition of the category "financial literacy", the point of view of representatives of the Bank of Russia deserves attention, according to which financial literacy is "the basic knowledge, skills and abilities necessary for making financial decisions in order to

achieve financial well-being and financial risk management" [7, p. 5]. Financial literacy as a broad program, covering large groups of the population, up to a national and international scale, it was developed in the mid-1980s, and in Russia in the 2010s [8]. It first emerged in the corporate sector and soon became part of national programs and an international movement. Back then, their main and only goal was to increase consumption and the subsequent economic growth. The inclusion of the issue of countering the growth of financial fraud in such programs was the response of the authorities to the explosive growth of financial fraud [9].

In the vast majority of publications on financial fraud and financial literacy, financial literacy is considered as a deterrent to financial fraud. The authors are unequivocally convinced that this is the format of the relationship between these categories. Attempts to objectively look at such a relationship, undertaken by Moscow economists, were based solely on logic and economic theory [5, 6]. However, when it comes to costs, especially large-scale costs such as the cost of promoting financial literacy on a national scale, profitability becomes an issue. The lack of research in this area can be explained by the relative novelty of the expansion of the financial literacy movement into the field of countering financial fraud.

At the same time, against the background of mass belief in the anti-fraud role of financial literacy, sometimes there are hints of doubt. For example, the Galanovs write: "Increasing the financial literacy of the population is considered a positive phenomenon, which, unfortunately, is inevitably accompanied by an increase in financial fraud, since they have a common market basis — trust in financial knowledge and in financial professionals" [6, p. 164]. This phrase concludes their article and reflects the economists' thoughts on the limits of the anti-fraud usefulness of financial literacy. It also suggests that a prerequisite for the implementation of financial fraud is "the availability of certain financial knowledge

from a citizen (market participant) and his obvious lack of professionalism” [6, p. 162]. In other words, a citizen may be financially educated enough to understand the benefits of investment, while also recognizing a lack of professional knowledge needed to maximize returns in the financial market. As a result, the citizen becomes open to advice from professionals, among whom scammers increasingly appear.

Agreeing with the arguments of Moscow researchers, this article aims to define the limits of the protective role of financial literacy in relation to financial fraud. The formation of national financial literacy programs took place at a time when the financial market in Russia was emerging, and financial knowledge was lacking among the population and many employees of financial organizations. For some time, financial pyramids and the deception of depositors were widespread. Russian legislation and law enforcement were adapting to market realities, and instruments for regulating the financial market were being formed.

In the early 2000s, crime statistics in Russia became publicly available, and the country joined the global effort to protect the financial system from illegal activities, primarily in the area of money laundering. Russian financial scientists have joined the study of the impact of financial literacy programs on reducing household losses due to erroneous financial decisions.

### ANALYSIS OF THE STATE OF FINANCIAL FRAUD-RELATED CRIME IN RUSSIA

The dynamics of registered crimes in Russia from 2003 to 2023 indicates the presence of persistent trends in the state of Russian crime (the coefficient of approximation of the polynomial trend line of this dynamics is  $R^2 = 0.7941$ ). One of these trends is a gradual but steady decrease in the number of illegal acts, which is associated with an increase in the effectiveness of law enforcement agencies. However, every time it comes to the effectiveness of law enforcement agencies, the issue of crime latency and, consequently, the

reliability of official statistics is immediately raised. Legal scholars and criminologists agree that latency is an unavoidable side of crime. Among the most high-latency crimes, fraud, especially financial fraud, is most often indicated. Well-known approaches to quantifying crime latency are based on the modular theory of society [10]. In the context of crime, the theory is concretized by D.A. Lee explains this theory as follows: “All people in a particular society can be divided into those who commit crimes and those who do not commit them. The combination of the first and second forms an integral unified social system. The number of those who commit crimes will be a certain constant that performs the function of disharmony in the system itself” [11, p. 38]. Regarding the quantitative assessment, it was suggested that “the number of criminals in a particular society should be 5.6% of the total population, thus fulfilling the function of preserving its integrity as a system and maintaining the necessary diversity, which serves as a prerequisite for the self-organization of the system” (Ibid.). This self-organization may mean that criminals who remain at large will continue illegal activity within limits shaped, on one side, by the work of law enforcement agencies and, on the other, by the vacant niches created after competitors are detained. In other words, latency may be considered as a function of the number of criminals who escaped punishment. This issue was seriously studied by O.A. Olkova and S.G. Olkov [12]. They showed that the number of crimes committed during a given period in a given territory is determined by the number of criminals remaining at large within the same time and territorial boundaries.

In modern criminology, criminal psychology, and sociology, there is an opinion regarding differences in individuals’ propensity to break the law. It is believed that the mechanisms of criminal behavior of persons involved in violent crimes and persons involved in mercenary legal relations differ [13, 14]. Further, quantitative assessments of the relationship between

financial fraud and financial literacy are carried out in comparison with data on non-violent crimes.

Based on the Poisson probability distribution, O.A. Olkova and S.G. Olkov suggested that, all else being equal, every criminal who remains at large during a relatively short period of time accounts for new crime. They considered the calendar year as a relatively short period. The actual crime consists of the number of registered ( $R$ ) and latent ( $L$ ) crimes:

$$C = R + L = R \cdot \beta,$$

where  $\beta = \frac{R}{W}$  — latency multiplier that de-

scribes the rate of change in latent crime as the number of people who have lost the ability to commit crimes because they have been held accountable for past offenses changes;  $W$  — the number of individuals convicted of crimes.

*Table 1* shows that in the last 20 years, the latency of non-violent crimes has been decreasing, while latency of fraud has been increasing rapidly.

Other important trends appear in a correlation matrix based on: 1) the data calculated above on the actual number of non-violent crimes and the actual number of frauds; 2) information published by the Ministry of Internal Affairs of Russia on the number of solved non-violent crimes and the number of solved frauds; 3) information from the Bank of Russia on the amount of cash in circulation, the value of 5,000 ruble banknotes in the total amount of cash and the specific weight of 5,000 ruble banknotes in the total amount of banknotes; 4) assessment of the level of financial literacy of Russians by the NAFI Analytical Center. Cash, especially large denomination banknotes [15], is used at various stages of laundering fraudulent income. The list of designations of the studied parameters is given in *Table 2*, the initial data are summarized in *Table 3*, and the correlation matrix is presented in *Table 4*.

Based on the data presented in *Table 4*, several conclusions can be drawn:

- A strong positive correlation between general non-violent crime rates and their detection rates may support the modular theory of society, which includes the idea of a stable level of criminality in the population;
  - The strong relationship between the number of non-violent crimes committed, the number solved, and the number of fraud cases uncovered suggests that over the past 20 years, crime in Russia has been largely influenced by the level of fraud;
  - A negative correlation between the number of non-violent crimes, solved crimes, and frauds on the one hand, and cash turnover indicators on the other hand, indicates that proceeds from these crimes, including unsolved fraud cases, are generated and laundered primarily without the use of cash.
- Since 2019, the Ministry of Internal Affairs of Russia has published data on the number of fraudulent crimes committed using information and telecommunication technologies (ITT). Although the number of these frauds has increased, the detection rate remains at an average of 10.2% per year, not exceeding 11.7%. This suggests that the proportion of actual frauds committed using ITT is constantly growing compared to the total number of actual frauds (from 53% in 2019 to 82% in 2023). Considering the high correlation between these two types of fraud (Pearson coefficient of 0.9966), we can assume that in the future, the actual number of all fraudulent activities will be determined by financial fraud. This information can be used to assess the effectiveness of financial literacy programs.
- The strong negative correlation between the detection rate of ITT-related crimes and the number of solved non-violent crimes, as well as the overall number of frauds, suggests that as the number of non-violent crime solutions and fraud increases, the detection rate for financial fraud decreases. This increased pressure on law enforcement weakens the protection of Russians against financial fraud.
  - The high correlation between ITT crime data and indicators related to cash circulation



Table 1

## The Calculation of the Current State of Non-violent Crimes and IT-related Fraud in Russia between 2003 and 2023

| Year | Non-violent Crimes |         |            |            | Fraud          |                |                |                | IT-related Frauds |                |                |                |                 |
|------|--------------------|---------|------------|------------|----------------|----------------|----------------|----------------|-------------------|----------------|----------------|----------------|-----------------|
|      | R                  | W       | L          | C          | R <sup>1</sup> | W <sup>1</sup> | L <sup>1</sup> | C <sup>1</sup> | R <sup>2</sup>    | W <sup>2</sup> | L <sup>2</sup> | C <sup>2</sup> | S <sup>12</sup> |
| 2003 | 2 659 596          | 649 784 | 8 226 254  | 10 885 850 | 87 471         | 11 452         | 580 637        | 668 108        |                   |                |                |                |                 |
| 2004 | 2 796 110          | 655 764 | 9 126 214  | 11 922 324 | 126 047        | 16 701         | 825 264        | 951 311        |                   |                |                |                |                 |
| 2005 | 3 456 804          | 727 268 | 12 973 857 | 16 430 661 | 179 553        | 26 411         | 1 041 123      | 1 220 676      |                   |                |                |                |                 |
| 2006 | 3 767 611          | 754 165 | 15 054 388 | 18 821 999 | 225 326        | 33 689         | 1 281 748      | 1 507 074      |                   |                |                |                |                 |
| 2007 | 3 505 928          | 763 187 | 12 599 602 | 16 105 530 | 211 277        | 36 801         | 1 001 678      | 1 212 955      |                   |                |                |                |                 |
| 2008 | 3 138 162          | 765 262 | 9 730 713  | 12 868 875 | 192 490        | 35 921         | 839 007        | 1 031 497      |                   |                |                |                |                 |
| 2009 | 2 928 640          | 735 702 | 8 729 521  | 11 658 161 | 188 723        | 32 229         | 916 380        | 1 105 103      |                   |                |                |                |                 |
| 2010 | 2 568 584          | 699 919 | 6 857 684  | 9 426 268  | 160 081        | 29 056         | 721 869        | 881 950        |                   |                |                |                |                 |
| 2011 | 2 347 189          | 648 127 | 6 153 145  | 8 500 334  | 147 468        | 25 559         | 703 379        | 850 847        |                   |                |                |                |                 |
| 2012 | 1 905 435          | 612 703 | 4 020 246  | 5 925 681  | 161 969        | 23 649         | 947 336        | 1 109 305      |                   |                |                |                |                 |
| 2013 | 1 813 490          | 606 399 | 3 609 913  | 5 423 403  | 164 629        | 25 155         | 912 799        | 1 077 428      |                   |                |                |                |                 |
| 2014 | 1 797 569          | 594 305 | 3 639 461  | 5 437 030  | 160 214        | 24 622         | 882 290        | 1 042 504      |                   |                |                |                |                 |
| 2015 | 1 978 917          | 612 776 | 4 411 856  | 6 390 773  | 200 598        | 22 206         | 1 611 505      | 1 812 103      |                   |                |                |                |                 |
| 2016 | 1 812 741          | 621 677 | 3 473 010  | 5 285 751  | 208 926        | 22 091         | 1 766 995      | 1 975 921      |                   |                |                |                |                 |
| 2017 | 1 763 264          | 600 944 | 3 410 429  | 5 173 693  | 222 772        | 23 058         | 1 929 512      | 2 152 284      |                   |                |                |                |                 |
| 2018 | 1 707 937          | 570 698 | 3 403 433  | 5 111 370  | 215 036        | 22 638         | 1 827 569      | 2 042 605      |                   |                |                |                |                 |
| 2019 | 1 754 045          | 519 653 | 4 166 586  | 5 920 631  | 257 187        | 25 254         | 2 362 008      | 2 619 195      | 136 709           | 7 414          | 2 384 110      | 2 520 819      | 14 678          |
| 2020 | 1 787 718          | 461 625 | 5 135 511  | 6 923 229  | 335 631        | 21 876         | 4 813 764      | 5 149 395      | 237 074           | 8 216          | 6 603 734      | 6 840 808      | 21 625          |
| 2021 | 1 750 276          | 495 449 | 4 432 936  | 6 183 212  | 339 606        | 20 607         | 5 257 144      | 5 596 750      | 249 249           | 8 224          | 7 304 869      | 7 554 118      | 21 610          |
| 2022 | 1 726 688          | 510 346 | 4 115 332  | 5 842 020  | 343 085        | 21 236         | 5 199 735      | 5 542 820      | 257 606           | 11 340         | 5 594 321      | 5 851 927      | 30 232          |
| 2023 | 1 719 846          | 486 751 | 4 356 917  | 6 076 763  | 433 708        | 24 579         | 7 219 273      | 7 652 981      | 356 079           | 14 736         | 8 248 173      | 8 604 252      | 37 634          |

Sources: Compiled by the author based on The state of crime. Ministry of Internal Affairs of Russia; Summary of statistical information on the status of criminal records in Russia. Judicial Department of the Supreme Court of the Russian Federation. URL: <http://www.cdep.ru/index.php?id=79&item=5669> (accessed on 06.02.2025).

Table 2

## Notations of the Studied Indicators

| Notation  | Description                                                                                        |
|-----------|----------------------------------------------------------------------------------------------------|
| $C_u$     | The actual number of non-violent crimes                                                            |
| $S_u$     | Number of solved crimes (without crimes against the person)                                        |
| $C_f$     | Actual number of frauds                                                                            |
| $S_f$     | Number of fraud cases uncovered                                                                    |
| $M$       | The value of cash in circulation, billion rubles                                                   |
| $B$       | The value of 5.000 rubles notes in the total amount of cash, billion rubles                        |
| $P$       | The specific weight of 5 thousand rubles of banknotes in the total amount of banknotes, %          |
| $C_i$     | The actual number of frauds committed using ITT                                                    |
| $S_i$     | The number of uncovered frauds committed using ITT                                                 |
| $F_{min}$ | Percentage of the population with below-average financial literacy (less than 47 points), %        |
| $F_{av}$  | Percentage of the population with an average level of financial literacy (from 47 to 57 points), % |
| $F_{max}$ | Percentage of the population with above-average financial literacy (over 57 points), %             |

Sources: Compiled by the author.

suggests that cash, particularly large-denomination banknotes, is used in these fraudulent schemes.

### FINANCIAL LITERACY AND FINANCIAL FRAUD

The assessment of the financial literacy level of the Russian population has been conducted since 2008 using international survey-based methods. This assessment is carried out by the NAFI Analytical Center, the Bank of Russia, and the Ministry of Finance. The most widely used method is the one developed by the Organization for Economic Cooperation and Development (OECD).<sup>1</sup>

<sup>1</sup> Indicators of financial literacy of the population: approaches to measurement and interpretation. Institute of National Projects. URL: <https://inp.ru/fingramota/> (accessed on 17.01.2025); The Group of twenty. OECD IFRS "The Concept of basic knowledge and skills in financial literacy for the adult

To analyze changes in financial literacy over time and compare it with other countries, survey results are combined into a single indicator — the Russian Financial Literacy Index. This index shows the proportion of respondents with different levels of financial literacy:

- The first group includes respondents whose financial literacy is below the average (less than 47 points on a 100-point scale);
- The second group includes respondents with an average level (between 47 and 57 points);
- The third group includes respondents with an above-average (more than 57 points).<sup>2</sup>

Since 2008, the NAFI Analytical Center has been publishing annual data on the ratio of

population", 2016. URL: <https://fingramota.econ.msu.ru/sys/raw.php?o=1519&p=attachment> (accessed on 17.01.2025).

<sup>2</sup> Socio-economic development. NAFI, 2017.

Table 3  
Data on the Current State and Detection of Non-violent Crimes and Fraud in Russia, as well as on Cash-inflows and the Level of Financial Literacy

| Year | Cu        | Su       | Cf       | Sf     | M*      | B*      | P*   | Ci     | Si    | Fmin | Fav | Fmax |
|------|-----------|----------|----------|--------|---------|---------|------|--------|-------|------|-----|------|
| 2003 | 10885 850 | 2659 596 | 2661 599 | 87471  |         |         |      |        |       |      |     |      |
| 2004 | 11922 324 | 2796 110 | 2798 114 | 126047 |         |         |      |        |       |      |     |      |
| 2005 | 16430 661 | 3456 804 | 3458 809 | 179553 |         |         |      |        |       |      |     |      |
| 2006 | 18821 999 | 3767 611 | 3769 617 | 225326 | 2379.7  | 119.0   | 5    |        |       |      |     |      |
| 2007 | 16105 530 | 3505 928 | 3507 935 | 211277 | 3287.7  | 690.4   | 21   |        |       |      |     |      |
| 2008 | 12868 875 | 3138 162 | 3140 170 | 192490 | 4128.1  | 1488.6  | 34   |        |       | 38   | 38  | 17   |
| 2009 | 11658 161 | 2928 640 | 2930 649 | 188723 | 3956.9  | 1622.3  | 41   |        |       | 35   | 50  | 15   |
| 2010 | 9426 268  | 2568 584 | 2570 594 | 160081 | 4844.4  | 2942.0  | 50.0 |        |       | 31   | 44  | 25   |
| 2011 | 8500 334  | 2347 189 | 2349 200 | 147468 | 5884.0  | 3907.0  | 57.0 |        |       | 36   | 44  | 20   |
| 2012 | 5925 681  | 1905 435 | 1907 447 | 161969 | 6798.3  | 4282.9  | 63.0 |        |       | 43   | 41  | 17   |
| 2013 | 5423 403  | 1813 490 | 1815 503 | 164629 | 7453.3  | 4993.7  | 67.0 |        |       | 49   | 38  | 13   |
| 2014 | 5437 030  | 1797 569 | 1799 583 | 160214 | 7953.4  | 5487.8  | 69.0 |        |       | 49   | 38  | 13   |
| 2015 | 6390 773  | 1978 917 | 1980 932 | 200598 | 7848.6  | 5494.0  | 70.0 |        |       | 34   | 46  | 20   |
| 2016 | 5285 751  | 1812 741 | 1814 757 | 208926 | 8261.0  | 6030.5  | 73.0 |        |       | 25   | 51  | 24   |
| 2017 | 5173 693  | 1763 264 | 1765 281 | 222772 | 8768.9  | 6576.7  | 75.0 |        |       | 34   | 32  | 34   |
| 2018 | 5111 370  | 1707 937 | 1709 955 | 215036 | 9671.4  | 7253.6  | 75.0 |        |       | 44   | 46  | 10   |
| 2019 | 5920 631  | 1754 045 | 1756 064 | 257187 | 10078.2 | 7760.2  | 77.0 | 136709 | 14678 | 44   | 46  | 10   |
| 2020 | 6923 229  | 1787 718 | 1789 738 | 335631 | 12025.6 | 9620.5  | 80.0 | 237074 | 21625 | 41   | 47  | 12   |
| 2021 | 6183 212  | 1750 276 | 1752 297 | 339606 | 13634.8 | 11180.5 | 82.0 | 249249 | 21610 | 41   | 47  | 12   |
| 2022 | 5842 020  | 1726 688 | 1728 710 | 343085 | 14798.1 | 12430.4 | 84.0 | 257606 | 30232 | 28   | 57  | 15   |
| 2023 | 6076 763  | 1719 846 | 1721 869 | 433708 | 17566.3 | 15107.0 | 86.0 | 356079 | 37634 | 28   | 57  | 15   |

Sources: Compiled by the author based on: The state of crime. Ministry of Internal Affairs of Russia; The structure of the cash in money supply. Bank of Russia; Korkonosova E.I., Imaeva G.R., Sharova P.A. Socio-economic development: Sociology. Statistics. Publications. Industry reviews. Issue 3. Moscow: NAFI Publishing House; 2017; Financial literacy of Russians – 2024. Moscow: NAFI; 2024. URL: [https://cbr.ru/Bank-notes\\_coins/sndmvo/str\\_nal1\\_dm\\_070101/](https://cbr.ru/Bank-notes_coins/sndmvo/str_nal1_dm_070101/) (accessed on 07.02.2025). URL: <https://nafi.ru/projects/finansy/finansovaya-gramotnost-rossiyan-2024/> (accessed on 17.01.2025).

Note: \* Calculated by the author as an arithmetic average for the year based on monthly data.

Table 4

**A Matrix of Correlations Between Data on Non-violent Crimes, as well as Data  
on Financial Literacy and Cash-inflows in Russia**

| Notation    | <i>Cu</i> | <i>Su</i> | <i>Cf</i> | <i>Sf</i> | <i>M</i> | <i>B</i> | <i>P</i> | <i>Ci</i> | <i>Si</i> | <i>Fmin</i> | <i>Fav</i> | <i>Fmax</i> |
|-------------|-----------|-----------|-----------|-----------|----------|----------|----------|-----------|-----------|-------------|------------|-------------|
| <i>Cu</i>   | 1.000     |           |           |           |          |          |          |           |           |             |            |             |
| <i>Su</i>   | 0.987     | 1.000     |           |           |          |          |          |           |           |             |            |             |
| <i>Cf</i>   | 0.987     | 1.000     | 1.000     |           |          |          |          |           |           |             |            |             |
| <i>Sf</i>   | -0.287    | -0.390    | -0.390    | 1.000     |          |          |          |           |           |             |            |             |
| <i>M</i>    | -0.676    | -0.767    | -0.767    | 0.836     | 1.000    |          |          |           |           |             |            |             |
| <i>B</i>    | -0.683    | -0.773    | -0.773    | 0.830     | 0.999    | 1.000    |          |           |           |             |            |             |
| <i>P</i>    | -0.951    | -0.978    | -0.978    | 0.464     | 0.854    | 0.860    | 1.000    |           |           |             |            |             |
| <i>Ci</i>   | 0.047     | -0.522    | -0.522    | 0.997     | 0.963    | 0.960    | 0.946    | 1.000     |           |             |            |             |
| <i>Si</i>   | -0.190    | -0.705    | -0.705    | 0.930     | 0.972    | 0.975    | 0.962    | 0.937     | 1.000     |             |            |             |
| <i>Fmin</i> | -0.158    | -0.149    | -0.149    | -0.325    | -0.196   | -0.219   | -0.039   | -0.776    | -0.940    | 1.000       |            |             |
| <i>Fav</i>  | -0.051    | -0.157    | -0.157    | 0.647     | 0.581    | 0.589    | 0.366    | 0.736     | 0.922     | -0.565      | 1.000      |             |
| <i>Fmax</i> | 0.051     | 0.161     | 0.161     | -0.287    | -0.307   | -0.282   | -0.187   | 0.856     | 0.955     | -0.550      | -0.342     | 1.000       |

Source: Author's calculations.

groups with different levels of financial literacy of Russians. *Table 4* shows a strong positive correlation between the number and disclosure of ITT-related frauds and average or high levels of financial literacy. That is, the greater the proportion of people with average and high levels of financial literacy in the population, the more financial fraud is committed and the more they are disclosed by law enforcement agencies.

Recognizing the relatively short period used in the study, as well as the low level of detail

in financial literacy indicators, the result can be considered a technical correlation. Further observations and repeated analysis are certainly required. However, even at this stage, it is reasonable to consider possible cause-and-effect relationships behind the identified correlations. Moreover, the results correspond to the opinion of the Galanovs, who believe that the basis of fraud is trust and that the degree of trust does not depend on the level of financial literacy [6]. Immunity to financial fraud is formed differently among different

people/ It may depend on socio-economic characteristics (age, gender, and income [16]), negative experience of deception by financial fraudsters, either personal or observed in one's environment [17], and personality type, but not on the level of education [18].

The results of the study show that financial literacy has little effect on the population's self-protection against the financial fraud. Technological progress has created new forms of financial fraud, that constantly seek to scale. The activities of financial pyramids and schemes to defraud bank depositors in the 1990s were significantly reduced only by legislative, supervisory, and law enforcement measures. In a situation where citizens remotely manage their financial assets, the population should develop cognitive skills to recognize fraudsters through such campaigns initiated by the Bank of Russia, the Ministry of Internal Affairs, and the Prosecutor General's Office as "Hang Up the Phone". From a technological point of view, the most effective protective measures appear to be banking-sector tools that use machine learning embedded in software to detect and suspend transactions carried out as part of fraud. At the same time, financial literacy is and remains an important element of the socialization of Russians in an era of rapid development of financial technology development.

### CONCLUSIONS

The present study is based on the work of Moscow economists [5, 6], who have logically justified the limits of the usefulness of financial literacy programs. The study uses statistical data on crime in Russia over the past 20 years, including fraud, as well as indicators of cash circulation and assessments of financial literacy levels among Russians. To get a more accurate picture, data published by the Russian Ministry of Internal Affairs has been adjusted to account for underreporting. The results of the correlation analysis show that in the new century in Russia fraud largely

determines the state of crime. However, the fight against non-violent crime and fraud in general leads to the fact that criminals transfer their activity to the sphere of financial fraud. Cash, which has already been excluded from many non-violent crimes involving the laundering criminal proceeds, still remains in the arsenal of financial fraud schemes.

Data on actual crime, including fraud, and on the financial literacy level of the population were also analyzed using correlation analysis. The study used financial literacy estimates obtained by the NAFI Analytical Center for 2008–2023. These estimates show the proportion of citizens with different levels of financial literacy (low, average, high) in the total population surveyed.

Empirical evidence shows a strong positive correlation between the number of financial fraud cases and the proportion of people with medium and high financial literacy levels, as well as a strong negative correlation between financial fraud data and the proportion of low-literate citizens in the population. In other words, the higher the level of financial literacy among citizens, the greater the risk of becoming a victim of financial fraud.

The results obtained confirm the assumptions made by Moscow economists regarding the existence of limits to the usefulness of financial literacy in protecting the population from financial fraud. On this basis, it seems promising to develop socio-psychological programs aimed at developing behavioral skills among the population to recognize and resist fraudulent forms of influence seems promising. For example, the "Hang Up the Phone" program is a promising initiative. However, the most effective solution to the problem appears to lie in external interventions. These could include software packages developed by financial organizations that use machine learning to detect and block fraudulent transactions. Law enforcement agencies can also play a significant role in addressing this issue.



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# Sector Financial Performance Analysis with Integrated SOWIA-ELECTRE III Methods: The Case of Turkish Real Sector

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## ABSTRACT

The **aim** of this study is to determine the financial performance of the corporate sector employing the integrated SOWIA-ELECTRE III method. In this **framework**, the data of 10 real sectors operating in Borsa Istanbul over the period 2016–2022 are utilized. It was **observed** that the financial performance indicators affecting the sector performance varied over the years and that current liability rate, price to earning ratio, firm value/EBITA and return on equity ratios were important determinants of financial performance. According to the **results** of the performance rankings of the sectors obtained by the ELECTRE III method, it is understood that the highest performance was realized by retail trade in 2017, 2018, 2019, 2021 and 2022, construction and public works in 2016 and food, beverage and tobacco in 2020. In addition, the study compared sector performance rankings with sector index return rankings and the degree of the relationship was determined by the Spearman's rank correlation coefficient. Accordingly, the correlation coefficients are positive, high and significant in 2017 and 2018. Accordingly, it can be said that there is a partial relationship between sector performances and sector returns. The study results show that portfolio managers and investors should give importance to financial performance analysis when making sector analysis, and economic managers that general economic conditions are important determinants in the development of sectors.

**Keywords:** Electre III Method; SOWIA Method; Financial Performance; Stock Market; Sector Performance

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## INTRODUCTION

Performance is the determination and management of causal models related to the achievement of targets set by firms [1]. Financial performance is an evaluation process that occurs as a result of the use of financial ratios, which are considered in terms of profitability, productivity, growth, and are valid for both firms and sectors [2]. Financial performance measurements provide a general and concise conclusion about the business as a whole [3]. Interest in financial performance analysis has increased over time. The most important reason for this increase is the increasing demand of investors and analysts for information on firm financial performance [4].

Performance metrics including liquidity, financial structure, efficiency, profitability, and value may alter as a result of the various factors that can impact a sector's growth and performance. Since the performance of sectors can be monitored with a large number of indicators, Multi Criteria Decision Making (MCDM) methods can be used to evaluate sector performances.

Determining the weights of importance criteria is an important issue in MCDM problems. While determining the criteria weights, which significantly affect the decision-making process, the suitability of the criteria weights to the multi-criteria model to be used should be taken into consideration. Various methods have been developed in the literature to determine the criteria weights [5]. Commonly used weighting methods fall into three categories: objective weighting methods, subjective weighting methods, and combinatorial weighting methods [6]. Objective approaches are based on the determination of criteria weights with the help of various mathematical models, taking into account the information in the decision matrix [5]. Subjective approaches, on the other hand, are based on determining the criteria weights using the knowledge, intuition or judgment of experts and academics. Objective methods have eliminated the potential bias in subjective methods as they do not require additional information provided by experts [7]. Combinative approaches are approaches based on determining criteria weights by considering objec-

tive and objective information simultaneously [6]. It is stressed in the literature that subjective weights should be computed in addition to objective weights when determining the ELECTRE III approach. In order to determine appropriate expert weights, Tu et al. [8] suggested an optimization model that combines subjective and objective weights. While objective weights are obtained by the entropy method, subjective weights are determined by experts.

In this study, a combined methodology consisting of SOWIA (Subjective and Objective Weight Integrated Approach) and ELECTRE III methods is proposed. In the study, a reasonable set of weights that takes into account both subjective and objective information is obtained by using a unifying weighting method. The CRITIC method, one of the MCDM methods, was used to determine the objective criteria weights. This method is a method that takes into account the intensity of contrast and conflict in the structure of decision problems [9]. These characteristics increase the method's value [7]. The subjective weights of the criteria were determined according to the knowledge, experience and intuition of experts in the field. Two sets of subjective weights were obtained by consulting with ten academic finance specialists and fourteen financial experts. In determining the weights of the decision criteria, the SOWIA method helps the decision maker to make a decision based on the objective weights of importance of the attributes or subjective preferences, or by considering both objective weights and subjective preferences [10]. One of the MCDM approaches, ELECTRE III, was employed to assess the sectors' performance. The ELECTRE III method is a ranking method designed to eliminate the uncertainty of the decision maker in preference modeling by using indifference and preference thresholds [11]. This method attempts to establish an outranking relation between pairs of alternatives without the need for normalization. It also acknowledges the incomparability between alternatives, which occurs when there is no sufficient or clear evidence in favor of any preference or indifference in either alternative  $a$  or  $b$  [12].

The study also compares with Spearman's rank correlation the return rankings of the sectors with the financial performance rankings of the sectors. Spearman's rank correlation analysis is a widely used method in the literature to determine whether there is a statistical relationship between the rankings

obtained in MCDM [13–17]. Using the Spearman's rank correlation coefficient, Akbulut [18] investigated the relationship between the performance rankings of companies in the BIST cement sector and their stock return rankings, while Orçun [19] investigated the relationship between the financial performance of companies in the BIST electricity index and their stock return rankings.

This study is expected to contribute to the literature for certain reasons. In the literature, firm performance data are generally used in MCDM analyses and firm performance rankings are made. The number of studies that make performance rankings based on sectors is quite few. In the literature review conducted for this study, it was observed that Yalçın et al. [20] and Yavuz et al. [21] made performance rankings based on sectors. Yalçın et al. [20] examined 7 sub-sectors of the Turkish manufacturing industry, whereas Yavuz et al. [21] studied 4 sub-sectors of the chemical industry. This study uses data from ten real sectors registered in BIST. Compared to Yalçın et al. [20] and Yavuz et al. [21], this study conducted a sectoral analysis and performance study on Turkish sectors, with the exception of finance. Sectoral research will also help to draw conclusions for the overall economy. Besides the performance indicators commonly used in the literature, cost of sales rate, sales growth, and price to earnings ratios are used in the study, whereas financial expense ratio and firm value/EBITA ratios, which have not yet been found to be used in the literature and can generally be seen in the research reports of financial institutions, are also used. Thus, the goal was to provide a comprehensive perspective in performance rating metrics. In addition to finance academics, financial specialists working in brokerage companies were recruited for expert opinions, ensuring diversity and variation in expert perspectives. The literature [18, 19, 22, 23] examines the relationship between sector financial performance and returns, as well as whether market prices reflect financial performance. Furthermore unlike the literature, the integrated SOWIA-ELECTRE III method was employed for the first time in the evaluation of sector performances.

## LITERATURE REVIEW

The literature review consists primarily of studies in which business and portfolio performance is

evaluated and ranked using MCDM approaches such as ELECTRE III and CRITIC methodologies.

Lima & Soares [24], Boonjing & Boongasame [25] and Chavira et al. [12] used the ELECTRE III method in their studies. Lima & Soares [24] used the ELECTRE III method to create defensive portfolios with a buy-sell strategy in which all criteria and alternatives are equally weighted using financial ratios for stocks traded on the Portuguese Stock Exchange. In the study, among shares traded in the Portuguese stock index (PSI), the ELECTRE III method was found to provide good results for investing in a buy-and-hold perspective and constructing defensive portfolios. Using data from Thailand's stock exchange (SET), Boonjing and Boongasame [25] discovered that the portfolio chosen using the ELECTRE III method outperformed the portfolio chosen using the fix-percentage allocation method. Chavira et al. [12] used the ELECTRE III approach to evaluate a small-scale financial institution in the agricultural sector. The results indicate that the ranking models fit the credit ratings, and the ranking results are appropriate for interpreting the relative relevance of the evaluation criteria.

Safaei Ghadikolaei et al. [26], Shaverdi et al. [2], İç et al. [27] and Aduba [28] used Analytical Hierarchy Process (AHP) and Fuzzy Analytical Hierarchy Process (FAHP) methods. Safaei Ghadikolaei et al. [26] analyzed the financial performance of six automobile companies listed on the Tehran Stock Exchange using a hybrid and hierarchical evaluation model that included both accounting-based and value-based variables. In this approach, FAHP was applied to weight the criteria. The firms were then simultaneously ranked using Fuzzy VIKOR, Fuzzy Additive Ratio Assessment (F-ARAS) and Fuzzy Complex Proportional Assessment (FCOPRAS). The results of these three ranking methods are combined using average rankings. The findings reveal that economic value-based indicators are much more important than accounting indicators in the financial performance evaluation of firms. Shaverdi et al. [2] developed a new financial performance evaluation strategy based on Fuzzy MCDM approach to rank seven firms operating in the petrochemical sector in Iran. Fuzzy AHP was used to determine the financial ratio weights and Fuzzy TOPSIS was used to rank the firms. The ranking results generated using these methodologies are similar to the sector's performance rankings.

İç et al. [27] analyzed 3-year data from 6 retail and wholesale enterprises using the AHP and modified VIKOR methods. AHP and the modified VIKOR method enable the data to be monitored annually or periodically. In the study, a comparison was made with TOPSIS and MOORA methods. Compared to other MCDM methods, it was observed that the ranking results with the modified VIKOR method changed significantly. Aduba [28] evaluated the performance of 18 Japanese firms for the period 2010–2020 using FAHP and TOPSIS methods with financial ratios. The study found that the most important financial performance evaluation criteria were economic value added (EVA), earnings before interest and taxes (EBIT), gross margin ratio, net operating profit after tax (NOPAT), return on asset (ROA), and return on equity (ROE), and firms were ranked based on value creation and profitability criteria.

The majority of MCDM studies are undertaken for firms. Yalçın et al. [20] and Yavuz et al. [21] ranked performance in sectors. In the study by Yalçın et al. [20], they ranked the financial performance of firms belonging to 7 sub-sectors of the Turkish manufacturing industry with 2017 data. A new hierarchical financial performance ranking method was used in which the main criteria are based on traditional accounting-based financial performance (AFP) measures and sub-criteria are based on value-based financial performance (VFP) measures. FAHP was used to determine the weights of the criteria. The ranking results show that there are similarities in the results of both methods. In another sector-level study, Yavuz et al. [21] used the VIKOR method with the data of four sub-sectors in the chemical industry in Turkey for the period 2010–2016 and discovered that the most important criteria are current ratio, net profit margin, and cost of sales ratio, with sector rankings varying by year.

When the research and conclusions collected for the examination of the financial performance of companies operating in different sectors registered in BIST are examined, it is found that the analysis methods utilized are generally TOPSIS, VIKOR, CRITIC, EDAS, ARAS, COPRAS, MOORA, Gray Relational Analysis methods. Karaoğlu and Şahin [29] used VIKOR, TOPSIS, MOORA and Gray Relational Analysis methods to rank 24 companies included in the BIST chemicals, petroleum, plastics index based



on 2015 data. According to the results obtained from the analysis methods, it was determined that the enterprises with high financial performance were almost the same in all four methods. In Kayahan Karakul and Özeydin's [30] study, TOPSIS and VIKOR methods were used with the 2017 financial data of 8 companies registered in the BIST electricity index, and financial performance ranking was made according to different situations by comparing between the two methods. In his study, Ekizler [31] used VIKOR and TOPSIS methods with the data of 19 companies operating in the weaving, clothing and leather sectors for the period 2011–2018 and determined that the rankings made according to both methods show similarities. Söylemez [32] analyzed the data of 18 firms operating in the BIST metal main industry for the years 2010–2019 using TOPSIS and Gray Relational Analysis methods. The study ranked the companies based on their financial performance, and there were no significant changes in ranking amongst the methodologies used.

Bozdoğan et al. [33] analyzed the financial performance of international banks that opened branches in Turkey using TOPSIS and ELECTRE methodologies with annual financial indicators from 2014–2018. Over time, both techniques of evaluating financial performance have produced broadly similar results. Akgün [34] analyzed the financial performance of energy companies using CRITIC and CODAS methods with data from 2020 and 2021. The study found that the parameters with the highest financial valuation weight were equity turnover, asset turnover, long-term liabilities/total assets ratio, and working capital turnover. Soy Temur [23] ranked the firms according to their financial performance using ARAS, COPRAS and TOPSIS methods with the data of eight firms registered in the BIST tourism index for the period 2016–2020. The study also found no similarities between performance ranking and stock returns. Öndeş & Özkan [35] analyzed the financial performance of firms in the BIST IT sector with three-quarter data for 2020. In the study using CRITIC and EDAS methods, it was observed that the performance rankings of the firms changed over the periods. Türegün [36] executed a performance review using TOPSIS and VIKOR techniques with data from ten tourism enterprises traded on BIST between 2018 and 2020. The study found that the results for 2018 and 2019 were

comparable, but the findings for 2020 were different, and firms with a higher price/sales ratio rose to the top of the ranking.

Liao et al. [6] proposed a mixed weighting technique that uses both subjective and objective expert views to determine the weights of the criteria used for the analysis. Chen et al. [37] used the Bayesian BWM method to integrate the subjective weighting method BWM (best-worst method) and the objective weighting method Entropy.

The integrated SOWIA-ELECTRE III method, a relatively new method in financial performance evaluation and ranking and sector performance evaluation, is used in this study to benefit decision makers, investors, financial analysts, economic managers, and the related sector from more detailed and different perspectives, and the results are interpreted in a comparative manner.

## MATERIALS AND METHODS

This study proposes a novel evaluation approach by examining 10 real sectors listed on BIST based on 11 financial performance metrics. The analysis makes use of annual data from the sectors for the period 2016–2022 gathered from the Central Securities Depository (CSD) and the Public Disclosure Platform (PDP).

The study's approach involved determining objective and subjective weights for the indicators, which were then merged with the SOWIA method. While the objective weights of the indicators were calculated with the CRITIC method using the Excel program, the subjective weights were determined by consulting with finance experts and academics. The performances of the sectors were evaluated with the ELECTRE III method using Matlab 2017 programming language and the sectors were ranked from best to worst based on their results.

### Evaluation Indicators of Sectors

The 10 sectors registered in BIST are evaluated based on the 11 financial performance indicators in *Table 1*. The literature was taken into consideration in determining the financial ratios used in the study. However, in addition to the literature, variables such as financial expense ratio and firm value/EBITA ratio used by brokerage houses in their financial research reports were added.

Table 1

## Evaluation Indicators, Abbreviations and Literature

| Symbol | Variable                | Statement                                                   | Literature                                                                                                                                                                                                                    |
|--------|-------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO     | Current ratio           | Current assets /Current liabilities                         | Akgün [34], Karaoğlu & Şahin [29], Soy Temur [23], Yavuz et al. [21], Öndeş & Özkan [35], Söylemez [32], Ömürbek & Eren [38], Kayahan Karakul & Özyayın [30], İç et al. [27], Türegün [36], Shaverdi et al. [2]               |
| LEV    | Leverage ratio          | Total liabilities / Total assets                            | Akgün [34], Karaoğlu & Şahin [29], Soy Temur [23], Yavuz et al. [21], Öndeş & Özkan [35], Ekizler [31], Söylemez [32], Ömürbek & Eren [38], Kayahan Karakul & Özyayın [30], İç et al. [27], Türegün [36], Shaverdi et al. [2] |
| CR     | Current liability ratio | Current liabilities / Total assets                          | Akgün [34], Karaoğlu & Şahin [29], Söylemez [32], İç et al. [27]                                                                                                                                                              |
| ATR    | Asset turnover ratio    | Net sales / Total assets                                    | Akgün [34], Karaoğlu & Şahin [29], Soy Temur [23], Yavuz et al. [21], Öndeş & Özkan [35], Ekizler [31], Söylemez [32], Kayahan Karakul & Özyayın [30], Türegün [36]                                                           |
| ROE    | Return on equity        | Net income / Stockholder's equity                           | Yalçın et al. [20], Akgün [34], Karaoğlu & Şahin [29], Soy Temur [23], Yavuz et al. [21], Öndeş & Özkan [35], Ömürbek & Eren [38], Kayahan Karakul & Özyayın [30], Türegün [36], Aduba [28], Shaverdi et al. [2]              |
| NPM    | Net profit margin       | Net income / Net sales                                      | Akgün [34], Karaoğlu & Şahin [29], Soy Temur [23], Yavuz et al. [21], Ekizler [31], Ömürbek and Eren [38], Kayahan Karakul & Özyayın [30], İç et al. [27], Türegün [36], Shaverdi et al. [2]                                  |
| CS     | Cost of sales rate      | Cost of sales / Total income                                | Soy Temur [23], Yavuz et al. [21]                                                                                                                                                                                             |
| FE     | Financial expenses rate | Financial expenses / Net sales                              | It was not found in the literature search                                                                                                                                                                                     |
| SG     | Sales growth            | $Sales_t - Sales_{t-1} / Sales_{t-1}$                       | İç et al. [27], Türegün [38], Shaverdi et al. [2]                                                                                                                                                                             |
| PE     | Price to Earnings ratio | Market price per Share / Earnings per Share                 | Yalçın et al. [20], Ömürbek & Eren [38], Türegün [36]                                                                                                                                                                         |
| FE     | Firm value / EBITA rate | Firm value / Earnings before interest, tax and amortization | It was not found in the literature search                                                                                                                                                                                     |

Source: It was created by the authors, taking into account the literature.

In identifying the 11 real sectors, the availability of sector data was a crucial determinant (Table 2).

#### Criteria Weighting by Subjective and Objective Weight Integrated Approach (SOWIA)

Since combined weighting methods take into account both the recommendations of experts and the information presented in the decision matrix when determining the weights of the criteria, these methods are expected to provide a more accurate evaluation than independent methods [39].

Upon determining the weights of importance of the criteria with the SOWIA method, the following three paths are followed [10]:

1) Objective weights of importance of criteria  $O_j$  is determined.

2) Subjective preferences of criteria  $S_j$  is determined.

3) Integrated weights,  $W_j$ , based on a combination of objective weights and subjective preferences is determined.

With the SOWIA method, the integration of objective and subjective weights is achieved with the help of Equation (1).

$$W_j = \alpha \times O_j + (1 - \alpha) S_j. \quad (1)$$

There  $\alpha$  is the objective factor decision weight within the range of (0.1). The objective factor decision

Table 2

## Sectors and Sector Assessment Indicators

| Sector                                                                         | Sector Assessment Indicator        |
|--------------------------------------------------------------------------------|------------------------------------|
| $A_1$ : Informatics                                                            | $g_1$ : Current ratio              |
| $A_2$ : Electricity, Gas, Water and Steam                                      | $g_2$ : Leverage ratio             |
| $A_3$ : Food, Beverage and Tobacco                                             | $g_3$ : Current liability ratio    |
| $A_4$ : Construction and Public Works                                          | $g_4$ : Asset turnover ratio       |
| $A_5$ : Metal Main Industry                                                    | $g_5$ : Return on equity           |
| $A_6$ : Metal Goods, Machinery, Electrical Devices and Transportation Vehicles | $g_6$ : Net profit margin          |
| $A_7$ : Retail Trade                                                           | $g_7$ : Financial expenses rate    |
| $A_8$ : Stone and Soil                                                         | $g_8$ : Cost of sales rate         |
| $A_9$ : Textile Clothing and Leather                                           | $g_9$ : Sales growth               |
| $A_{10}$ : Transportation and Storage                                          | $g_{10}$ : Price to Earning ratio  |
|                                                                                | $g_{11}$ : Firm value / EBITA rate |

Source: It was created by the authors.

weight,  $\alpha$ , guides decision makers on the level of objective weight dominance while analyzing performance scores. Usually this value ( $\alpha = 0.5$ ) is taken as  $\alpha$  of (0.1) range offering flexibility to the decision maker and within these ranges. The dominance of the objective weight will be greater for a larger  $\alpha$  value. On the other hand, the dominance of the subjective weight components will be larger for a lower  $\alpha$  value.

#### Objective Weight Determination Method: CRITIC Method

The CRITIC method (Criteria Importance Through Intercriteria Correlation), which belongs to the class of correlation methods, is based on analytical testing of the decision matrix to determine the information contained in the criteria by which alternatives are evaluated [5]. The CRITIC method is a method that determines the objective weights of criteria, taking into account the contrast intensity and the conflict between criteria inherent in the structure of decision problems [9]. The contrast intensity is determined by standard deviation, while the conflict between criteria is determined by correlation analysis. Criteria with a high difference between the scores of alternatives have a high contrast intensity. Similarly, as the correlation between decision criteria approaches  $-1$ , the conflict between the two criteria will become stronger. A criterion with a higher contrast intensity

and a higher degree of conflict with other criteria will be assigned a higher weight [7].

The CRITIC method includes the following steps: Krishnan et al [7]; Zhong et al [40]:

**Step 1. Creating the Decision Matrix:** Firstly, a decision matrix consisting of evaluation criteria, namely  $m$  alternative and  $n$  evaluation, is determined.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}, \quad (2)$$

$i = 1, 2, \dots, m$  and  $j = 1, 2, \dots, n$ .

Here  $x_{ij}$  is the performance value of the alternative  $i$  in the criterion  $j$ .

**Step 2: Creating the Normalized Matrix:** Positive normalization (3) is used for benefit criteria and negative normalization (4) is used for cost criteria.

$$r_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}, \quad (3)$$

$i = 1, 2, \dots, m$  and  $j = 1, 2, \dots, n$ .

$$r_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)}, \quad (4)$$

$i = 1, 2, \dots, m$  and  $j = 1, 2, \dots, n$ .

**Step 3: Creating the Correlation Matrix and Calculating the Degree of Conflict:** A conflict between criteria represents a type of relationship that may exist between criteria. To take into account such conflicting relationships, the Pearson's correlation coefficient is used.

$$\rho_{jk} = \frac{\sum_{i=1}^m (r_{ij} - \bar{r}_j)(r_{ik} - \bar{r}_k)}{\sqrt{\sum_{i=1}^m (r_{ij} - \bar{r}_j)^2 \sum_{i=1}^m (r_{ik} - \bar{r}_k)^2}}, \quad j, k = 1, 2, \dots, n. \quad (5)$$

$\rho_{jk}$ , any  $j$  with criterion  $k$  is the correlation value between the criteria. As the correlation coefficient converges to  $-1$ , the conflict becomes stronger and the difference between the two criterion values becomes larger.

Using the correlation coefficient, the degree of conflict is calculated as follows:

$$R_j = \sum_{k=1}^n (1 - \rho_{jk}), \quad j = 1, 2, \dots, n. \quad (6)$$

The degree of conflict reflects the amount of similar information between different criteria. The criterion with a higher degree of conflict is assigned a higher weight.

**Step 4. Calculation of contrast intensity:** The contrast intensity of each criterion is measured by standard deviation.

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^m (r_{ij} - \bar{r}_j)^2}{m}}. \quad (7)$$

**Step 5. Calculation of the total amount of information contained in any criterion  $j$ :**

$$C_j = \sigma_j \cdot R_j, \quad j = 1, 2, \dots, n. \quad (8)$$

**Step 6. Obtaining Criteria Weights:**

$$w_j = \frac{C_j}{\sum_{k=1}^n C_k}, \quad j, k = 1, 2, \dots, n. \quad (9)$$

**Subjective Weighting Method:  
Opinions of Finance Experts  
and Academicians**

Subjective weights are weights obtained by experts who compare the criteria against each other and

score each criterion according to its relative importance. The weights of importance of the calculated criteria contain subjective opinions based entirely on the knowledge and intuition of the experts.

### ELECTRE III METHOD

The ELECTRE III method is an outranking approach method that makes pairwise comparisons of available alternatives to derive the degree of preference of one alternative over the other among pairs of alternatives [41]. With the outranking relationship between two alternatives, four different preference situations emerge such as,  $aIb$  indifference;  $aPb$  ( $bPa$ ) strong preference;  $aWb$  ( $bWa$ ) weak preference; and  $aRb$  incomparability [42, 43]. The ELECTRE III methodology requires three input data [44]:

1. A performance matrix that reports the scores of alternatives according to criteria.
2. Weights for each identified criterion.
3. Indifference, preference, and veto thresholds.

Figure shows that the ELECTRE III approach consists of two stages. First, each pair of options is compared, and an outranking relationship is determined. The outranking results are then analyzed using a distillation process algorithm [44].

**Construction of the Outranking Relation:** In the ELECTRE III method, firstly, a  $A = \{a_1, a_2, a_3, \dots, a_n\}$  set of alternatives and a  $G = \{g_1, g_2, g_3, \dots, g_m\}$  a performance matrix is created by determining the criteria set. For each criterion  $q_j$ ,  $p_j$  and  $v_j$  ( $q_j < p_j < v_j$ ) threshold values and  $w_j$  weights of importance are determined. Indicating the importance of a criterion  $w_j$  the criterion weight concordance index and  $v_j$  veto threshold affects the discordance index.

After setting the parameters, a concordance fuzzy  $aSb$  outranking relation is established with the claim "a is at least as good as b". This outranking relation is established with the help of two indexes called  $C(a, b)$  concordance and  $d_j(a, b)$  discordance [45]. The concordance index  $C(a, b)$  represents the strength of the coalition of criteria in favor of the hypothesis whereas the discordance index  $d_j(a, b)$  represents the set of opposing criteria that are incompatible with the hypothesis [46].

$$c_j(a,b) = \begin{cases} 1, & g_j(a) + q_j(g_j(a)) \geq g_j(b) \\ 0, & g_j(a) + p_j(g_j(a)) \leq g_j(b) \\ \frac{g_j(a) - g_j(b) + p_j(g_j(a))}{p_j(g_j(a)) - q_j(g_j(a))}, & \text{if otherwise} \end{cases} \quad (10)$$

$$C(a,b) = \frac{1}{w} \sum_{j=1}^n w_j c_j(a,b), \quad w = \sum_{j=1}^n w_j, \quad 0 \leq C(a,b) \leq 1 \quad (11)$$

$$d_j(a,b) = \begin{cases} 0, & \text{if } g_j(a) + p_j(g_j(a)) \geq g_j(b), \\ 1, & \text{if } g_j(a) + v_j(g_j(a)) \leq g_j(b) \\ \frac{g_j(b) - g_j(a) - p_j(g_j(a))}{v_j(g_j(a)) - p_j(g_j(a))}, & \text{if otherwise} \end{cases} \quad (12)$$

By comparing the hypothesis tests established with the help of these two indexes, the credibility index  $\sigma(a,b)$  is established.

$$\sigma(a,b) = \begin{cases} C(a,b), & \forall j \text{ for } d_j(a,b) \leq C(a,b) \\ C(a,b) \cdot \prod_{j \in J(a,b)} \frac{1-d_j(a,b)}{1-C(a,b)}, & \exists j \text{ for } d_j(a,b) > C(a,b) \end{cases} \quad (13)$$

**Exploitation of the Outranking Relation:** Lastly, using an algorithm named the distillation process, an overall ranking of alternatives is obtained. The ranking algorithm relies on the reliability degree of each alternative. Within the distillation process, utilizing the values of the credibility matrix  $\sigma(a,b)$  calculated in Equation (13), two partial pre-rankings are obtained. One of these rankings arranges the alternatives from best to worst (descending distillation), while the other arranges the alternatives from worst to best (ascending distillation). These partial preliminary rankings are based on the calculation of an adequacy score for each alternative. The intersection of the descending and ascending distillation rankings results in a final ranking.

#### Spearman's Rank Correlation Coefficient

The Spearman's rank correlation coefficient is a non-parametric method that measures the similarity between two sets of rankings. The rank correlation coefficient between Spearman's  $p^{th}$  and  $t^{th}$  rankings are calculated using Equation (14).

$$\rho_{pt} = 1 - \frac{6 \sum d_t^2}{m(m^2 - 1)}. \quad (14)$$

There,  $m$  is the number of alternatives and  $d_t$  indicates the difference in the ranking obtained by the two methods for an alternative [13].

Positive  $\rho_{pt}$  values indicate a positive relationship among the variables, whereas negative  $\rho_{pt}$  values indicate a negative relationship among the variables [16].



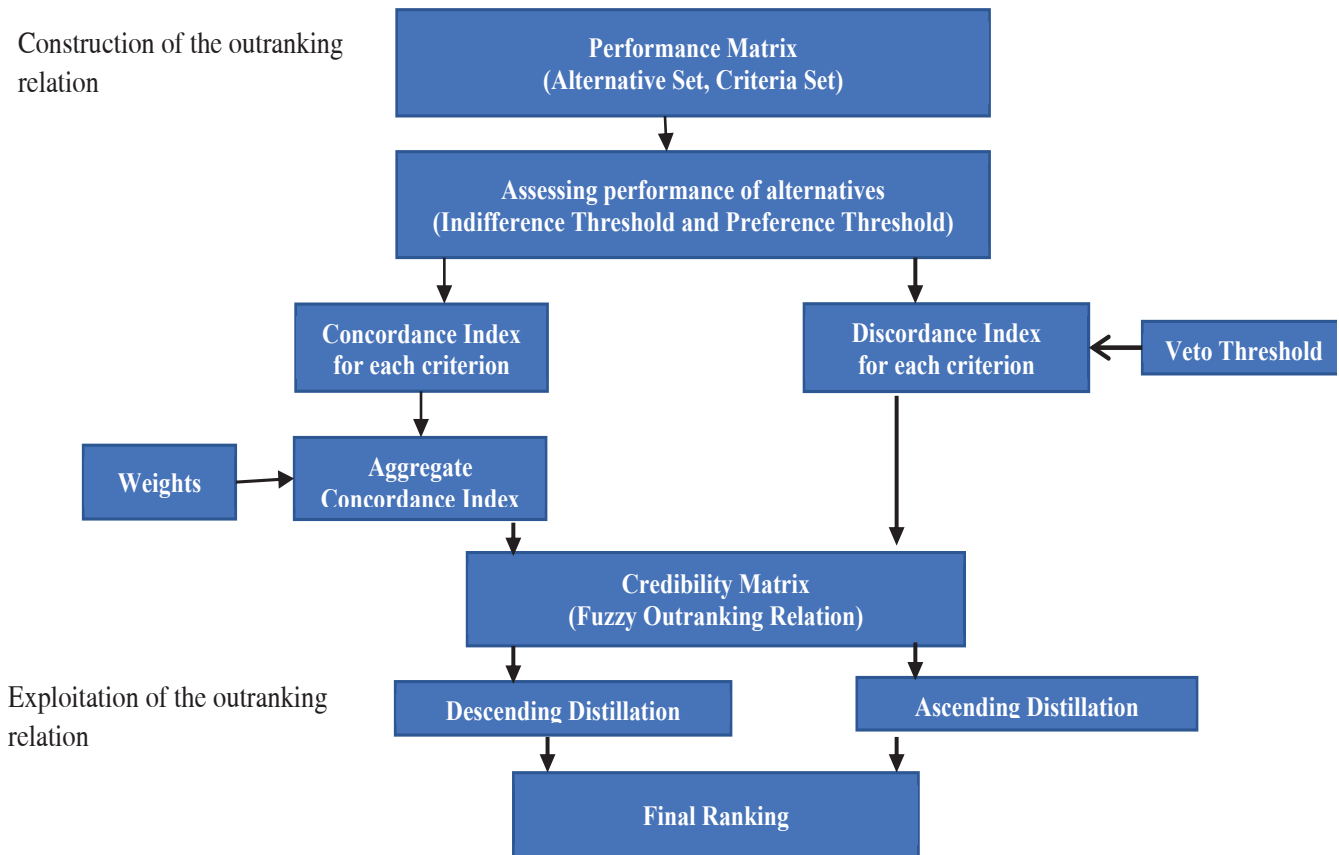


Fig. Flowchart of the ELECTRE III Method

Source: Micale et al. [44]; Leyva-López et al. [45].

## RESULTS

In the study, the performance of the sectors in the last seven years has been tried to be determined by an integrated MCDM method by considering the data obtained over the period 2016 and 2022. First, a decision matrix was obtained by determining the financial performance values of 10 sectors according to 11 indicators between 2016 and 2022, and then the objective and subjective weights of importance of the indicators were determined using these decision matrixes prepared by years.

### Objective Weights: Determining the Weights of Importance of Indicators with CRITIC Method

First, the decision matrix given in equation (2) was normalized in terms of utility indicators and cost indicators using Equations (3) and (4), respectively. Then, a correlation matrix was created using Equation (5) and the degree of conflict and contrast intensity were calculated using Equation (6) and Equation (7), respectively. Finally, the total amount of information

of each indicator was calculated with Equation (8) and the weights of importance of each indicator were determined using this amount of information. The weights of importance of the indicators obtained by the method are given in *Table 3*.

Sales growth data is obtained from the Central Securities Depository (CSD). CSD sector data starts in 2016. In order to calculate the sales growth rate data, data for the previous year (2015) is needed. Since CSD did not have 2015 data, sales growth data for 2016 could not be calculated (*Table 3*). Therefore, 10 indicators were considered for 2016. In 2016, 2019, and 2022, the current liabilities rate had the greatest impact on sector performance, followed by the price to earnings ratio (PE) in 2017 and 2018, the firm value/EBITA ratio in 2020, and the cost of sales rate in 2021. The indicators with the least impact on sector performance were net profit margin in 2016, 2017, and 2019, return of equity in 2018 and 2019, current ratio in 2021, and firm value/EBITA ratio in 2022.

Table 3

## CRITIC Indicator Weights of Importance by Year

| Indicator               | 2016     | 2017     | 2018     | 2019     | 2020     | 2021     | 2022     |
|-------------------------|----------|----------|----------|----------|----------|----------|----------|
| Current ratio           | 0.07966  | 0.070095 | 0.070174 | 0.080407 | 0.086857 | 0.075068 | 0.088286 |
| Leverage ratio          | 0.077806 | 0.102982 | 0.095637 | 0.095738 | 0.080845 | 0.079293 | 0.095685 |
| Current liability ratio | 0.139233 | 0.101857 | 0.089861 | 0.107343 | 0.102237 | 0.081615 | 0.106927 |
| Asset turnover ratio    | 0.12968  | 0.096744 | 0.088545 | 0.092679 | 0.096758 | 0.101301 | 0.095312 |
| Return on equity        | 0.092932 | 0.077987 | 0.060835 | 0.086803 | 0.070344 | 0.10067  | 0.09411  |
| Net profit margin       | 0.068117 | 0.064164 | 0.062481 | 0.070284 | 0.082483 | 0.079496 | 0.083505 |
| Financial expenses rate | 0.125742 | 0.086988 | 0.076931 | 0.099502 | 0.093991 | 0.09967  | 0.09476  |
| Cost of sales rate      | 0.070642 | 0.068059 | 0.087933 | 0.096936 | 0.105191 | 0.108315 | 0.092107 |
| Sales growth            | –        | 0.098135 | 0.121719 | 0.08534  | 0.073789 | 0.101845 | 0.0821   |
| Price to Earning rate   | 0.116472 | 0.128961 | 0.137289 | 0.093356 | 0.075246 | 0.084339 | 0.087941 |
| Firm value / EBITA rate | 0.099715 | 0.104028 | 0.108595 | 0.091614 | 0.132259 | 0.088389 | 0.079266 |

Source: Authors' calculations.

#### Subjective Weights: Determining the Weights of Importance of Indicators with the Opinions of Finance Experts and Finance Academicians

Subjective indicator weights were obtained from a survey conducted separately with a group of finance experts and finance academics. Finance experts and academics were asked to rate 11 decision indicators that affect the performance of sectors separately on a scale of 1 to 10. Years were ignored in the scoring with the same weights of importance applied to each year. The weights of importance of the indicators were calculated by dividing the total weight given to each indicator by the overall weight, taking into account the ratings given by the finance experts and finance academics participating in the survey separately. The indicator weights obtained by taking the opinions of experts and academicians are shown in Table 4.

Table 4 shows that according to the opinions of finance experts and academicians, the indicator that affects sector performance the most is the return of equity indicator, while the indicator that affects sector

performance the least is the financial expense ratio. It is understood that finance experts attach more importance to the value indicators consisting of price to earnings rate and firm value/EBITA and current liability ratios than finance academics, whereas finance academics attach more importance to current rate and leverage ratios than finance experts.

#### Integrated Weights: Determination of the Weights of Importance of Indicators by SOWIA Method

Using the SOWIA method, which combines the objective importance weights and subjective preferences of decision makers, the weights of importance of the indicators were obtained with the help of Equation (1).  $\alpha$ , the objective factor decision weight in this study, is obtained as  $\alpha = 0.5$ . SOWIA weights of importance combining CRITIC importance weights and finance expert weights are given in Table 5 (SOWIA-1) and SOWIA weights of importance combining CRITIC weights of importance and finance academician weights are given in Table 6 (SOWIA-2).

Table 4

## Subjective Indicator Weights

| Indicator               | Finance Expert Weights | For 2016      | Finance Academician Weights | For 2016      |
|-------------------------|------------------------|---------------|-----------------------------|---------------|
| Current ratio           | 0.0794                 | 0.0882        | 0.0911                      | 0.0999        |
| Leverage ratio          | 0.091                  | 0.101         | 0.1024                      | 0.1122        |
| Current liability ratio | 0.0902                 | 0.1001        | 0.0811                      | 0.0889        |
| Asset turnover ratio    | 0.0852                 | 0.0946        | 0.0899                      | 0.0985        |
| Return on equity        | <b>0.1017</b>          | <b>0.1129</b> | <b>0.1049</b>               | <b>0.1149</b> |
| Net profit margin       | 0.0976                 | 0.1084        | 0.1024                      | 0.1122        |
| Financial expenses rate | 0.0769                 | 0.0854        | <b>0.0799</b>               | <b>0.0876</b> |
| Cost of sales rate      | 0.0819                 | 0.0909        | 0.0899                      | 0.0985        |
| Sales growth            | 0.0993                 | –             | 0.0874                      | –             |
| Price to Earnings ratio | 0.0959                 | 0.1065        | 0.0836                      | 0.0917        |
| Firm value / EBITA rate | 0.1009                 | 0.112         | 0.0874                      | 0.0958        |

Source: Authors' calculations.

Table 5

## SOWIA-1 Indicator Weights of Importance by Year\*

| Indicator               | 2016            | 2017            | 2018            | 2019            | 2020            | 2021            | 2022            |
|-------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Current ratio           | 0.08393         | <b>0.074748</b> | <b>0.074787</b> | <b>0.079904</b> | <b>0.083129</b> | <b>0.077234</b> | <b>0.083843</b> |
| Leverage ratio          | 0.089403        | 0.096991        | 0.093319        | 0.093369        | 0.085923        | 0.085147        | 0.093343        |
| Current liability ratio | <b>0.119667</b> | 0.096029        | 0.090031        | <b>0.098772</b> | 0.096219        | 0.085908        | <b>0.098564</b> |
| Asset turnover ratio    | 0.11214         | 0.090972        | 0.086873        | 0.08894         | 0.090979        | 0.093251        | 0.090256        |
| Return on equity        | 0.102916        | 0.089844        | 0.081268        | 0.094252        | 0.086022        | <b>0.101185</b> | 0.097905        |
| Net profit margin       | 0.088259        | 0.080882        | 0.080041        | 0.083942        | 0.090042        | 0.088548        | 0.090553        |
| Financial expenses rate | 0.105571        | 0.081944        | 0.076916        | 0.088201        | 0.085446        | 0.088285        | 0.08583         |
| Cost of sales rate      | <b>0.080771</b> | 0.07498         | 0.084917        | 0.089418        | 0.093546        | 0.095108        | 0.087004        |
| Sales growth            | –               | 0.098718        | 0.11051         | 0.09232         | 0.086545        | 0.100573        | 0.0907          |
| Price to Earning rate   | 0.111486        | <b>0.112431</b> | <b>0.116595</b> | 0.094628        | 0.085573        | 0.09012         | 0.091921        |
| Firm value / EBITA rate | 0.105858        | 0.102464        | 0.104748        | 0.096257        | <b>0.11658</b>  | 0.094645        | 0.090083        |

Source: Authors' calculations.

Note: \* Combined weights of CRITIC weights and financial expert weights. According to the SOWIA-1 weighting results, the indicator that most affected the performance of the sectors was the current liability rate in 2016, 2019, and 2022, the price-to-earnings rate in 2017 and 2018, the firm value/EBITA rate in 2020, and the return of equity in 2021 (Table 5). The least influential indicator was the cost of sales rate in 2016, whereas it was the current rate in all other years.

Table 6

## SOWIA-2 Indicator Weights of Importance by Year\*\*

| Indicator               | 2016     | 2017     | 2018     | 2019     | 2020     | 2021     | 2022     |
|-------------------------|----------|----------|----------|----------|----------|----------|----------|
| Current ratio           | 0.08978  | 0.080598 | 0.080637 | 0.085754 | 0.088979 | 0.083084 | 0.089693 |
| Leverage ratio          | 0.095003 | 0.102691 | 0.099019 | 0.099069 | 0.091623 | 0.090847 | 0.099043 |
| Current liability ratio | 0.114067 | 0.091479 | 0.085481 | 0.094222 | 0.091669 | 0.081358 | 0.094014 |
| Asset turnover ratio    | 0.11409  | 0.093322 | 0.089223 | 0.09129  | 0.093329 | 0.095601 | 0.092606 |
| Return on equity        | 0.103916 | 0.091444 | 0.082868 | 0.095852 | 0.087622 | 0.102785 | 0.099505 |
| Net profit margin       | 0.090159 | 0.083282 | 0.082441 | 0.086342 | 0.092442 | 0.090948 | 0.092953 |
| Financial expenses rate | 0.106671 | 0.083444 | 0.078416 | 0.089701 | 0.086946 | 0.089785 | 0.08733  |
| Cost of sales rate      | 0.084571 | 0.07898  | 0.088917 | 0.093418 | 0.097546 | 0.099108 | 0.091004 |
| Sales growth            | 0        | 0.092768 | 0.10456  | 0.08637  | 0.080595 | 0.094623 | 0.08475  |
| Price to Earning rate   | 0.104086 | 0.106281 | 0.110445 | 0.088478 | 0.079423 | 0.08397  | 0.085771 |
| Firm value / EBITA rate | 0.097758 | 0.095714 | 0.097998 | 0.089507 | 0.10983  | 0.087895 | 0.083333 |

Source: Authors' calculations.

Note: \*\*Combined weights of CRITIC weights and finance academicians weights.

According to the SOWIA-1 weighting results, the indicator that most affected the performance of the sectors was the current liability rate in 2016, 2019, and 2022, the price-to-earnings rate in 2017 and 2018, the firm value/EBITA rate in 2020, and the return of equity in 2021 (Table 5). The least influential indicator was the cost of sales rate in 2016, whereas it was the current rate in all other years.

According to the SOWIA-2 weighting results, the indicator that most affected the performance of the sectors was asset turnover rate in 2016, price to earning rate in 2017 and 2018, leverage ratio in 2019, firm value/EBITA ratio in 2020, and return of equity indicator in 2021 and 2022. The least influential indicators were cost of sales rate in 2016 and 2017, financial expenses rate in 2018, current rate in 2019, price to earnings rate in 2020, current liability rate in 2021 and firm value/EBITA ratio in 2022.

#### Assessment of the Performance of Sectors with ELECTRE III Method

In order to evaluate the performance of the sectors with the ELECTRE III method, firstly  $w_j$  weights of importance are obtained above. Other parameters to be used in the method  $q_j$  indifference  $p_j$  preference and  $v_j$  veto ( $q_j < p_j < v_j$ ) threshold values are obtained

separately over years by using the decision matrix given in Equation (2) and Table 7. When the data are analyzed column-wise for each indicator, the standard deviation of each column  $q_j$  indifference threshold, the difference between the largest and smallest sector performance in each column  $v_j$  veto threshold and  $q_j$  with the threshold of indifference  $v_j$  the average veto threshold is also  $p_j$  is taken as the threshold of preference.

In the study, by using the threshold values  $q_j$ ,  $p_j$  and  $v_j$  obtained in Table 7, the threshold values as well as the indicator weights  $w_j$  given in Tables 3–6, concordance, aggregate concordance, discordance and credibility indexes for each indicator were calculated using Equations (10)–(13). Five different sector performance rankings were obtained as a result of a distillation process using the data in the obtained credibility index.

**Analysis 1:** Ranking obtained using CIRITIC weights.

**Analysis 2:** Ranking using subjective weights of financial experts.

**Analysis 3:** Ranking obtained using subjective weights of finance academics.

**Analysis 4:** Combined weights of CRITIC and financial expert weights with SOWIA method (SOWIA-1).

Table 7

## Threshold Values of Indicators by Years

| Ind.        | $g_1$ | $g_2$  | $g_3$  | $g_4$ | $g_5$  | $g_6$  | $g_7$  | $g_8$  | $g_9$  | $g_{10}$ | $g_{11}$ |
|-------------|-------|--------|--------|-------|--------|--------|--------|--------|--------|----------|----------|
| <b>2016</b> |       |        |        |       |        |        |        |        |        |          |          |
| $q_j$       | 0.54  | 11.96  | 8.39   | 0.8   | 18.94  | 7.63   | 14.76  | 6.86   | -      | 10.14    | 6.36     |
| $p_j$       | 1.035 | 23.105 | 18.135 | 1.78  | 39.27  | 16.57  | 27.99  | 15.99  | -      | 21.24    | 14.575   |
| $v_j$       | 1.53  | 34.25  | 27.88  | 2.76  | 59.6   | 25.51  | 41.22  | 25.12  | -      | 32.34    | 22.79    |
| <b>2017</b> |       |        |        |       |        |        |        |        |        |          |          |
| $q_j$       | 1.53  | 11.92  | 9.02   | 0.51  | 8.39   | 9.06   | 13.65  | 4.28   | 9.48   | 9.16     | 4.38     |
| $p_j$       | 3.52  | 23.745 | 19.89  | 1.11  | 17.385 | 20.62  | 26.67  | 10.005 | 20.31  | 17.405   | 9.535    |
| $v_j$       | 5.51  | 35.57  | 30.76  | 1.71  | 26.38  | 32.18  | 39.69  | 15.73  | 31.14  | 25.65    | 14.69    |
| <b>2018</b> |       |        |        |       |        |        |        |        |        |          |          |
| $q_j$       | 1.2   | 11.76  | 10.3   | 0.52  | 16.62  | 16.64  | 28.94  | 4.36   | 10.09  | 9.34     | 5.55     |
| $p_j$       | 2.765 | 22.63  | 23.83  | 1.14  | 40.085 | 38.65  | 60.62  | 9.25   | 21.345 | 17.265   | 10.825   |
| $v_j$       | 4.33  | 33.5   | 37.36  | 1.76  | 63.55  | 60.66  | 92.3   | 14.14  | 32.6   | 25.19    | 16.1     |
| <b>2019</b> |       |        |        |       |        |        |        |        |        |          |          |
| $q_j$       | 0.96  | 11.89  | 9.03   | 0.61  | 6.89   | 5.26   | 15.26  | 6.29   | 16.07  | 23.06    | 8.19     |
| $p_j$       | 2.06  | 24.135 | 19.99  | 1.37  | 15.73  | 11.875 | 28.04  | 13.71  | 35.775 | 51.395   | 18.935   |
| $v_j$       | 3.16  | 36.38  | 30.95  | 2.13  | 24.57  | 18.49  | 40.82  | 21.13  | 55.48  | 79.73    | 29.68    |
| <b>2020</b> |       |        |        |       |        |        |        |        |        |          |          |
| $q_j$       | 0.41  | 9.69   | 8.4    | 0.53  | 12.28  | 11.97  | 35.26  | 7.43   | 16.56  | 37.99    | 14.14    |
| $p_j$       | 0.755 | 20     | 19.99  | 1.1   | 26.96  | 28.24  | 71.11  | 14.525 | 34.48  | 86.505   | 27.125   |
| $v_j$       | 1.1   | 30.31  | 31.58  | 1.67  | 41.64  | 44.51  | 106.96 | 21.62  | 52.4   | 135.02   | 40.11    |
| <b>2021</b> |       |        |        |       |        |        |        |        |        |          |          |
| $q_j$       | 0.6   | 6.11   | 9.07   | 0.6   | 13.39  | 16.17  | 20.31  | 4.54   | 25.49  | 12.95    | 28.34    |
| $p_j$       | 1.39  | 13.675 | 19.11  | 1.32  | 29.36  | 36.24  | 43.285 | 8.015  | 48.575 | 28.73    | 60.955   |
| $v_j$       | 2.18  | 21.24  | 29.15  | 2.04  | 45.33  | 56.31  | 66.26  | 11.49  | 71.66  | 44.51    | 93.57    |
| <b>2022</b> |       |        |        |       |        |        |        |        |        |          |          |
| $q_j$       | 0.95  | 4.37   | 9.08   | 0.57  | 11.85  | 31.59  | 10.32  | 7.18   | 39.47  | 15.23    | 8.82     |
| $p_j$       | 2.075 | 8.305  | 16.04  | 1.28  | 24.165 | 68.21  | 22.47  | 15.485 | 85.18  | 30.15    | 20.23    |
| $v_j$       | 3.2   | 12.24  | 23     | 1.99  | 36.48  | 104.83 | 34.62  | 23.79  | 130.89 | 45.07    | 31.64    |

Source: Authors' calculations.



Table 8

## Performance Ranking and Return Ranking of Sectors by Year

| 2016   |                 | Method Rankings |            |            |            |            |
|--------|-----------------|-----------------|------------|------------|------------|------------|
| Sector | Return Rankings | Analysis1       | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 |
| A1     | 6               | 7               | 8          | 8          | 8          | 8          |
| A2     | 7               | 1               | 9          | 9          | 9          | 9          |
| A3     | 9               | 8               | 8          | 8          | 8          | 8          |
| A4     | 2               | 1               | 1          | 1          | 1          | 1          |
| A5     | 1               | 9               | 8          | 8          | 8          | 8          |
| A6     | 4               | 7               | 7          | 8          | 7          | 7          |
| A7     | 8               | 4               | 5          | 5          | 5          | 5          |
| A8     | 5               | 6               | 6          | 6          | 6          | 6          |
| A9     | 3               | 10              | 10         | 10         | 10         | 10         |
| A10    | 10              | 9               | 9          | 9          | 9          | 9          |
| 2017   |                 | Method Rankings |            |            |            |            |
| Sector | Return Rankings | Analysis 1      | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 |
| A1     | 6               | 6               | 10         | 10         | 8          | 8          |
| A2     | 5               | 3               | 5          | 5          | 4          | 3          |
| A3     | 9               | 8               | 7          | 7          | 8          | 8          |
| A4     | 8               | 9               | 10         | 10         | 10         | 10         |
| A5     | 2               | 4               | 5          | 5          | 5          | 4          |
| A6     | 7               | 6               | 5          | 5          | 5          | 5          |
| A7     | 4               | 1               | 1          | 1          | 1          | 2          |
| A8     | 10              | 10              | 10         | 10         | 10         | 10         |
| A9     | 3               | 8               | 7          | 7          | 8          | 8          |
| A10    | 1               | 1               | 1          | 1          | 1          | 1          |
| 2018   |                 | Method Rankings |            |            |            |            |
| Sector | Return Rankings | Analysis 1      | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 |
| A1     | 10              | 7               | 8          | 8          | 8          | 8          |
| A2     | 4               | 3               | 5          | 4          | 3          | 3          |
| A3     | 5               | 8               | 8          | 8          | 8          | 8          |
| A4     | 6               | 10              | 10         | 10         | 10         | 10         |
| A5     | 8               | 7               | 5          | 8          | 4          | 4          |
| A6     | 9               | 7               | 8          | 8          | 8          | 8          |
| A7     | 2               | 1               | 1          | 1          | 1          | 1          |
| A8     | 7               | 9               | 9          | 9          | 9          | 9          |
| A9     | 3               | 4               | 5          | 4          | 5          | 5          |
| A10    | 1               | 3               | 2          | 2          | 2          | 2          |
| 2019   |                 | Method Rankings |            |            |            |            |
| Sector | Return Rankings | Analysis 1      | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 |
| A1     | 1               | 6               | 4          | 4          | 4          | 6          |
| A2     | 4               | 5               | 5          | 5          | 5          | 5          |
| A3     | 7               | 8               | 9          | 8          | 8          | 8          |
| A4     | 5               | 10              | 10         | 10         | 10         | 10         |
| A5     | 8               | 4               | 9          | 8          | 8          | 6          |
| A6     | 3               | 8               | 9          | 8          | 8          | 8          |
| A7     | 9               | 1               | 1          | 1          | 1          | 1          |
| A8     | 6               | 3               | 3          | 5          | 3          | 3          |
| A9     | 2               | 9               | 9          | 9          | 9          | 9          |
| A10    | 10              | 2               | 2          | 2          | 2          | 2          |

Table 8 (continued)

| 2020   |                 | Method Rankings |            |            |            |            |
|--------|-----------------|-----------------|------------|------------|------------|------------|
| Sector | Return Rankings | Analysis 1      | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 |
| A1     | 1               | 8               | 4          | 6          | 4          | 7          |
| A2     | 3               | 10              | 10         | 10         | 10         | 10         |
| A3     | 8               | 1               | 1          | 1          | 1          | 1          |
| A4     | 9               | 8               | 8          | 7          | 8          | 8          |
| A5     | 6               | 8               | 5          | 5          | 7          | 4          |
| A6     | 5               | 8               | 3          | 3          | 3          | 3          |
| A7     | 7               | 2               | 3          | 3          | 2          | 3          |
| A8     | 2               | 8               | 8          | 8          | 7          | 7          |
| A9     | 4               | 9               | 9          | 9          | 9          | 9          |
| A10    | 10              | 8               | 8          | 8          | 7          | 8          |
| 2021   |                 | Method Rankings |            |            |            |            |
| Sector | Return Rankings | Analysis 1      | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 |
| A1     | 3               | 10              | 10         | 10         | 10         | 10         |
| A2     | 7               | 4               | 4          | 4          | 5          | 5          |
| A3     | 8               | 8               | 9          | 9          | 9          | 9          |
| A4     | 2               | 5               | 6          | 2          | 5          | 5          |
| A5     | 1               | 5               | 5          | 6          | 6          | 5          |
| A6     | 4               | 6               | 6          | 6          | 6          | 6          |
| A7     | 10              | 1               | 1          | 1          | 1          | 1          |
| A8     | 9               | 4               | 4          | 5          | 5          | 4          |
| A9     | 6               | 9               | 9          | 9          | 9          | 9          |
| A10    | 5               | 7               | 7          | 7          | 7          | 7          |
| 2022   |                 | Method Rankings |            |            |            |            |
| Sector | Return Rankings | Analysis 1      | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 |
| A1     | 9               | 10              | 8          | 9          | 8          | 9          |
| A2     | 2               | 5               | 4          | 4          | 4          | 4          |
| A3     | 7               | 9               | 10         | 10         | 10         | 10         |
| A4     | 4               | 5               | 3          | 3          | 3          | 3          |
| A5     | 10              | 6               | 6          | 6          | 6          | 6          |
| A6     | 8               | 6               | 7          | 7          | 7          | 7          |
| A7     | 6               | 1               | 1          | 1          | 1          | 1          |
| A8     | 5               | 5               | 2          | 2          | 2          | 2          |
| A9     | 3               | 9               | 10         | 9          | 10         | 9          |
| A10    | 1               | 7               | 8          | 9          | 8          | 9          |

Source: Authors' calculations.

**Analysis 5:** Combined weights of CRITIC and finance academician weights with SOWIA method (SOWIA-2).

The performance rankings and return rankings of the sectors obtained by years using five different indicator weights are given in *Table 8*.

According to *Table 8*, the best performance in 2016 belonged to construction and public works ( $A_4$ ) sector, whereas the worst performance belonged to textile clothing and leather ( $A_9$ ) sector. In 2016, construc-

tion and public works ( $A_4$ ) along with electricity, gas, water and steam ( $A_2$ ) exhibited the best performance in Analysis 1 ranking, whereas electricity, gas, water and steam ranked 9<sup>th</sup> in the ranking obtained with all other weights ( $A_2$ ). In 2017, the best performance belonged to transportation and storage ( $A_{10}$ )(in all analyses) and retail trade ( $A_7$ )(except for Analysis 5), whereas stone and soil ( $A_8$ )(all analyses), construction and public works ( $A_4$ )(except for Analysis 1) and informatics ( $A_1$ )(except for Analysis 1, 4, and 5) had

Table 9

## Spearman's Rank Correlation Results

| Year | Cor. Coef. / Analysis   | Analysis 1 | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 |
|------|-------------------------|------------|------------|------------|------------|------------|
| 2016 | Correlation Coefficient | -.043      | .209       | .188       | .209       | .209       |
|      | Sig. (2-tailed)         | .907       | .562       | .603       | .562       | .562       |
|      | N                       | 10         | 10         | 10         | 10         | 10         |
| 2017 | Correlation Coefficient | .752*      | .688*      | .688*      | .712*      | .757*      |
|      | Sig. (2-tailed)         | .012       | .028       | .028       | .021       | .011       |
|      | N                       | 10         | 10         | 10         | 10         | 10         |
| 2018 | Correlation Coefficient | .603       | .652*      | .715*      | .632*      | .632*      |
|      | Sig. (2-tailed)         | .065       | .041       | .020       | .050       | .050       |
|      | N                       | 10         | 10         | 10         | 10         | 10         |
| 2019 | Correlation Coefficient | -.663*     | -.394      | -.388      | -.460      | -.573      |
|      | Sig. (2-tailed)         | .037       | .260       | .268       | .181       | .083       |
|      | N                       | 10         | 10         | 10         | 10         | 10         |
| 2020 | Correlation Coefficient | -.451      | -.215      | -.311      | -.190      | -.190      |
|      | Sig. (2-tailed)         | .191       | .550       | .382       | .599       | .600       |
|      | N                       | 10         | 10         | 10         | 10         | 10         |
| 2021 | Correlation Coefficient | -.390      | -.385      | -.244      | -.333      | -.326      |
|      | Sig. (2-tailed)         | .265       | .271       | .497       | .347       | .358       |
|      | N                       | 10         | 10         | 10         | 10         | 10         |
| 2022 | Correlation Coefficient | .216       | .018       | .067       | .018       | .067       |
|      | Sig. (2-tailed)         | .549       | .960       | .853       | .960       | .853       |
|      | N                       | 10         | 10         | 10         | 10         | 10         |

Source: Authors' calculations.

Note: \* Correlation is significant at 0.05 significance level.

the worst performance. In 2018 and 2019, retail trade ( $A_7$ ) had the best performance while construction and public works ( $A_4$ ) had the worst performances. In 2020, food, beverage and tobacco ( $A_3$ ) exhibited the best performance and the electricity, gas, water and steam ( $A_2$ ) had the worst performance, whereas best performance belonged to retail trade in 2021 ( $A_7$ ) and  $A_1$  sector had the worst performance. In 2022, retail trade ( $A_7$ ) had the best performance while food, beverage and tobacco ( $A_3$ ) had the worst performance in all analyses except for Analysis 1, informatics ( $A_1$ ) had the worst performance only in Analysis 1 and textile clothing and leather ( $A_9$ ) sector exhibited the worst performance in Analysis 1. The sector with the best financial performance in all periods was retail trade.

Construction and public works ( $A_4$ ) sector in 2016 and food, beverage and tobacco ( $A_3$ ) sector in 2020 were the best performing sectors, although those two sectors underperformed in other years.

#### Comparison of Return Rankings and Method Rankings

Another significant conclusion of the study are the results of the Spearman's rank correlation analysis of the relationship between sector performance rankings and return rankings. The purpose of this analysis is to determine the extent to which the financial performance indicators determined by the SOWIA-ELECTRE III methods are priced in BIST sector returns and to what extent the financial

Table 10

## Final Performance Rankings of Sectors by Years

| Year | Analysis                 | Rankings                                                                                                                         |
|------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 2016 | Analysis 4<br>Analysis 5 | $A_4 > A_7 > A_8 > A_6 > A_1 = A_3 = A_5 > A_2 = A_{10} > A_9$<br>$A_4 > A_7 > A_8 > A_6 > A_1 = A_3 = A_5 > A_2 = A_{10} > A_9$ |
| 2017 | Analysis 4<br>Analysis 5 | $A_7 = A_{10} > A_2 > A_5 = A_6 > A_1 = A_3 = A_9 > A_4 = A_8$<br>$A_{10} > A_7 > A_2 > A_5 > A_6 > A_1 = A_3 = A_9 > A_4 = A_8$ |
| 2018 | Analysis 4<br>Analysis 5 | $A_7 > A_{10} > A_2 > A_5 > A_9 > A_1 = A_3 = A_6 > A_8 > A_4$<br>$A_7 > A_{10} > A_2 > A_5 > A_9 > A_1 = A_3 = A_6 > A_8 > A_4$ |
| 2019 | Analysis 4<br>Analysis 5 | $A_7 > A_{10} > A_8 > A_1 > A_2 > A_3 = A_5 = A_6 > A_9 > A_4$<br>$A_7 > A_{10} > A_8 > A_2 > A_1 = A_5 > A_3 = A_6 > A_9 > A_4$ |
| 2020 | Analysis 4<br>Analysis 5 | $A_3 > A_7 > A_6 > A_1 > A_5 = A_8 = A_{10} > A_4 > A_9 > A_2$<br>$A_3 > A_6 = A_7 > A_5 > A_1 = A_8 > A_4 = A_{10} > A_9 > A_2$ |
| 2021 | Analysis 4<br>Analysis 5 | $A_7 > A_2 = A_4 = A_8 > A_5 = A_6 > A_{10} > A_3 = A_9 > A_1$<br>$A_7 > A_8 > A_2 = A_4 = A_5 > A_6 > A_{10} > A_3 = A_9 > A_1$ |
| 2022 | Analysis 4<br>Analysis 5 | $A_7 > A_8 > A_4 > A_2 > A_5 > A_6 > A_1 = A_{10} > A_3 = A_9$<br>$A_7 > A_8 > A_4 > A_2 > A_5 > A_6 > A_1 = A_9 = A_{10} > A_3$ |

Source: Authors' calculations.

performance indicators are reflected in pricing behavior.

According to Table 9, there is a significant positive relationship between return ranking and five different analysis rankings in 2017 and between return ranking and four other analysis rankings except Analysis 1 in 2018. In 2019, there is a significant negative relationship only with Analysis 1, while there is no significant relationship with all other analyses. As a result, there appears to be a partial relationship between sector financial performance rankings and sector index returns.

According to Table 10, the results obtained from the two analyses are generally consistent. Retail trade ( $A_7$ ) sector has always been in the top two rankings in all years according to the results of the two analyses, while textile clothing and leather ( $A_9$ ) sector ranked in the last two places in all years except 2018. The retail trade sector is mostly comprised of chain grocery stores. Another noteworthy result in Table 10 is that food, beverage and tobacco, which

were in the last three rankings in all years, have been ranked in the bottom three. ( $A_3$ ) sector ranked first with the best performance in 2020. The food sector performed well during COVID-19, namely in 2020. During COVID-19, when people were confined to their houses, demand for food, the most fundamental essential, surged. Also, the stone and soil ( $A_8$ ) sector ranked in the top three in 2016, 2019, 2021 and 2022, and in the last rankings in the other years. The stone and soil sector covers cement and construction activities. This sector is highly affected by economic policy and credit expansions. In this respect, the sector gains momentum during periods of monetary expansion and easier credit facilities, while activities in the stone and soil sector decline during periods of monetary contraction and credit costs increase, making it difficult to obtain financing. The results of the analysis are consistent with periods of declining interest rates and easier access to credit. Other sectors' rankings have generally altered over the years in response to economic trends.

## CONCLUSION

In this study, the integrated SOWIA-ELECTRE III method is used to evaluate the performance of sectors in a more realistic way by using weights that include both subjective and objective opinions about the relative importance of indicators and by taking into account the uncertainties in the decision maker's preference modeling with different thresholds in the structure of the method.

The financial performance metrics that have the greatest impact on sector performance share more similarities than differences. In both SOWIA-1 and SOWIA-2 outcomes, value performance measures (price to earnings ratio and firm value/EBITA ratio) and return on equity have the greatest impact on sector performance. While the current liability rate had the greatest impact on performance in 2016, 2019, and 2022 according to SOWIA-1 results, it was one of the top three critical indicators in SOWIA-2. While the current liability rate was the most influential indicator when financing costs rose, access to financing became difficult, and monetary tightening occurred, value ratios such as the price to earnings ratio and firm value/EBITA ratio were effective when BIST volatility increased and downward or upward trends emerged.

According to the findings, the retail trade industry performed best in 2018, 2019, 2021, and

2022, while the transportation and storage sector did best in 2017, alongside the retail trade sector. Construction and public works performed best in 2016, followed by food, beverage, and tobacco in 2020. Indicators affecting sector performances have changed over the years. Interest rates, periods of monetary expansion and contraction, the COVID-19 pandemic, BIST volatility and trends are considered to be influential in this change. The highest performance of the retail trade sector is attributed to the purchasing power of consumers.

The relationships between the return rankings and performance rankings of the sectors were analyzed by Spearman's rank correlation. As a result of the analysis, considering the results of the integrated method, it was found that there was a positive and high coefficient relationship between these two variables only in 2017 and 2018, whereas no statistically significant relationship was found in other years. Therefore, it was revealed that there was performance-based pricing in the pricing of BIST sector indices from time to time, as well as behavioral pricing, macroeconomic factor pricing, and technical analysis pricing. The results of this study are useful for investors, financial analysts, sector analysts, portfolio managers and economic managers.

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**S. Şener** — methodology, software, theoretical part, writing-review, description of results, formation of tables and figure, representation of results.

**T. Gülcemal** — theoretical part, collection and analysis of literature, writing-review.

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# Commercial Banks' Mandatory Regulations Set by the Bank of Russia as Factors in Revoking Licenses

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## ABSTRACT

All the Russian commercial banks, which have any types of license, whether basic or universal, must meet the mandatory standards set by the Bank of Russia. Otherwise they may face the risk of having their license revoked. The problem raised by the study relates to the question of whether it is possible for the Bank of Russia to strengthen its control over default factors in commercial banks through economic regulatory measures, such as monitoring compliance with banking regulations. The purpose of this work is to identify factors that influence the probability of license revocation for commercial banks in Russia during a period of relative stability in the banking system between 2016 and 2021. Special attention is paid to the reasons for the revocation of licenses and the analysis of factors related to compliance by commercial banks with basic standards of banking activity. The following methods were used: analysis of the reasons for the revocation of banking licenses, division of 244 banks that lost their licenses into two groups: those with license revoked for economic reasons, and those in connection with violations of legislation. A multinomial logistic regression was used to analyze the impact of banking regulations' value on the probability of license revocation. The econometric analysis showed that factors influencing the license revocations of Russian commercial banks, including those belonging to both groups considered, vary significantly. Not all indicators related to regulations and the probability of license revocation proved to be significant in this sample. Lowering the capital adequacy ratio significantly increases the risk of license revocation due to economic reasons. An increase in the maximum value of large credit risk also increases the likelihood of license withdrawal, regardless of reason.

**Keywords:** commercial banks; Bank of Russia; license revocation; capital adequacy ratio; liquidity ratio; large credit risk ratio

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## INTRODUCTION

The stable state of the banking system is seen as one of the key factors in sustainable economic development. This is confirmed by the award of the Nobel Prize in Economics to American economists Ben Bernanke, Douglas Diamond, and Philip Dybvig in 2022 “for their research on banks and financial crises”.<sup>1</sup> Their work has shown the importance of banks in the economy and the need to avoid the collapse of commercial banks. It has also suggested measures to support banks during times of crisis, which have been put into practice in many countries

The Russian banking system has seen significant changes in terms of the structure and composition of credit institutions since 2013. This was due to the Bank of Russia’s revision of its approach to the reliability and transparency requirements for commercial banks. Then, the banking system faced one of the worst crises when, in early 2015, its profitability decreased almost to zero and for the category of “large private banks”, it was negative.<sup>2</sup> In the period from 2013 to 2015, 190 licenses were revoked from commercial banks and 27 banks voluntarily ceased their activities. In 2016 the economy and banking system recovered, but the license revocation process continued. In 2022, the Bank of Russia revoked the licenses of three banks, in 2023 three commercial banks were liquidated independently, in 2024 seven banks ceased to exist, including four that had their licenses revoked.<sup>3</sup> Despite the decrease in the number of bank failures in the Russian Federation, it cannot be said that the banking business currently has no problems. The role of the regulator in monitoring the state of banks is crucial.

<sup>1</sup> The Nobel Prize in Economics was awarded for the study of financial crises on October 10, 2022. URL: <https://www.interfax.ru/world/867094> (accessed on 02.01.2024).

<sup>2</sup> Report on the development of the banking sector and banking supervision in 2015. Bank of Russia, 2016. URL: [https://www.cbr.ru/Collection/Collection/File/24206/bsr\\_2015.pdf](https://www.cbr.ru/Collection/Collection/File/24206/bsr_2015.pdf) (accessed on 03.01.2024).

<sup>3</sup> Defunct credit organizations. URL: <https://www.banki.ru/banks/memory/> (accessed on 15.07.2024).

In our work, we aimed to identify the factors that influence the likelihood of license revocation for commercial banks in the Russian Federation during a period of relative stability in the banking system from 2016 to 2021. We examined the reasons for license revocations and focused on analyzing factors related to compliance with basic banking regulations by commercial banks. These include capital adequacy, liquidity, and maximum size of large credit risk.

The main hypothesis of our study is that indicators of banking regulations are significant factors that may influence the probability of a bank’s bankruptcy. A decrease in capital adequacy and liquidity, as well as an increase in maximum large credit risk, are associated with a higher likelihood of bank failure for any official reason leading to license revocation.

## LITERATURE REVIEW

In modern Russian and foreign scientific literature, there are numerous works dedicated to the issue of the likelihood of bankruptcy for commercial banks. This topic is closely related to assessing default factors. Traditionally, authors have focused on indicators related to a bank’s financial health of the bank itself [1–6] and its management effectiveness [7]. The research also includes parameters reflecting the state and competitive environment of the banking system [2–4, 8] and macroeconomic factors. [2, 5, 6, 9]. In addition, the authors also considered variables characterizing the regulator’s control of banking risks [2, 8, 10–12], the influence of monetary policy instruments [12, 13], as well as factors related to the political environment [9]. Some of the publications used by us in developing the approach for this study are reflected in *Table 1*.

Based on the description of the works presented in *Table 1*, we can conclude that in the classical approach to the problem of assessing the likelihood of bank failure, the authors consider financial indicators, most of



which are part of the CAMEL-indicators,<sup>4</sup> as well as macroeconomic indicators and banking standards. The methods used to solve research problems vary. Traditionally, researchers have used logistic regression, binary and multiple choice models, panel data models, and impulse response models. However, in more recent works, economists are increasingly likely to incorporate machine learning algorithms into their methodological approaches or as the basis for their methods.

The research covers various countries and regions around the world, including several works dedicated to the analysis of the Russian banking system [1, 5, 15–18]. As a rule, studies are conducted over several years, close to the time of publication of a scientific work. However, there are also studies that focus on stable and crisis periods in economic development [2, 10, 13].

Let's take a closer look at the studies that focused on the regulatory indicators of banking activity. One of the significant factors that emerged from the research was the capital adequacy ratio, which was studied in relation to the probability of default for small regional cooperative banks in Italy between 1993 and 2011 [2]. In another study [6], based on statistics for 457 commercial banks from 20 countries in the period 2000–2019, it was shown that the regulator can reduce systematic risk by influencing the formation of banks' liquidity reserves, which is important in times of uncertainty.

The article [7] found that for European banks between 2006 and 2017, there was a significant probability of default with a high level of credit risk and liquidity problems. Qualified managers could not always prevent these defaults. A study [8], based on data from 156 American banks (78 of which went bankrupt between 2001 and 2015), found that one of the most

significant factors in assessing the likelihood of bankruptcy is the capital adequacy index. The authors of a study on commercial, cooperative, savings, and Islamic banks in 111 countries between 1998 and 2009 found that increased regulation of capital adequacy reduces the risk of bankruptcy [10]. A study of commercial banks in the Eurozone between 2008 and 2019 showed that the implementation of Basel III standards, which increase capital adequacy levels, significantly reduced CDS spreads, which can be interpreted as a reduction in the risk of commercial bank default [11]. An important aspect of our research was to consider the reasons for the revocation of licenses from Russian commercial banks. The authors of the study addressed this issue [16] and identified 10 different reasons. The most common reason is the violation of the requirements of Federal Law No. 115-FZ. A.A. Peresetsky [1] identifies two main reasons for this phenomenon: economic and legal, noting the significance of various factors for each one. A.V. Zubarev and K.D. Shilov [5] also recognize these reasons and highlight differences in the factors involved.

## METHODOLOGICAL APPROACH AND STATISTICAL BASE OF THE STUDY

### The Research Method

In this study, we used multinomial logistic regression because it was necessary to assess the impact of a commercial bank's standards on the likelihood of license revocation for various reasons. This type of regression does not require the assumption of normal distribution of variables, which makes it more flexible and less susceptible to outliers. Additionally, the logit model is more commonly used in scientific literature than the probit model because it is easier to interpret the results [19].

The multinomial logistic regression model (MNL) is a nonlinear model in terms of probabilities. That is, the effect of a change in one regressor on the dependent variable depends on the values of the other ones. This makes it difficult to interpret the individual effects of each regressor in the model [20].

<sup>4</sup> Currently, the abbreviation of the indicators has been expanded and is used as CAMELS: Capital adequacy, Asset quality, Management efficiency, Earnings power, Liquidity, Sensitivity to market risk (capital adequacy, asset quality, management efficiency, profitability, liquidity, sensitivity to market risk). CAMEL was created by the Fed as a rating system for evaluating American banks.

Table 1

## Review of the Banks' Failure Research

| Authors                                                 | Countries, regions, time period       | Factors of Failures                                                                                                            | Methods                                                       | Key results                                                                                                                                                                                     |
|---------------------------------------------------------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| N. Soenen, R.V. Vennet [11]                             | The Eurozone, 2008–2018               | Asset structure, sources of funding, income structure, capital adequacy                                                        | VAR model, CDS spreads                                        | Basel III standards contribute to reducing the risk of the banking business                                                                                                                     |
| R.B. Abdesslem, I. Chkir, H. Dabbou [7]                 | 16 European countries, 2006–2017      | Indicators of credit risk and liquidity, managerial efficiency, monetary policy, macroeconomic indices                         | Dynamic panel regression, a generalized method                | Credit risk is associated with management. Increased credit and liquidity risks increase the likelihood of bank bankruptcy                                                                      |
| V. Lagasio, F. Pampurini, A. Pezzola, A.G. Quaranta [4] | The Eurozone, 2018 and 2020           | Indicators of capital adequacy, asset quality, liquidity, market risk, profitability and price competition of Lerner and Boone | and Machine learning algorithms                               | The bank's default is explained by the indicators of capital adequacy of the first level, the share of risky assets and the average return on assets of the bank                                |
| A.V. Zubarev, K.D. Shilov [5]                           | The Russian Federation 2013–2021      | Financial indicators of the banking business, macroeconomic indicators                                                         | Multinomial logistic regression                               | The factors of license revocation differ for different reasons – economic and legislative                                                                                                       |
| B.N. Ashraf, C. Zheng, C. Jiang, N. Qian [10]           | 111 countries of the world, 1998–2009 | Capital adequacy level, deposit insurance, banking sector indicators, macroeconomic indices                                    | Panel regression, the least squares method                    | Increased capital regulation reduces the risk of bankruptcy in a stable period, and deposit insurance is necessary in times of crisis                                                           |
| P. Carmona, F. Climent, A. Momparler [8]                | The USA, 2001–2015                    | Financial indicators of the banking business, capital adequacy standards of various levels                                     | Machine learning method – gradient boosting method            | The most significant factors are the profitability of operating assets, the amount of loan collateral, and the overall capital adequacy ratio                                                   |
| M. Myakinen, L. Solanko [14]                            | The Russian Federation, 2013–2017     | Indicators of banks' condition: capital, asset quality, profitability, liquidity, bank size, credit activity, deposits         | Linear probabilistic binary response model with fixed effects | The liquidity indicators, considered in dynamics, require the greatest attention                                                                                                                |
| D.S. Mare [2]                                           | Italy, 1993–2011                      | Macroeconomic indicators, capital adequacy level, income-expense ratio, bank size                                              | Binomial logistic regression                                  | Macroeconomic factors are more likely to determine the probability of default of small banks                                                                                                    |
| A.A. Peresetsky [1]                                     | The Russian Federation, 2005–2008     | Financial indicators of banks, macroeconomic indicators, "unaccounted for" factors                                             | Binary choice model, multinomial logistic regression          | Bankruptcy factors are related to the reasons for license revocation (economic and withdrawal of funds); "unaccounted for" factors increase the likelihood of bankruptcy for fraudulent reasons |

Source: Compiled by the authors based on the Reference list sources.

Table 2

## List of Explanatory Variables

| Variable                       | Description                                                 | Units of measure |
|--------------------------------|-------------------------------------------------------------|------------------|
| <b>Financial indicators</b>    |                                                             |                  |
| ASSETS                         | Assets                                                      | thousand rubles  |
| CASH                           | Cash                                                        | thousand rubles  |
| CORR_CB                        | Funds in correspondent accounts with the Bank of Russia     | thousand rubles  |
| CORR_NOSTRO                    | Funds in nostro accounts with other banks                   | thousand rubles  |
| BONDS                          | FLB value in the bank's assets                              | thousand rubles  |
| STOCKS                         | The value of shares in the bank's assets                    | thousand rubles  |
| LOANS_ENTITY                   | Loans to legal entities                                     | thousand rubles  |
| OVERDUE_LOANS_ENTITY           | Overdue loans to legal entities                             | thousand rubles  |
| LOANS_ENTREPR                  | Loans to individual entrepreneurs                           | thousand rubles  |
| OVERDUE_LOANS_ENTREPR          | Overdue loans to individual entrepreneurs                   | thousand rubles  |
| LOANS_INDIVIDUAL               | Loans to individuals                                        | thousand rubles  |
| OVERDUE_LOANS_INDIVIDUAL       | Overdue loans to individuals                                | thousand rubles  |
| FUNDS_ENTITY                   | Current funds of legal entities                             | thousand rubles  |
| FUNDS_INDIVIDUAL               | Current funds of individuals                                | thousand rubles  |
| DEPOSITS_ENTITY                | Time deposits of legal entities                             | thousand rubles  |
| DEPOSITS_INDIVIDUAL            | Time deposits of individuals                                | thousand rubles  |
| OWN_FUNDS                      | Own funds                                                   | thousand rubles  |
| NET_INTEREST                   | Net interest income                                         | thousand rubles  |
| NET_COMMISSION                 | Net commission income                                       | thousand rubles  |
| NET_PROFIT                     | Net profit                                                  | thousand rubles  |
| <b>Regulatory requirements</b> |                                                             |                  |
| N1                             | The Bank's capital adequacy ratio (H1.0)                    | percent          |
| N3                             | The bank's current liquidity ratio (H3)                     | percent          |
| N7                             | The standard of the maximum size of large credit risks (H7) | percent          |
| <b>Macroeconomic factors</b>   |                                                             |                  |
| GDP                            | Real GDP growth rate                                        | index            |
| INCOME                         | The growth rate of real incomes of the population           | index            |
| CPI                            | Consumer Price Index                                        | index            |

Source: Compiled by the authors.

We directly analyzed the nature and magnitude of the influence of each regressor on the dependent variable. We interpreted the coefficients based on their signs in the regression equation. Due to the complexity of the MNLM, we did not calculate marginal effects in this study. The coefficients were calculated for a large number of models evaluated with sequential inclusion of variables. Based on the minimum values of the Akaike information criteria (AIC) and Bayesian (BIC) [20], the best models were determined.<sup>5</sup> After determining the three most suitable specifications, the Hosmer-Lemeshowe test was performed to analyze the reliability of the results obtained [21].<sup>6</sup> The null hypothesis of the test is that there are no significant differences between the observed and modeled frequency distributions of the license revocation events for commercial banks [22]. Finally, an error matrix was created to analyze the predictive ability of the best model from the three previously proposed variations.

### Selection of Factors

Considering the specific features of the Russian banking system as a research object, based on the works of authors in this area, and also based on publicly available statistics, we have identified three groups of variables that may influence the likelihood of commercial bank bankruptcy: 1) financial reporting indicators reflecting the specifics and results of the banking business; 2) standards established by the Bank of Russia and characterizing compliance with regulatory requirements; 3) macroeconomic indicators for the Russian Federation (*Table 2*).

During the econometric analysis, financial indicators were transformed using a logarithmic scale or converted into binary variables, in the presence of negative values. This was done for

indicators such as income from various sources and profits, for example.

### Standards of Banking Activity

These variables were included in the model due to the importance of the central bank's role in commercial banking activities and the active efforts of the Bank of Russia to improve the national banking system.

The capital adequacy ratio (H1) considers the size of a bank's equity, risk ratios for assets, market risks, and reserves for potential losses in various activities. This high standard indicates the reliability of a bank, especially during unpredictable events. It may also be significant for the revocation of licenses due to economic reasons.

The current liquidity ratio (H3) measures the amount of liquid assets a bank has compared to its liabilities. The average volume of liquid funds available to a bank is an indicator of its sustainability. The standard for the maximum size of large credit risks (H7) is calculated and published by all commercial banks with a universal license, as well as by some previous ones. Despite the development of the banking and financial services market and the growth of its diversity, lending remains the main activity of the Russian banking industry.

### Reasons for License Revocation

For our study, we included all banks that had their licenses revoked during the analyzed period, excluding those that underwent reorganization, ceased to exist due to a decision of shareholders, or were included in the list of systemically important banks identified by the Central Bank of the Russian Federation.

Official press releases from the Bank of Russia and other news announcements were analyzed for each bank that had its license revoked. Based on our research, we identified two main reasons for the revocation of licenses: economic and regulatory. In some cases, it was difficult to determine the exact cause, as it could be due to both economic difficulties and violation of regulations. Therefore,

<sup>5</sup> The article provides the values of the information criteria for three models, the calculation is performed for all.

<sup>6</sup> Pearson and Hosmer's Chi-square tests do not allow comparing competing model specifications with each other; they are already used for the selected best model based on AIC and BIC criteria [20].

Table 3

## Statistics on the Reasons for the Revocation of Banking Licenses

| Year  | Reasons of the Revocation |                              |                 |                                     | Total |
|-------|---------------------------|------------------------------|-----------------|-------------------------------------|-------|
|       | Economic                  | Violation of the legislation | Mainly economic | Mainly violation of the legislation |       |
| 2016  | 19                        | 32                           | 11              | 30                                  | 92    |
| 2017  | 7                         | 18                           | 6               | 16                                  | 47    |
| 2018  | 5                         | 15                           | 5               | 21                                  | 46    |
| 2019  | 3                         | 13                           | 4               | 4                                   | 24    |
| 2020  | 6                         | 8                            | 0               | 1                                   | 15    |
| 2021  | 5                         | 8                            | 2               | 5                                   | 20    |
| Total | 45                        | 94                           | 28              | 77                                  | 244   |

Source: Compiled by the authors based on The memory book. URL: <https://www.banki.ru/banks/memory/> (accessed on 10.04.2024).

we classified the main reason as either economic or regulatory, depending on the circumstances. For example, if a bank resorted to asset withdrawal as a means to conduct questionable transactions from the perspective of the regulator, and if this occurred after the license had been revoked, the reason would be classified as primarily economic.

The most common formulations in the orders of the Bank of Russia when revoking a license for reasons of violation of the law were the following: “falsification of financial statements”, “violation of the law on money laundering”, “withdrawal of assets”, “withdrawal of highly liquid funds”, “questionable transit operations”, “cashing out”, “scheme operations”, “captive nature”, “opaque transactions”, “shadow currency exchange operations”.

Justifying the revocation of the license for economic reasons, such facts as “risky model”, “liquidity deficit”, “problem assets”, “loss of own funds” were stated.

#### Information Sources and Statistical Base

Available financial statements were used to collect statistical data. For existing banks,

data was collected for the period from January 1, 2016, to January 1, 2022. For non-operating organizations, data was limited to the latest reporting date prior to liquidation. All indicators (*Table. 2*) as well as information about non-functioning commercial banks, were found on the websites of the Bank of Russia, the Federal State Statistics Service, and KUAP banking analytics ([kuap.ru](http://kuap.ru)) and the financial marketplace ([banki.ru](http://banki.ru)).

The sample includes 536 banks, of which 292 were active and 244 were liquidated as of January 1, 2022. A total of 2,350 observations were used for calculations.

#### ANALYSIS OF THE RESULTS OBTAINED

An analysis of information regarding the reasons for the revocation of licenses of Russian banks for the period 2016–2021 revealed that of the 317 banks that ceased to exist, only 73 did so voluntarily. The remaining 244 banks had their licenses revoked by the Bank of Russia. The results of the analysis of the reasons for license revocation are presented in *Table 3*.

Further calculations were carried out for three groups of banks: 1) currently operating,



Table 4

## Mean Values of the Compulsory Standards by the Banking Groups

| Bank status                                                                                           | Number of the banks | Capital adequacy ratio (H1.0) | Current liquidity ratio (H3) | Maximum amount of large credit risks (H7) |
|-------------------------------------------------------------------------------------------------------|---------------------|-------------------------------|------------------------------|-------------------------------------------|
| The bank is operating                                                                                 | 292                 | 30.95                         | 265.41                       | 149.01                                    |
| The license was revoked for economic reasons                                                          | 73                  | 23.35                         | 143.25                       | 239.19                                    |
| The license was revoked for reasons related to violation of the legislation of the Russian Federation | 171                 | 24.74                         | 209.26                       | 230.00                                    |

Source: Compiled by the authors based on КУАП (kuap.ru).

2) which have been deprived of their license for economic reasons and mainly due to such factors, and 3) which have been deprived of their licenses for reasons related to violations of legislation and primarily due to these facts. The average values of mandatory banking regulations were calculated for these three groups (see Table 4).

It should be noted that non-compliance with standards is rare, and all banks in the sample fulfilled the H7 standard. However, there are significant differences in average values between groups. For example, banks that have had their licenses revoked have an average capital adequacy ratio that is lower than that of existing banks, while the maximum size of their large credit risks is significantly higher. Then, a number of models of multinomial logistic regression were evaluated, where the dependent variable was the status of a commercial bank: 0 – currently operating, 1 – license revoked for economic reasons, 2 – license revoked for reasons of violation of legislation.<sup>7</sup> Table 5 shows the results of evaluating the coefficients for the three models that were selected as the best based on the AIC

and BIC criteria.<sup>8</sup> The models include, among other things, variables of the squares of the two standards to verify the presence of a nonlinear relationship between these regressors and the probability of revocation of the bank's license.

According to the AIC and BIC criteria, Model 2 is the most appropriate. Based on the Hosmer-Lemeshow test, the null hypothesis was accepted that there are no significant differences between the observed and predicted distribution of the number of revocations of licenses for commercial banks for various reasons.

In the multinomial logistic regression model, the coefficients presented in Table 5 cannot be directly interpreted in terms of their influence on the likelihood of license revocation [23]. The marginal effects, which are usually interpreted in conventional regression as the effect of a one percent change in a predictor variable on the outcome variable, depend on the values of the other predictors, making interpretation difficult. In these cases, it is common to calculate marginal odds ratios to better understand the relationship between the predictors and the outcome [23].<sup>9</sup> The Appendix

<sup>7</sup> Since the analysis was based on a multinomial logistic regression ( $Y_i = j | X_{i,t}$ ) =  $\frac{e^{\beta_j X_{i,t}}}{1 + \sum_{j=1}^K e^{\beta_j X_{i,t}}}$ ,  $j=1..K$ . In our case,  $K=3$

(possible classes of variables). One class (reference or basic) is selected for evaluation and the probabilities of other events are considered relative to it – in our case, license revocation. The base class will be the value of the dependent variable equal to zero, in other words, the availability of a license from a commercial bank [5, 22].

<sup>8</sup> We consistently evaluated multinomial logistic regression for more than 40 models, including all regressors and their combinations in turn, and evaluated AIC and BIC criteria for each model [22]. As a result, three models with the lowest criteria values were selected. The results of the evaluation of the AIC and BIC criteria for all modifications are available on request.

<sup>9</sup> In this case, we are talking about “odd ratios” (marginal odds ratios), which, unlike “marginal ratios” (marginal effects), do not depend on the values of other regressors and can be used as an analysis of changes in the probability of license revocation when the regressor changes. This approach is described in more detail in [22].

Table 5

## Multinomial Logistic Regression Coefficients

| Variable                          | Model 1  |          | Model 2  |          | Model 3  |          |
|-----------------------------------|----------|----------|----------|----------|----------|----------|
|                                   | Reason 1 | Reason 2 | Reason 1 | Reason 2 | Reason 1 | Reason 2 |
| ASSETS                            | -0.765** | 0.002    | -0.074** | 0.01     | -0.772** | -0.006   |
| CASH                              | 0.081    | 0.47*    | 0.08     | 0.476*   | 0.081    | 0.474*   |
| CORR_CB                           | -0.02    | -0.21*   | -0.022   | -0.207*  | -0.019   | -0.206*  |
| CORR_NOSTRO                       | -0.21*   | -0.15*   | -0.21*   | -0.153*  | -0.212*  | -0.153*  |
| BONDS                             | 0.05*    | -0.045*  | 0.05*    | 0.956*   | 0.052*   | -0.043*  |
| STOCKS                            | 0.07**   | 0.04**   | 0.074**  | 0.043**  | 0.074**  | 0.04**   |
| LOANS_ENTITY                      | 0.08     | 0.039    | 0.075    | 0.04     | 0.027    | 0.045    |
| OVERDUE_LOANS_ENTITY              | 0.027    | 0.022    | 0.028    | 0.041    | 0.027    | 0.022    |
| OVERDUE_LOANS_ENTREPR             | -0.027   | -0.067*  | -0.026   | -0.023*  | -0.027   | -0.067*  |
| FUNDS_ENTITY                      | -0.02    | -0.029   | -0.013   | -0.067   | -0.0152  | -0.031   |
| FUNDS_INDIVIDUAL                  | -0.127   | -0.033   | -0.129   | -0.029   | -0.126   | -0.029   |
| DEPOSITS_INDIVIDUAL               | 0.023    | -0.079*  | 0.024    | -0.079*  | 0.024    | -0.08*   |
| DEPOSITS_ENTITY                   | 0.053    | -0.027   | 0.052    | -0.026   | 0.053    | -0.027   |
| OWN_FUNDS                         | 0.413    | -0.376** | 0.384    | -0.397** | 0.413    | -0.383** |
| NET_INTEREST                      | -0.804*  | 0.059    | -0.114*  | 0.06     | -0.116*  | 0.06     |
| NET_COMMISSION                    | -0.004   | 0.041    | -0.003   | 0.045    | -0.005   | 0.043    |
| NET_PROFIT                        | -0.081*  | -0.464   | -0.809*  | -0.047*  | -0.804*  | -0.469*  |
| N1                                | -0.04**  | -0.013   | -0.032** | -0.009   | -0.041** | -0.013   |
| N1*N1                             | 0.001    | 0.001    |          |          | 0.00092  | 0.000224 |
| N3                                | -0.002   | 0.0001   | -0.001   | 0.0004   | -0.001   | 0.0003   |
| N3*N3                             |          |          | 0.00001  | 0.00001  | 0.00001  | 0.00001  |
| N7                                | 0.004*   | 0.003*   | 0.004*   | 0.004*   | 0.004*   | 0.004*   |
| GDP                               | -34.8*   | -30.503* | -34.781* | -30.698* | -34.75*  | -30.675* |
| INCOME                            | -16.58*  | -16.81*  | -16.542* | -16.73*  | -16.56*  | -16.75*  |
| CPI                               | -4.495   | -6.24*   | -4.509   | -6.237*  | -4.491   | -6.23*   |
| constant                          | 27.5     | 24.971   | 27.234   | 24.604   | 27.54    | 24.803   |
| Pseudo R <sup>2</sup>             | 18.84    | 18.84    | 18.84    | 18.84    | 18.86    | 18.86    |
| Number of degrees of freedom (df) | 50       |          | 50       |          | 52       |          |
| AIC                               | 1595.86  |          | 1595.72  |          | 1599.35  |          |
| BIC                               | 1883.64  |          | 1883.50  |          | 1898.66  |          |
| The Hosmer's Lemeshowe Test       | 0.486    |          | 0.476    |          | 0.407    |          |

Source: Calculated by the authors.

Notes: The group of operating banks was regarded as a basic class. Reason 1 – license revocation based on the economic reasons. Reason 2 – license revocation according to the legislative problems. \*, \*\* – factor significance at 1 and 5 percentage levels.

Table 6

**Error Matrix**

| Bank status                                                       | A bank operating (forecast) | A license is withdrawn for economic reasons (forecast) | A license is withdrawn for violation of the legislation reasons (forecast) |
|-------------------------------------------------------------------|-----------------------------|--------------------------------------------------------|----------------------------------------------------------------------------|
| Operating bank (fact)                                             | 55.21                       | 34.96                                                  | 9.84                                                                       |
| The license was revoked for economic reasons (fact)               | 4.23                        | 94.37                                                  | 1.41                                                                       |
| The license was revoked for reasons related to legislation (fact) | 11.76                       | 32.35                                                  | 55.88                                                                      |

Source: Calculated by the authors.

to this article provides estimates of the odds ratio for each of the three models. These estimates can be used to analyze the degree of influence that the considered regressors have on the value being studied. We have limited ourselves to analyzing the direct significance of the factors under consideration and the nature of their impact on the likelihood of license revocation for commercial banks.

In general, when considering the factors that significantly impact the likelihood of a license revocation, it is important to note that the state of the national economy is always a significant factor. During periods of steady economic growth, the chance of license revocation decreases, regardless of the specific reason. Additionally, the increase in investment activity by banks, including investments in stocks and bonds, is an indicator of a stable financial institution. Finally, any decrease in a bank's profits can affect the likelihood of license revocation, irrespective of the cause.

The revocation of a license due to violations of the law is related to several indicators, such as an increase in cash in the asset structure and a decrease in funds on individual accounts. Additionally, a decrease in equity is also a factor that can lead to the likelihood of losing a license due to economic reasons.

According to the estimates obtained, a decrease in the capital adequacy ratio (H1.0)

significantly affects the likelihood of license revocation for economic reasons, but this factor is not significant for the likelihood of license revocation for reasons of violation of legislation. The liquidity ratio (H3) did not turn out to be significant for the entire sample, as well as the modified indicators of the standards H1.0 and H3, taken as factors reflecting their likely nonlinear relationship with the dependent variable. At the same time, an increase in the standard for the maximum size of large credit risks (H7) leads to an increase in the likelihood of license revocation for all the reasons considered.

Finally, an error matrix has been calculated, which allows us to assess the ability to predict the likelihood of license revocation due to various reasons based on the model that has been constructed. This is presented in *Table 6*.

*Table 6* shows that, based on Model 2, we can predict the probability of a commercial bank's license being revoked for economic reasons with an accuracy of 94.37%. However, other cases, such as whether a bank will remain among the current ones or commit an illegal act, are more difficult to predict.

## CONCLUSIONS

In the Russian Federation, the performance of credit institutions is monitored and licenses can be revoked if necessary. The Bank of

Russia has the authority to revoke licenses from commercial banks for various reasons. There are two main categories of reasons that can lead to the revocation of a license: economic and legal violations.

During the relatively stable period between 2016 and 2021, there were 73 cases where banks lost their licenses due to economic issues, and 171 cases where the loss of the license was due to legal reasons.

The factors that influence the likelihood of a license being revoked vary. Banks that have had their licenses revoked due to economic issues are more likely to experience a decrease in assets, funds in correspondent accounts, and profits. Banks that face the threat of license revocation due to legal violations often experience an increase in cash assets and

difficulties accessing funding from individuals and entrepreneurs.

Focusing on banking regulations as factors, we found that not all of the reviewed regulations were significant in the sample under study. The hypothesis stated in the article was partially confirmed. Using the estimates obtained, we were able to demonstrate the importance of monitoring the capital adequacy ratio for banks experiencing financial difficulties. It is also essential for all banks to adjust their standards for the maximum size of large credit risks, as this is a crucial indicator for the banking sector. It may be beneficial for the Bank of Russia to monitor compliance with these standards and their modifications, as well as their approach to critical thresholds.

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*The authors read and approved the final version of the manuscript.*

Appendix

### Odds Ratios for the Model Specifications under Consideration

| Variable              | Model 1  |          | Model 2  |          | Model 3  |          |
|-----------------------|----------|----------|----------|----------|----------|----------|
|                       | Reason 1 | Reason 2 | Reason 1 | Reason 2 | Reason 1 | Reason 2 |
| ASSETS                | 0.464**  | 1.002    | 0.48**   | 1.01     | 0.46**   | 0.993    |
| CASH                  | 1.08     | 1.60*    | 1.08     | 1.61*    | 1.084    | 1.61*    |
| CORR_CB               | 0.979    | 0.809*   | 0.978    | 0.813*   | 0.981    | 0.813*   |
| CORR_NOSTRO           | 0.808*   | 0.858*   | 0.807*   | 0.585*   | 0.809*   | 0.859*   |
| BONDS                 | 1.094*   | 1.095*   | 1.094*   | 1.095*   | 1.094*   | 1.095*   |
| STOCKS                | 1.078**  | 1.043**  | 1.076**  | 1.043**  | 1.077**  | 1.04**   |
| LOANS_ENTITY          | 1.07     | 1.03     | 1.078    | 1.04     | 1.081    | 1.049    |
| OVERDUE_LOANS_ENTITY  | 1.027    | 1.023    | 1.028    | 1.023    | 1.027    | 1.023    |
| OVERDUE_LOANS_ENTREPR | 0.973    | 0.935*   | 0.974    | 0.935*   | 0.973    | 0.935*   |
| FUNDS_ENTITY          | 0.984    | 0.971    | 0.987    | 0.968    | 0.984    | 0.969    |
| FUNDS_INDIVIDUAL      | 0.881    | 0.967    | 0.878    | 0.971    | 0.882    | 0.971    |
| DEPOSITS_INDIVIDUAL   | 1.03     | 0.923*   | 1.02     | 0.923*   | 1.023    | 0.923*   |

## Appendix (continued)

| Variable        | Model 1               |                       | Model 2               |                       | Model 3              |                       |
|-----------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|-----------------------|
|                 | Reason 1              | Reason 2              | Reason 1              | Reason 2              | Reason 1             | Reason 2              |
| DEPOSITS_ENTITY | 1.05                  | 0.973                 | 1.052                 | 0.97                  | 1.054                | 0.972                 |
| OWN_FUNDS       | 1.152                 | 0.686**               | 1.468                 | 0.672**               | 1.511                | 0.681**               |
| NET_INTEREST    | 0.089*                | 1.06                  | 0.892*                | 1.06                  | 0.891*               | 1.062                 |
| NET_COMMISSION  | 0.995                 | 1.04                  | 0.996                 | 1.04                  | 0.996                | 1.044                 |
| NET_PROFIT      | 0.447*                | 0.628                 | 0.445*                | 0.624*                | 0.447*               | 0.625*                |
| N1              | 0.959**               | 0.987                 | 0.967**               | 0.991                 | 0.959**              | 0.987                 |
| N1*N1           | 1.001                 | 1.001                 |                       |                       | 1.001                | 1.001                 |
| N3              | 0.998                 | 1.001                 | 0.9985                | 1.00                  | 0.998                | 1.00                  |
| N3*N3           |                       |                       | 1.001                 | 1.001                 | 1.001                | 1.001                 |
| N7              | 1.004*                | 1.001*                | 1.004*                | 1.004*                | 1.004*               | 1.004*                |
| GDP             | 0.00001*              | 0.00001*              | 0.00001*              | 0.00001*              | 0.00001*             | 0.00001*              |
| INCOME          | 0.00001*              | 0.00001*              | 0.00001*              | 0.00001*              | 0.00001*             | 0.00001*              |
| CPI             | 0.011                 | 0.002*                | 0.011                 | 0.001*                | 0.011                | 0.001*                |
| constant        | 9.08*10 <sup>11</sup> | 6.65*10 <sup>10</sup> | 6.76*10 <sup>11</sup> | 4.85*10 <sup>10</sup> | 9.1*10 <sup>11</sup> | 5.91*10 <sup>10</sup> |

Source: Calculated by the authors.

Notes: The presented odds ratios can be interpreted in terms of the effect on the probability of an event occurring compared to the baseline level. For example, according to Model 1, a 1% increase in assets reduces the likelihood of license revocation due to economic reasons by 53.6%. (1–0.464) – the significance of factors at the 1st and 5th percentile levels.

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JEL E31, E52, F31, F51, G21

# Current Currency and Financial Issues of Iran

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## ABSTRACT

**The study** focuses on Iran's monetary and financial challenges between 2018 and 2025, which are caused by a complex combination of external and internal factors that have impacted the country's economic situation. External factors, such as sanctions imposed on Iran, have restricted its access to global capital markets and contributed to the country's financial difficulties. Internal factors like the specific functioning of the banking system, institutional limitations, and monetary policy decisions, including the use of multiple exchange rates, also contribute to these challenges. **The purpose** of this study is to investigate the role of both external and internal factors in the emergence and evolution of Iran's monetary and financial challenges between 2018 and 2025. We employ **methods** of comparative and structural analysis as well as statistical analysis of macroeconomic data sourced from official government reports. Through our analysis of these economic issues, we have been able to draw the following conclusions. Firstly, international sanctions, restrictions on oil exports, the disconnection of the banking sector from global payment systems, and the blocking of assets have significantly reduced the space for maintaining macroeconomic stability and weakened the stability of the national currency. Secondly, internal imbalances, including inefficient currency regulation, vulnerable banking systems, high levels of problematic assets, and limited independence of financial institutions, have increased the impact of external shocks and contributed to the formation of persistent inflation and reduced confidence in the Rial. Monetary and financial instability in Iran is caused by external restrictions imposed on internal institutional and structural vulnerabilities. To maintain macroeconomic stability in modern times, it is essential to adapt to external challenges while also implementing consistent institutional changes that affect monetary policy, the transparency and competitiveness of the foreign exchange market, and the organization of the banking sector. The results of this study have **practical value**, as they provide a systematic approach to understanding the dynamics of monetary aggregates, inflation, and exchange rates in Iran. By identifying the relationships between external and internal factors that contribute to monetary and financial instability, we can develop solutions to improve the country's financial situation and conduct comparative and applied research in global finance.

**Keywords:** Iran; financial instability; international sanctions; banking system; monetary policy; Islamic finance; inflation; exchange rates

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## INTRODUCTION

Iran's current monetary and financial challenges are influenced by several factors, both external and internal. In a broader sense, these constraints are related to the global imbalances that characterize the modern global financial system [1–3]. This phenomenon raises the question of the dual nature of imbalances affecting the economic stability of developing countries in recent years.

The scientific and expert literature on Iran often focuses on the first group of factors — the effects of international sanctions. It is important to recognize that external constraints play a significant role in shaping Iran's economic and financial issues. In several important international reports, such as the Iran Economic Monitor from the World Bank, sanctions are seen as a major macroeconomic factor. Thus, according to World Bank data for 2023, the tightening of sanctions after 2012, and in particular after the US withdrawal from the nuclear deal in 2018, has been the main driver of the devaluation of the Iranian rial, rising inflation, and the deterioration of the banking sector.<sup>1</sup> This is supported by the publications of M. Kandil and I.A. Mirzaie [4], who emphasize that sanctions restrictions form the boundaries for macroeconomic policy in Iran. The emphasis on external constraints is also characteristic of the work of H. Hemmati, M. Tabrizy, Y. Tarverdi [5], who demonstrate that the dynamics of inflation and the exchange rate in Iran closely correlate with periods of tightening of the sanctions regime. M. Hassanzadeh and S. Mousavi [6] in their empirical assessments emphasize the role of sanctions as a trigger of currency and banking crises. The emphasis on sanctions is also present in the works of D. Laudati, M.H. Pesaran, M.R. Farzanegan, E. Batmanghelidj, and N. Bajoghli, among others, who analyze in detail the impact of sanctions on key macroeconomic indicators,

the exchange rate, and the financial sector in Iran [7–9].

It should be noted that the choice of the time period from 2018 to 2025 in this article is due to the transition of the Iranian economy to a new stage of monetary and financial instability after the US withdrawal from the nuclear deal and the increased sanctions pressure. However, data from earlier periods is also used in some cases to complete the analysis.

Russian authors also mostly study the impact of sanctions and external restrictions on Iran's monetary and financial systems [10–17]. This topic has become even more relevant after the imposition of large-scale sanctions on Russia, leading to increased interest in Iran's experience of adapting and surviving financially in conditions of international isolation.

However, Iran's experience shows that internal financial imbalances play a significant role due to the specific features of its national regulation, institutional constraints, and structural characteristics of its banking system. In recent years, several studies have focused on these internal constraints and institutional characteristics that affect the stability of the Iranian financial system [18; 19, p. 18–20]. Important material on the banking sector and the impact of macroeconomic shocks on credit risk can be found in the work of F. Abdolshah, S. Moshiri, and A. Worthington. Their research shows that the vulnerability of the banking sector is largely determined by internal factors, such as credit policy, and regulatory deficiencies [20]. A study by M. Vahabi is worth noting, in which the author examines the impact of the Islamic Revolution and political decisions on the economic structure and resource redistribution mechanisms, with a focus on internal contradictions and imbalances within the country's financial system [21]. These studies show that external shocks can often trigger crisis situations, but it is the underlying imbalances created by national monetary policies and the specific features of the banking system, with its concentration of state-owned capital, that

<sup>1</sup> World Bank. Iran Economic Monitor, Spring 2023. Washington, D.C.: World Bank; 2023:18.

determine the severity and duration of these monetary and financial shocks. These considerations have led to the uniqueness of our research — its **scientific novelty** lies in the systematic analysis of up-to-date statistical data on monetary aggregates, inflation, and exchange rates. Additionally, the emphasis is placed on internal institutional and structural imbalances within the economy.

In addition, despite the fact that most of the work was done in 2025, subsequent events in Iran did not reduce the relevance of the issues raised, and further emphasized the importance of internal factors of monetary and financial instability. Thus, the validity of the chosen analytical structure of this article is confirmed: considering external constraints as a key trigger allows us to correctly interpret the evolution of internal problems, and comparing both factors reveals their mutual impact on financial stability. This method helps us to deeply understand the specifics of Iran's monetary and financial difficulties.

### EXTERNAL FACTORS

International sanctions imposed since 2012 and reintroduced with renewed vigor after Donald Trump's withdrawal from the nuclear deal have significantly limited the country's ability to access global capital markets, and, as a result, to maintain macroeconomic stability [15, p. 162]. Disconnecting the national banking system from SWIFT, blocking foreign assets, and restrictions on oil exports have become key instruments of pressure on the Iranian economy [16]. The analysis of these areas appears to be the most relevant at the initial stage of considering external factors.

One of the most significant consequences of international sanctions was the exclusion of Iranian banks from the SWIFT interbank messaging system [12]. This measure, first introduced in 2012 and re-introduced after 2018, has severely limited Iran's ability to conduct cross-border financial transactions. The ban on access to global payment channels has made it difficult for Iranian companies to

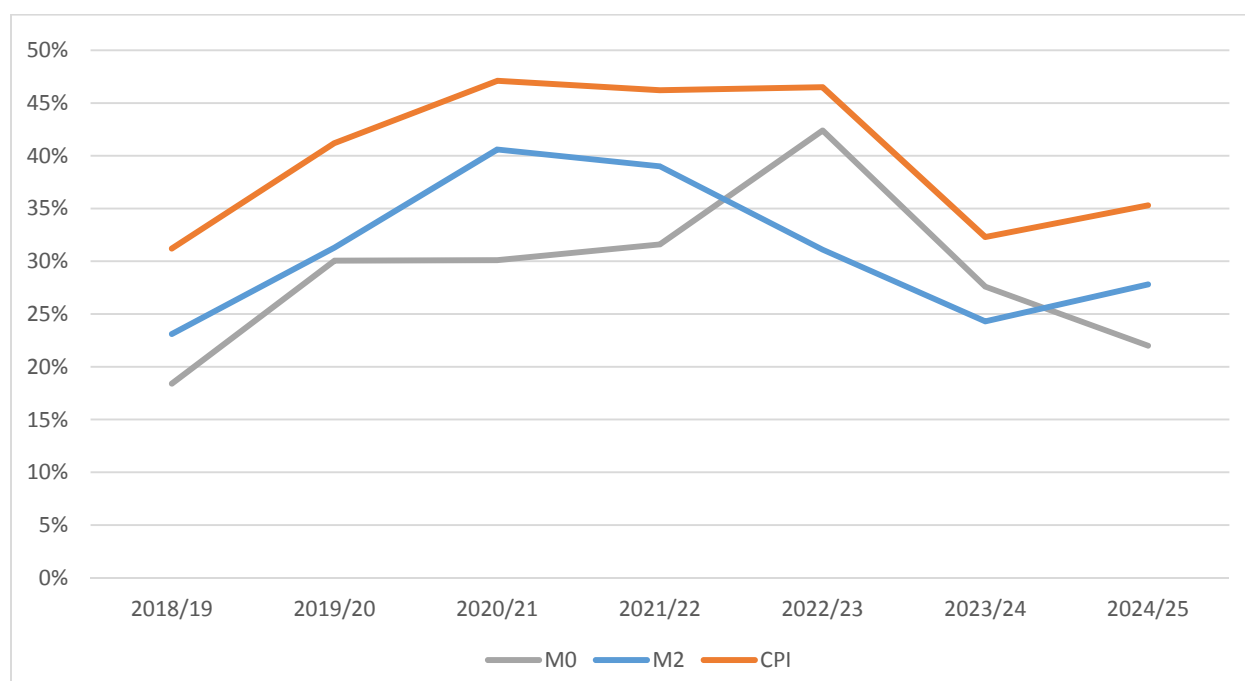
settle accounts with foreign partners, leading to increased transaction costs and forcing them to look for alternative payment methods. As a result, a significant portion of foreign economic activity has been forced to switch to less transparent and less reliable methods. Despite the fact that some of these methods are still used separately, they are not very effective. Barter transactions, for example, have become widespread in trade with Russia, where oil is supplied in exchange for machine-building products or food.<sup>2</sup> However, these transactions are limited in nature and have not been very successful. The practice of settling in gold also developed in a similar manner and became somewhat widespread in the early 2010s. However, the United States responded quickly by expanding control over the supply channels of precious metals.<sup>3</sup> At the same time, settlements through third countries were also used, mainly involving intermediary financial institutions in countries such as Afghanistan, Türkiye, Iraq, and the United Arab Emirates. This scheme allowed Iran to avoid direct contact with banks in countries that enforce sanctions. In this context, the hawala system, which relies on off-balance transfer channels and personal agreements between parties, has become widespread [22, p. 46–47]. In general, although alternative financial channels may not fully replace traditional ones, they can partially or even completely compensate for some of the negative effects of sanctions and help maintain the minimum level of foreign economic activity required.

Next, the blocking of foreign assets should be considered. This measure has started to have a long-term negative impact on Iran's monetary and financial system. Under the sanctions regime, Iran has lost full access to a significant

<sup>2</sup> Natural exchange: why Russia imports oil from Iran — Forbes. ru. URL: <https://www.forbes.ru/biznes/356741-naturalnyy-obmen-zachem-rossiya-importiruet-neft-iz-irana> (accessed on 07.06.2025).

<sup>3</sup> Exclusive: Turkey-to-Iran gold trade wiped out by new U.S. sanction. Reuters. URL: <https://www.reuters.com/article/world/exclusive-turkey-to-iran-gold-trade-wiped-out-by-new-us-sanction-idUSBRE91E0IN> (accessed on 07.06.2025).





**Fig. 1. The Dynamics of the CPI Indicator and the Monetary Aggregates M0 and M2**

Source: CBI. URL: <https://cbi.ir/category/3392.aspx> (accessed on 07.06.2025).

Note: The periods are given according to the Iranian calendar. For 2024–2025, the data cover the period from February 2024 to February 2025.

portion of its foreign exchange earnings, mainly from oil exports. Funds accumulated in bank accounts in countries such as China, India, and South Korea can only be used with permission from the relevant countries and exclusively for specific categories of imports.<sup>4</sup> According to some sources, the amount of frozen assets has reached \$ 100 billion in some years, creating an imbalance between nominal foreign exchange earnings and actual liquidity. This, in turn, has led to restrictions on foreign trade and the destabilization of the domestic foreign exchange market.<sup>5</sup>

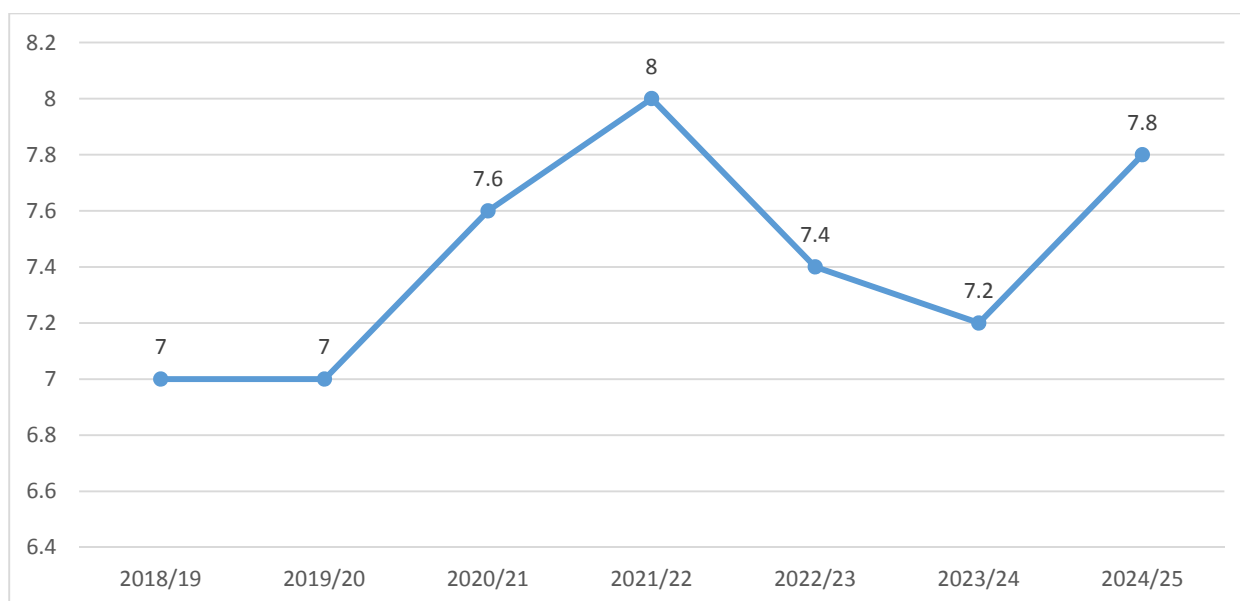
In addition to disconnecting Iran from SWIFT and blocking its assets, one of the most significant sanctions measures was a restriction on oil exports. Oil revenue traditionally forms the basis of foreign exchange earnings for the country, playing a crucial role in financing

the budget and maintaining the stability of the exchange rate. With limited access to oil revenue, the authorities have few tools available to maintain macroeconomic stability, putting pressure on inflation and encouraging the monetization of budget deficits. To better understand the relationship between external shocks, monetary expansion, and inflation, we can look at Fig. 1, which shows the growth rates of M0 and M2 aggregates, as well as the CPI index from 2018 to 2024.

The graph clearly shows that since 2018, inflation in Iran has consistently been at high rates, outpacing the growth of the money supply. This is particularly noticeable during the period under review, when the M2 aggregate grew at a slower rate than inflation. At the same time, the fastest expansion of M0 and M2 occurred in 2020 and 2022, due to maximum sanctions and a pandemic shock. The state attempted to compensate for the lack of foreign exchange reserves by borrowing domestically and issuing more money. In particular, the M0 aggregate grew by over 30% annually, and in 2022–2023 it increased above 40%. This reflects the scale

<sup>4</sup> Shargh Daily. URL: <https://www.sharghdaily.com/بخش-اخبار-رد-دهش-هکولب-ی-اه-ل-وپ-ن-اب-حاص-6/896274-ت-س-ای-س-چ-را-خ-ز-ا-دن-رادن-اه-ل-وپ-ن-ی-ا-ت-ی-ع-ض-و-ن-ا-ز-ی-م-م-ال-ع-ا-ه-ب-ی-ل-ی-ام-ت-ر-وش-ک-ز-ا> (accessed on 07.06.2025).

<sup>5</sup> Tabnak. URL: <https://www.tabnak.ir/fa/news/1302836> (accessed on 07.06.2025).



**Fig. 2. The Dynamics of the Money Multiplier Values**

Source: CBI. URL: <https://cbi.ir/category/3392.aspx> (accessed on 07.06.2025).

Note: The periods are given according to the Iranian calendar. For 2024–2025, the data cover the period from February 2024 to February 2025.

of monetary expansion. The monetization of the budget deficit through the Central Bank led to a situation known as the “inflation tax”, which is described in the scientific literature [23, p. 638], that is, the redistribution of income in favor of the state due to the depreciation of cash and savings of citizens. At the same time, the CPI remained in the range of 45–47%, which indicates a steady inflationary inertia. The dynamics of 2023–2024 deserve special attention. Despite some disinflation caused by the transition to a more flexible exchange rate and the relative stabilization of exports, the price level remains significantly higher than the monetary growth rate. It is also important to note significant fluctuations in the monetary multiplier (Fig. 2).

From 2019 to 2021, the value of the money multiplier increased from 7 to 7.6 (M2 increased by about 40%, with an increase in M0 of 30%), indicating the expansion of lending. On the contrary, from 2022 to 2023, the value decreased from 8 to 7.4 (an increase of M2 of 31% was significantly lower than growth in the base M0 of about 42%). This clearly indicates a contraction in the credit multiplier, likely due to tighter banking regulations, directive

lending and funding budget deficits.<sup>6</sup> More detailed analysis is required here. According to the Central Bank of Iran’s report,<sup>7</sup> the main contributor to the increase in the monetary base in 2023–2024 was claims on banks. This is confirmed by the World Bank’s graph.<sup>8</sup> On the contrary, the net claims on the government were negative during the same period. This can be interpreted as an absence of direct monetary financing of the budget at first glance. However, such financing can be carried out indirectly through the provision of liquidity to banks. The funds received are then used, including for the purchase of government bonds or participation in quasi-budgetary programs. This mechanism of hidden budget financing through the banking sector may indicate the transformation of classical fiscal dominance into a structural and indirect form. Consequently, such a structure can contribute to the compression of the

<sup>6</sup> World Bank. Iran Economic Monitor, Spring 2024. Washington, D.C.: Bank; 2024:11.

<sup>7</sup> Central Bank of Iran. URL: <https://cbi.ir/simplelist/30492.aspx> (accessed on 07.06.2025).

<sup>8</sup> World Bank. Iran Economic Monitor, Spring 2024. Washington, D.C.: Bank; 2024:12.

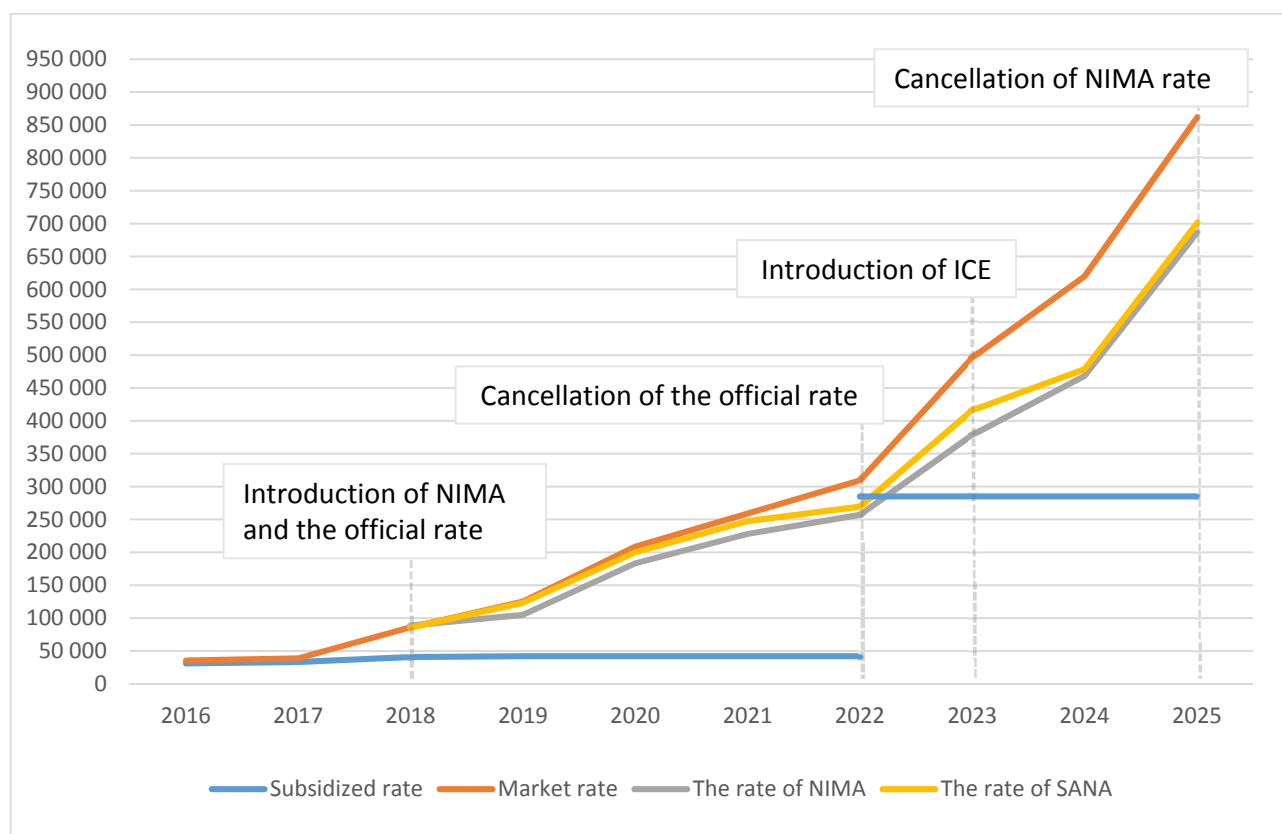


Fig. 3. The Dynamics of the Iranian Rial to US Dollar Exchange Rates

Source: CBI, TGJU, ICE. URL: [https://cbi.ir/exrates/rates\\_en.aspx](https://cbi.ir/exrates/rates_en.aspx); <https://www.tgju.org/>; <https://ice.ir/market-view/زرارازاب> (accessed on 07.06.2025).

monetary multiplier since liquidity does not grow into an equivalent increase in deposit supply. Thus, the nature of the dynamics of these indicators suggests the underlying nature of inflation in Iran. External constraints trigger the mechanism, but the main pressure on prices is formed internally through fiscal dominance.

### INTERNAL FACTORS

As you can see, sanctions on oil exports have become one of the key triggers for structural inflation in the Iranian economy. Since maintaining price stability largely depends on the effectiveness of currency regulation, it is advisable to analyze the internal mechanisms of monetary and financial policies. One of the systemic problems in this case is the exchange rate policy, which has been characterized by multiple exchange rates and administrative opacity for a long time. In recent years, several exchange regimes have operated in Iran simultaneously: the subsidized exchange rate

(official exchange rate), NIMA platform rate, SANA cash rate and free market rate (Fig. 3).

Each of these systems had a different range of application, level of government involvement, and structure of participants. In response to the currency crisis that followed the sanctions in 2018, a rate of 42,000 rials to the dollar was introduced. Officially, the exchange rate was announced and was intended to be the same for all foreign exchange market participants, but due to limited currency availability, it actually began to be applied only to a limited number of importers of essential goods. In the same year, the NIMA system (Persian: “samane-e nima” — integrated system of currency transactions) was launched, designed for exporters and large importers.<sup>9</sup> Through the platform, exporters were required to sell a portion of their foreign exchange earnings, while importers could

<sup>9</sup> Iran's Economy and the Burden of Multiple Exchange Rates. Atlantic Council. URL: <https://www.atlanticcouncil.org/blogs/iransource/irans-economy-and-the-burden-of-multiple-exchange-rates> (accessed on 07.06.2025).

purchase foreign currency at a rate that fell between the official rate and the market rate. Despite some degree of liberalization, the system did not fully function as a market-based platform, as the exchange rate was still determined by administrative measures.<sup>10</sup> Against the background of the market rate, which was several times higher than the official rate, a “breeding ground” for arbitrage and speculation was created [24]. In addition, in 2018, the Central Bank introduced the SANA system, which stands for “samane-e nazarat-e arz” in Persian, or “currency supervision system”. This system records transactions made by exchangers and publishes the average rate of cash transactions.<sup>11</sup> The SANA exchange rate is a weighted average of the purchase and sale of currency by licensed exchangers and actually reflected the average exchange rate for individuals. In 2022, the Iranian authorities abandoned the 42,000 rials exchange rate, replacing it with a notional level of 285,000 rials, which is also used to subsidize critical imported goods.<sup>12</sup> However, this did not mean the abandonment of exchange rate fragmentation: the SANA rate continued to be used for cash transactions, while the free rate was used in informal transactions, still determining the actual level of inflation expectations. The launch of the Currency and Gold Exchange Centre (ICE) in 2023 was a turning point. This center was established to ensure a transparent and fair market by publicly disclosing quotes, exchange rates, and forming prices based on supply and demand.<sup>13</sup> Currently, ICE has four sections for the foreign exchange market (cash, transfers, currency derivatives, and new types of foreign exchange contracts), and two sections for the gold market (spot trading and futures market). The cash currency section allows major world currencies to be traded in cash

to meet the various needs of individuals, such as tuition fees, medical treatments, business trips, and other expenses. The transfer section is designed to facilitate the work of exporters and importers. Currency derivatives segments are also in operation, covering futures, options, swaps, foreign-currency bonds, including murabaha instruments, and certificates of deposit. Transactions in gold bars and coins are conducted on the gold market, alongside gold-based derivative instruments.

As a result of ICE’s activities, the NIMA platform gradually began to lose importance and was completely abolished (or rather, integrated into the ICE platform)<sup>14</sup> in 2025. The same applies to the SANA exchange rate: the former system is not actually used, and exchange offices now operate through the ETS (Electronic Trading System) on the ICE platform,<sup>15</sup> where the cash exchange rate is directly quoted. As for the official exchange rate, which was previously published on the Central Bank’s website, at the moment it is a weighted average indicator, while the main reference is the rates published on the ICE platform.<sup>16</sup> These changes indicate a gradual transition to a more market-based exchange rate system; however, the government’s influence on the foreign exchange market remains significant.

As part of the consideration of internal factors, it is necessary to analyze the banking sector in more detail. This is where the problem of non-performing loans (NPL) comes to the fore. According to the World Bank report, in 2021–2022, the average level of problem loans reached 16.2%, while this estimate does not cover extended (restructured) loans, which make up a significant share of the portfolio in Iran. This dynamic is explained by an insufficiently rigorous assessment of credit risk, the provision of loans based on non-financial criteria, as well as weak supervision

<sup>10</sup> Iran’s Rial Gains Slightly As Forex Website Reopens. Iran International. URL: <https://www.iranintl.com/en/202504309977> (accessed on 07.06.2025).

<sup>11</sup> TGJU. URL: <https://www.tgju.org/sana> (accessed on 07.06.2025).

<sup>12</sup> IRNA. URL: <https://www.irna.ir/news/84984262> (accessed on 07.06.2025).

<sup>13</sup> Iran Currency Exchange (ICE). URL: <https://ice.ir/about-us> (accessed on 07.06.2025).

<sup>14</sup> Tasnim News Agency. URL: <https://tasnimnews.ir/fa/news/1403/09/22/3218047> رذا-24-هبنش-زا-امین-رال-د-خرن-فدح (accessed on 07.06.2025).

<sup>15</sup> Financial Tribune. URL: <https://financialtribune.com/articles/business-and-markets/115822> (accessed on 07.06.2025).

<sup>16</sup> Central Bank of Iran. FX Market Rate. URL: <https://fxmarketrate.cbi.ir> (accessed on 07.06.2025).



by the Central Bank. The systemic problem of substandard assets is aggravated by the low level of capital adequacy (CAR) in most Iranian banks — more than 70% of banks do not meet capital adequacy requirements, and almost half of credit institutions demonstrate a negative CAR [25, p. 12]. Inflation and revaluation of assets exacerbate the capital deficit, creating bankruptcy risks and an additional burden on the state budget, especially since a significant amount of lending in the banking system is still of a directive nature [25, pp. 11–12]. The Central Bank of Iran continues to be dependent on the executive branch, as evidenced both in the appointment of its management and in the strategic priorities of its monetary policy. Corporate governance problems exist not only at the CBI level, but also in commercial banks as a result of significant government influence, low standards of risk management and weak procedures for selecting senior personnel [25, pp. 13–15]. The quality of supervision by the CBI continues to be insufficient: reporting under IFRS standards is not carried out, which makes it difficult to identify risks, and regulatory measures are often formal [25, p. 25]. Despite this, there are positive developments, for example, the CBI has revised the reporting system in accordance with the international standards of MFSMCG 2016 (Monetary and Financial Statistics Manual and Compilation Guide 2016).<sup>17</sup> A number of experts also speak about a feature related to the activities of the Central Bank, namely, the role played by the principles of Islamic finance, since they have created a strong link between the real and financial sectors, which leads to a redistribution of risks between them and increases the vulnerability of the economy as a whole [25, p. 13]. However, there is reason to believe that this connection between the banking and real sectors may be the result of the high concentration of state capital in banks. In fact, this raises questions about the consistency with the principles of Sharia [26,

pp. 145–149]. In Iran's banking system, Islamic norms are often formal in nature: most of the credit and investment products are structured according to Islamic contracts, but, in fact, they reproduce classic lending schemes with pre-agreed profitability and minimization of banking risks. A number of studies have noted that banks charge fees similar to interest under a different legal name [27, 28]. Under conditions of external pressure and sanctions, the “fictitious” nature of Islamic finance and its similarity to conventional banking can increase the flexibility of the financial system and act as a kind of adaptability mechanism that allows for the use of a wide range of tools and supports lending to the real economy, while formally complying with legal requirements.

In general, Islamic banking in Iran has several important differences from that of other Islamic countries, which may be beneficial [29].

## CONCLUSIONS

The analysis of Iran's monetary and financial problems in 2018–2025 shows that their origin is due to a complex interaction of external and internal factors. International sanctions, restrictions on oil exports, the disconnection of the banking sector from global payment systems, and the blocking of assets have seriously narrowed the space for maintaining macroeconomic stability and jeopardized the stability of the exchange rate. However, internal imbalances also play a significant role, including inefficiency of currency regulation, vulnerability of the banking system, a high level of problem assets, and limited independence of financial institutions.

An analysis of the dynamics of monetary aggregates and inflation confirms that shocks initiated from outside were largely amplified by internal institutional and structural problems. The growth of the money supply and monetization of budget deficits against the backdrop of a limited inflow of foreign exchange led to sustained inflation and devaluation. Peculiarities of Islamic finance, corporate governance, and concentration of

<sup>17</sup> IMF (2016) Monetary and Financial Statistics Manual and Compilation Guide. 418 p.



capital in state-owned banks reinforce these trends. Monetary and financial instability in Iran can be attributed to external shocks imposed on internal vulnerabilities, and solving this problem requires advances in foreign policy as well as institutional reforms. With the comprehensive modernization of monetary policy, increased transparency and competitiveness in the foreign exchange

market, restructuring of the banking sector, and the introduction of modern regulatory standards, it is possible to ensure the sustainable restoration of confidence in the national currency and reduce inflationary risks. Thus, Iran's financial stability depends on its ability to simultaneously neutralize external constraints and eliminate internal structural problems.

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# Foreign Direct Investment in Russia: How Can It Be Made More Effective for the Country?

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## ABSTRACT

**The subject** of this study is the financial aspects of international industrial cooperation. **The aim** of the work is to identify the motivations of foreign companies to engage in production activities in the Russian Federation and develop proposals to improve its economic efficiency. **The research methodology** includes the use of theories of international economic cooperation, as well as empirical-statistical and qualitative analysis. **The study found** that countries with large and solvent markets, such as China and Russia, are attractive to foreign direct investment (FDI). Multinational enterprises (MNEs) operating in these countries often use more advanced production technologies than they would in other countries. As a result, the rate and amount of profit from producing goods in these countries is typically higher than exporting the same goods from the manufacturing country. The paper **argues** that these circumstances may override MNEs' desire to maintain control over imported technologies if the authorities of the FDI host country insist on partnership with a local company in the enterprise established by the MNE. A condition of such partnership should be the obligation of the MNE to transfer its technology used in production to the local company, with the right for the latter to freely use and further develop it. Although such a requirement did not exist for foreign companies in the Russian Federation previously, the study suggests that foreign MNEs are likely to consider this exchange acceptable and beneficial. Establishing a condition for foreign MNEs to carry out production activities in the Russian Federation in partnership with local businesses would allow Russian companies to more quickly adopt new technologies. This would contribute to enhancing the efficiency of the Russian economy. Additionally, society would benefit from higher-quality products that are created with the participation of local capital, meeting the demands of consumers.

**Keywords:** joint venture; technology transfer; economic development; profit maximization; compromise between MNEs and FDI host country

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## INTRODUCTION

The refusal of many foreign companies to supply goods and services to the Russian Federation, as well as the curtailment of their production activities in Russia with the termination in most cases of the right to use relevant technologies, created serious imbalances in supply and demand within the Russian Federation after 2022. This was not only due to a lack of finished goods produced by Western companies, but also because of disruptions in international supply chains for raw materials, components and materials used in the production of various items within the country. These issues immediately had a negative effect on the inflation rate in the country [1] and on the exchange rate of the national currency.

Currently, the general approach of Russian business and authorities is that they are not opposed to the return of Western industrial corporations, if this will contribute to the country's technological development and will not harm Russian enterprises that have managed to occupy vacant market niches during the sanctions period. Without disputing the correctness of this view, the question nevertheless arises: on what terms will Western companies operate? As before, will these be mainly 100% subsidiaries of foreign multinational enterprises (MNEs), or will they be required to have a Russian partner in the capital with the transfer of technologies brought-in by foreign companies with the right to further develop them on their own?

The first option was effective for foreign companies, which were able to quickly occupy market segments where Russian companies were technologically behind, financially weaker, and less skilled at marketing their products. This led to the downfall and collapse of many Russian businesses, which proved uncompetitive in comparison to foreign MNEs and were unable to develop their own production. Joint ventures were formed, but there were no obligations for foreign companies to transfer relevant technology to their Russian partners.

The purpose of the study is to find a balance between the interests of the state, foreign corporations and Russian companies, if foreign MNEs wish to establish production facilities in the Russian Federation, in order to increase the efficiency of the Russian economy. The main focus of the work is on analyzing the situation in non-resource industries and, above all, in the manufacturing industry of Russia.

### THE THEORETICAL FOUNDATIONS OF FOREIGN DIRECT INVESTMENT (FDI)

Theoretical ideas about importance of locating production facilities outside national borders for the economy of a country from which capital is exported and for a country receiving FDI have changed, as the scale of establishment of foreign industrial facilities has increased, and the authorities have recognized their significance for the national economy. Gradually, attention of scientists began to be attracted not only to intercountry trade and investment relationships, but also to the activities of MNEs, which were the initiators of establishing production facilities in countries whose jurisdiction differed from the location of their headquarters.

J. Dunning was the first to study the impact of FDI on their host country using the example of investments by American companies in the UK manufacturing industry, that, as he found out [2], contributed to the growth of local industry and helped the United States to look for new markets during the economic recovery of Western Europe in the 50s of the XX century. In 1980 Dunning proposed his concept of the “eclectic paradigm”

[3], which still serves as a guide for economists to study the motivation of industrial corporations for international expansion. This motivation is determined by three key factors:

- competitive advantages in technology and product quality compared to analogues of companies in the host country (“ownership advantage”);
- opportunities to create added value due to availability of required resources and more favorable business conditions in the host country (“location advantage”);
- the ability of in-house intermediate production in the host country to build a vertically integrated global value chain within the corporation (the “internalization advantage”).

This concept was largely based on the provisions of S. Hymer’s 1960 doctoral dissertation [4], which concluded that firms operate in a foreign country in order to fully appropriate income from certain abilities they possess. They choose this type of activity because market imperfections prevent profit maximization unless the firm exercises control over its operations. A certain amount of direct investment in a foreign enterprise is required to acquire ownership and gain control. The significance of S. Hymer’s work is also determined by the fact that he was the first to move away from the postulates of neoclassical theory. At that time, this theory believed that a company’s foreign activity was carried out only through trade and was determined by dynamics of exchange rates and differences in interest rates on loans in different countries.

R. Vernon’s idea [5] about the preferences of MNEs to produce goods domestically, and to export or import, depending on the stage of its life cycle, proved to be very viable. The practice of American corporations, that was then confirmed by MNEs from other countries of “Triad” (the USA, Western Europe and Japan), indicates that new products are developed and manufactured in the country of their headquarters and at this initial stage it is expedient only to export them. As the technology stabilizes, manufacturing is transferred to foreign branches of MNEs to close



demand in the respective countries, and only with standardization of the technology and loss of novelty of the product, when the increased added value associated with these factors decreased or disappeared, its production is transferred to other companies, and the demand of the domestic market for MNEs is provided by the import of the product.

A. Ragman and A. Verbeke prove [6] that international expansion through wholly owned MNE subsidiaries occurs when the benefits of production within a vertically integrated MNE structure (in terms of R&D and production, as well as the exploitation and expansion of company-specific advantages) outweigh the advantages associated with alternative modes of entry into other countries' markets (export, licensing or joint ventures). At the same time, MNEs arbitrage the benefits of internalization between different countries hosting FDI. The existing institutional and cultural differences with the country exporting capital lead MNEs, as pointed out by J. Hillemann and M. Gestrin [7], to additional costs, the need to compensate for which is another argument in favor of owning foreign production and controlling their advantages.

A. Ragman, A. Verbeke and K.T.K. Nguyen [8, p. 759] draw attention to the fact that "MNE's existence is not caused by monopolistic advantages leading to entry barriers and consumer exploitation, but by its efficiency properties, i.e., its capacity to reduce transaction costs when replacing an inefficient or non-feasible arm's length transaction in the market ... with an internal transaction, inside the firm, especially in the context of transferring intermediate (mostly knowledge-based) output across borders".

Considering the expediency of FDI in the framework of intercountry relations, K. Kojima believes [9, p. 6] that MNE FDI in new market economies should play the role of a "tutor". In other words, the main role of FDI is to transfer technology through workforce training, management and marketing from developed industrial countries to developing countries in order to transfer an "superior production

function" in order to replace an inferior one in the host country. In his opinion, FDI will gradually have a positive impact on the target and related industries in the host country and make it possible for local capital to create competitive firms, ultimately improving the production function of the entire industry in question and its competitiveness in international markets. When the process is completed, it will be possible to say, he believes, that the new technology has indeed been transferred and installed in the host country.

These conclusions of K. Kojima are somewhat inconsistent with theoretical ideas about the role of developing countries receiving FDI in the international division of labor and seem idealistic in terms of the goal of equalizing the level of their technological development with those of the countries exporting capital. For FDI host country, it is certainly important to fill the market with goods produced domestically (which is often more beneficial than importing them), increase employment through the people working at enterprises established by foreign investors, improve their skills, receive additional taxes (especially in light of recently agreed global minimum corporate taxes on MNE activities in foreign jurisdictions), and other things. With that, "location advantages" and preferences of MNEs may change, and their activities in a given country may become more unprofitable or less interesting for other reasons, leading to their closure. Then, all the above benefits for the host country disappear. When a MNE manufacturing unit is sold to a local business, the technologies used in the production are not always sold as well. Besides, supplies of key materials and components, without which the final product loses its properties, are often limited, as happened, for example, in the Russian Federation after 2022.

In this regard, it should be noted that the key elements of MNE industrial expansion are their knowledge and skills, which allow them to develop unique products. An MNE can establish a manufacturing unit in another country to reduce costs and enter new markets, but they do not have the goal of transferring technology

to local companies. Instead, such corporations generate profits through the use of their technology. Moreover, Western experts, as can be seen from the above, understand the transfer of technologies as their use by foreign subsidiaries of MNEs, and not the transfer of such knowledge to the FDI host country, recognizing such transfer of technologies as merely “indirect.” [8, p. 756].

Thus, it can be stated that industrialized countries MNEs, in principle, have no commercial interest in transferring their knowledge to the countries in which they conduct their production activities, since as a result, they may lose their competitive advantages and part of the profits for which MNEs place their manufacturing facilities around the world. MNE can voluntarily sell or transfer only less modern technologies, provided that the corporation has more progressive and effective solutions. But this does not always happen, given that, as noted above, the creation of its own production unit in another country occurs when the technology is already standardized, while before that, only the export of finished products from the MNE’s home region is possible, i.e. the use of even not the most advanced technology is a source of profit generation by its foreign branch.

As a result, it becomes obvious: firstly, the unstable nature of MNEs’ foreign branches activity; secondly, local personnel are allowed to master only the rules for using technologies used in production of these branches; thirdly, technologies themselves are not transferred by MNEs voluntarily to the host country; fourthly, those technologies used by foreign branches are not the most advanced; and fifthly, MNEs do not have motivation to sell even these technologies voluntarily.

Therefore, it seems a great mistake to hope that a FDI hosting country will receive the latest technologies and freely use them at its discretion to raise the level of its industrial development in connection with the functioning of manufacturing facilities owned by foreign MNEs in the country. This narrative only works to create a general impression of the usefulness of FDI for the host country and to create

attractive operating conditions for MNEs, but it is not voluntarily implemented in practice by such corporations. Moreover, 100% ownership of foreign production branches does not oblige MNEs to share with local authorities and companies the technologies they use that are not the most up-to-date, but only allows them to use the results of their application.

### INCREASING PROFITS OR OWNING TECHNOLOGY: WHAT IS MORE IMPORTANT IN FDI FOR MNEs?

FDI may be of interest to the host country in solving tactical tasks of filling the domestic market with high-quality consumer and investment goods. However, a MNE may, driven by its own priorities, unexpectedly close its enterprise. In this case, even if the MNE leaves its equipment, the technologies that form the basis of the added value created by it, are not usually sold along with the machinery. The supply of raw materials and components required to ensure proper quality of the finished product is also often limited. The use of MNE brands that generate product recognition is prohibited. Therefore, without local companies obtaining and mastering technologies related to MNE products, FDI is strategically useless, since it not only “kills” local competitors by overflowing demand to the products of MNE branches, but also leaves few financial opportunities for local companies that remain “alive” to create competitive goods and organize their large-scale production.

In this context, it is expedient to consider the ratio between J. Dunning’s “ownership advantage”, which later became known as the firm’s specific advantage, and the “location advantage” regarding the specific advantages of the country (SAC) receiving FDI, which then extended to the advantages of the country of origin of MNEs. From the literature review on this issue conducted by H. Zhang [10], it follows that the main scientific discourse on the topic is complementary to specific advantages of capital exporting countries, while the SAC of FDI host countries are taken for granted that means these countries should not only hope for their

opportunities to be taken advantage of but also compete for FDI offering them the best possible conditions.

Supplementing the argument in favor of the backwardness of not the most developed countries, S.K. Baumik, N. Driffield and I. Zhu [11] believe that if and when companies in these countries become MNEs, this happens solely due to scaling operations at the international level, while for MNEs in the most mature economies global activity is the result of leading positions in technology. At the same time, they acknowledge that some MNEs in countries with economies in transition have been able to break this paradigm and have not only caught up with, but also overtaken their competitors in terms of technological excellence.

Considering this issue taking into account the above circumstances, R. Vernon's life cycle theory, K. Kojima's concept of "assistance" by MNEs of developed countries to increase the competitiveness of catching-up countries through FDI, as well as the "indirect" nature of the transfer by MNEs of their technologies to local companies by A. Ragman, A. Verbeke and K.T.K. Nguyen, it can be concluded that the perception of FDI by the host country should not be based on declarations of its usefulness actively promoted at various levels (which actually means maximizing the profits of global MNEs), but they rather should objectively assess the interest in FDI from the point of view of the country's achievement of its own goals with their help and establish appropriate terms for the functioning of MNE branches in the country.

Whether MNEs agree to legally transfer the technologies used in production of goods to local companies in the FDI host country largely depends on the industrial policy of that country. If the policy focuses on supporting market competition, the free movement of capital, and openness to foreign trade, then, given the technological imperfections and financial weaknesses of local enterprises, which operated under completely different conditions prior to the arrival of MNEs and the removal of import restrictions, it is difficult to expect local enterprises to be able to compete successfully

with MNEs. If free competition and an open economy are combined with measures to protect local enterprises that need a time and resources to adapt to new conditions, primarily in terms of mastering modern technologies, updating their production equipment and improving the skills of their staff, then MNEs may have the motivation to be less selfish in providing local companies with access to brought-in technologies used in the country, the market of which is promising for selling their goods.

It is necessary to take into account that such readiness of MNEs may arise due to several factors. Firstly, they may not be using their most advanced technologies in their foreign subsidiaries. Secondly, their aim is to maximize profits for the entire corporation by entering new markets. Thirdly, increased profits are not only achieved through increased sales, but also through more favorable conditions for local production compared to exporting products to the country.

Thus, with the government's approach to the manufacturing activities of foreign companies justified by its strategic interests, MNEs face a dilemma of sharing their technology or missing out on the opportunity to increase their profits. Although MNEs strive to maintain their technological superiority and maximize profits, the likelihood of persuading them to compromise depends on how much the host country is interested to MNEs to improve their financial performance. The specific advantages of a country may, for the sake of profit, prevail over the desire of MNEs to retain ownership of the technology. In this regard, R. Arend [12, p. 5–6, 9] notes that foreign investors in the Russian Federation want to maintain control over profits, marketing, and product quality, while intellectual property rights are systematically considered a lesser problem than property rights, given that 70% of them claim to use well-known, traditional technology in the Russian Federation. On the other hand, the understanding of its specific advantages by the host country, combined with the acceptance of the fact that it is lagging behind in a number of important technologies, can and should



motivate it to establish stricter conditions for FDI in terms of transfer of technologies brought-in by MNEs to local companies in enterprises organized in the country.

Analyzing the state of affairs with FDI in different countries 10 years later, S. Fu, L. Pietrobelli and L. Soit [13, p. 2, 9–10, 17] find that there is no convincing evidence that there is significant positive technology transfer or spillover effects from FDI to local firms from the wholly owned production facilities established by foreign MNEs. In addition, they point out that without proactive local innovation efforts, foreign technologies remain embedded in imported machines and processes, but will never translate into real local technological capabilities, meaning local and foreign innovation efforts must be complementary.

Weighing the priority for foreign investors to increase profits or preserve the rights to their technologies used in the country, it seems reasonable to conclude that in order to maximize financial results MNEs can share their knowledge with local companies if the state obliges them to do so.

### THE RUSSIAN EXPERIENCE OF ATTRACTING FDI

The Russian practice of attracting FDI is based on the provisions of the 1999 Law on Foreign Investment,<sup>1</sup> which are based on the ideas of the international division of labor, open markets, global competition and the free flow of capital. In many ways, they repeat the narratives of Western experts (for example, [18]) about the need to provide guarantees to foreign investors, about the FDI host country's the refusal to engage in import substitution, and about technology transfer mainly through the use of foreign-made finished products by local companies.

In the law, they were embodied in granting foreign investors equal rights with Russian companies. The restrictions applied only to foreign investments in organizations of strategic

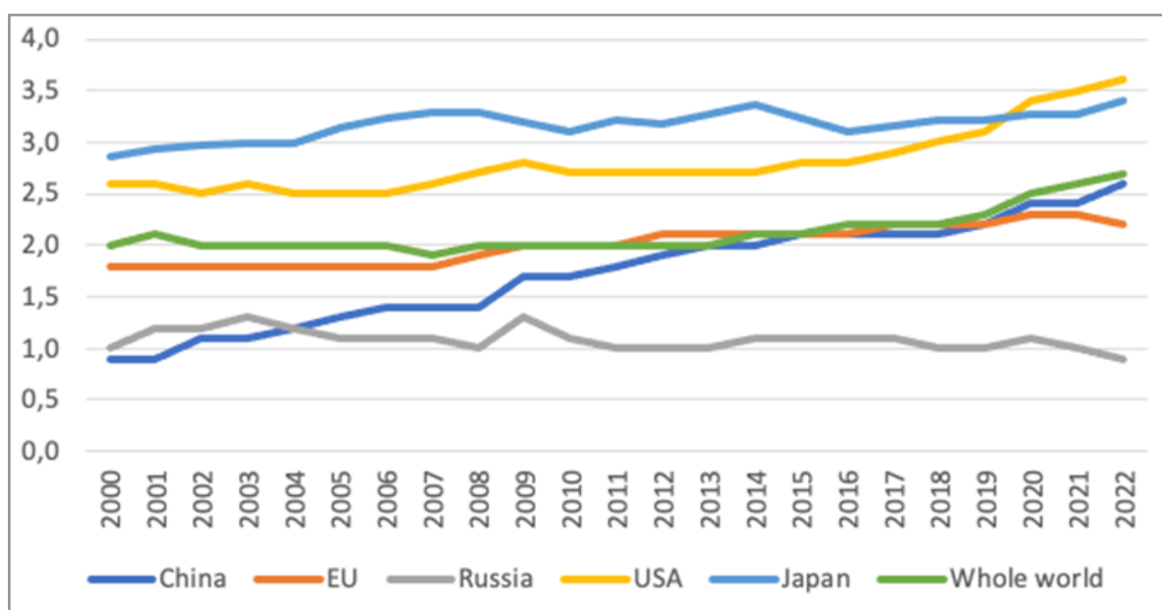
importance for the country's defense and security. Thus, for other sectors of the Russian economy, this meant the need to compete with world leaders who possessed incomparable financial power and technological superiority. As a result, MNEs predominantly established companies in the Russian Federation in which they owned 100% of shares in some non-prohibited industries, that did not create a basis for the transfer of technologies used in such enterprises to Russian companies operating in the relevant industry, since they were competitors. Herewith, FDI coming to Russia went weakly into the production of high-tech tradable goods [19, p. 83], on the import of which the Russian Federation was highly dependent [20].

Russian buyers of investment and consumer goods made a choice in favor of higher-quality products from foreign enterprises in the Russian Federation or imports instead of domestic ones, as a result of that in a number of Russian industries (mechanical engineering, for example), enterprises gradually lost their competencies and went bankrupt. Many Russian companies that remain afloat occupy unprofitable manufacturing segments where they use outdated technologies if they cannot buy imported equipment. It is important to note that foreign companies often purchase the required materials (for example, packaging) and services (for instance, banking) from other companies established by foreigners in Russia, thereby forming a special sector of foreign economy within the country.

Thus, Russia have got an opportunity only to use the results of application of modern technologies by foreign companies which replaced exports of their products to the Russian Federation with more profitable its manufacturing in the country without transferring its industrial technologies to Russian enterprises for its independent development in the creation of similar goods.

The reason for the demand for foreign technologies is that the share of research and development expenditures in GDP has been stagnating in the Russian Federation over the

<sup>1</sup> URL: <http://pravo.gov.ru/proxy/ips/?docbody=&nd=102060945> (accessed on 09.08.2025).



**Fig. Расходы на исследования и разработки (% от ВВП) / Research and Development Expenditure (% of GDP)**

Source: Compiled by the author based on data from the World Bank. URL: <https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS> (accessed on 31.08.2025).

past twenty years, while in other countries it has been steadily growing (Fig. 1). It is obvious that the bulk of the funds are directed by the Russian government to research in strategically important areas, and Russian enterprises in other industries that manufacture goods in demand on the domestic market, which, however, are inferior in quality to their foreign counterparts, do not invest in raising it to a level competitive with foreign analogues, or do so insufficiently.

As a result, with the total volume of FDI entering the Russian Federation in 1992–2021 amounting to 670 bln US dollars, they contributed to saturation of the market with some goods produced using more advanced technologies than Russian ones, but did not have an impact on the increase in knowledge of domestic enterprises in the relevant fields. During this period, in China, under the rule to foreign investors to establish joint ventures with local companies, the inflow of FDI was an order of magnitude higher: 4,162.9 bln US dollars,<sup>2</sup> and the technological level of Chinese

companies increased significantly, including in the creation of high-tech products that are already competitive in the global market.

The motivation of foreign companies to direct investments in the Russian economy during the period of their greatest intensity (2006–2014) was determined by the search for resources (46–71% of all FDI in various industries), the desire to discover a new market (21–29%), and the desire to improve their efficiency (8–25%).<sup>3</sup> Such data logically follows from the sectoral structure of investments, in which mining accounted for 26% of the total amount of FDI accumulated in the Russian Federation as of 01.01.2022, finance and insurance — 17%, trade — 16%, manufacturing — 18% and other industries — 22% [21, p. 123].

In general, the above figures correspond to the previously mentioned theoretical assumptions about MNEs' desire to use the resources and market of the FDI host country to maximize profits, while investments in manufacturing were largely of no interest. Nevertheless, even with

<sup>2</sup> Calculated by the author based on the World Bank data "Foreign direct investment, net inflows (BoP, current US\$)". URL: <https://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD> (accessed on 09.08.2025).

<sup>3</sup> Foreign direct investment in the Russian economy: what to expect after stress? CMACP, December 2014 23 p. (p. 19). URL: [http://www.forecast.ru/\\_ARCHIVE/Presentations/RFTPP/CMASF\\_4RFTPP.pdf](http://www.forecast.ru/_ARCHIVE/Presentations/RFTPP/CMASF_4RFTPP.pdf); Foreign Direct Investment in the Russian Economy: What to Expect After Stress? CMAKS, December 2014. 23 p. (in Russ.) (accessed on 09.08.2025).



a relatively small share of FDI in manufacturing, foreign companies that actually left Russia accounted for 35% of revenue in this sector of the country's economy in 2023 [22, p. 205]. Analysis of Rosstat data [23, p. 27] shows that the share of imported machine-building equipment in the gross fixed capital formation in 2016–2020 in the Russian Federation was in the range of 73.7–97.7%, i.e. Russian manufacturers could not meet this demand. For those Russian enterprises that produce machinery and equipment themselves, intermediate consumption of foreign components in the early 2020s was more than 20% [24, p. 60]. As a result, domestic engineering shows, according to the Institute of National Economic Forecasting, the smallest share of domestic value added in the structure of the final product of all Russian industries — 74% [25].

The problems with modern equipment in mechanical engineering hinder the production by Russian companies of modern complex finished goods for consumer and investment purposes. One of the sources of these problems appears to be the ineffective regulation of FDI in terms of determining the form of its implementation in the Russian Federation: except for some strategic sectors of the economy, foreign investors could create enterprises completely controlled by them without the participation of Russian capital. Attempts to localize the production of components (when the goods of Russian manufacturers did not meet foreign quality standards) often ended with foreign investors attracting their global suppliers to the Russian Federation. Alternatively, foreign enterprises in the Russian Federation imported the components they needed or large nodal elements, assembling which in the Russian Federation turned them into finished products. For example, the Ford plant in St. Petersburg imported, as D. Dyker testifies [26, p. 29], 95% of the units and components required for car assembly. At the same time, he points out that combining imported components into a finished product is “the lowest form of cooperation in terms of scope for technology transfer and network-building”.

K. Yudaeva, K. Kozlov, N. Melentyeva and N. Ponomareva [27, p. 31], examining the

situation with FDI in the 1990s, assert that “if a foreign partner does not have sufficient control over the company (more than 90%), then he has no incentive to introduce new technologies and power for effective restructuring of the company”. D. Kotov, in his study of investment decisions of German firms to locate production facilities in the Russian Federation, notes [28, p. 3, 8], that German companies have such valuable competitive advantages and advanced technologies that allow them to successfully enter the Russian market, even if there are local competitors. Herewith, in some industries, such as automotive, mechanical engineering or petrochemistry, the technological gap is huge. Therefore, 79% of German investors choose full or prevailing capital control of a company being created in the Russian Federation, and only 7% organize it in the form of a joint venture. Herewith, the contribution of the Russian JV participant in two thirds of the projects consisted in providing, as shown by a survey of European companies in the Russian Federation in 1999 [12, p. 9], the opportunity to place equipment and in half of the projects in connection with the local market.

Obviously, the Russian Federation's practice of attracting FDI until 2022 proved useful in filling the market with better quality goods than domestic manufacturers could offer. At the same time, it provided foreign companies with the opportunity to make higher profits than when exporting such goods to the Russian Federation. However, the technologies used in enterprises under full control by foreign MNEs proved to be inaccessible for Russian companies. Thus, in terms of its own technological growth in the areas where such enterprises operated, the country did not achieve any effect, which was especially evident starting in 2022, when foreign enterprises began to cease their operations in the Russian Federation.

### CONSIDERATIONS FOR IMPROVING THE EFFICIENCY OF INCOMING FDI FOR THE RUSSIAN ECONOMY

It must be admitted that, for the reasons mentioned earlier, it is difficult to hope

for transfer of the most advanced foreign developments. But one can expect appearance of technologies that are absent in the Russian Federation and have become standard on the global market. Foreign companies come to the country with investments in order to generate profits in a larger amount than the financial result from exporting their products. Herewith, they seek to place their FDI in countries where there is a massive, solvent, unmet demand for high-quality goods. If we take the countries of the world with developing or transition economies with a population of more than 70 million people, it turns out that China and the Russian Federation have the highest GDP per capita at current prices (13–14 thousand US dollars),<sup>4</sup> i.e. they are the most promising for selling their products compared to countries with much less wealth, but a large number of consumers.

When comparing the volume of incoming FDI accumulated in 1992–2021 and GDP in 2024, China and Russia do not differ significantly: the ratio is 4.5 and 3.2 times, respectively.<sup>5</sup> This shows that the interest of MNEs in FDI in China and Russia is approximately the same and generally proportional to the volume and differentiation of the economies of these countries.

Despite external circumstances, favorable operating conditions (infrastructure, qualified personnel, and relatively low salaries<sup>6</sup>) and a large local market continue to attract foreign companies to establish their production facilities in the Russian Federation. In 2025, 62% of members of the Association of European Businesses in the Russian Federation indicate

that their operations in Russia are important or very important for the global business of its corporations, bearing in mind the large volume of the market and the great potential for its growth, which ensure high financial results.<sup>7</sup> Head of the American Chamber of Commerce in Russia in 2025 noted that many US companies are ready to invest in expanding production in Russia; the main thing for them is their presence in such a large market.<sup>8</sup>

It should be recognized that if foreign companies produce consumer goods and services on the territory of the country that are better than analogues of local enterprises, then the quality of life of people increases as a result. If such companies produce investment goods using technologies more advanced than those used in the country, then local companies get the opportunity to use materials, components, finished products or equipment produced by a foreign subsidiary of MNE to create higher-end products or increase their productivity. In both cases, this is beneficial for the economies of the countries receiving FDI.

But is the above a reason to create particularly favorable conditions for FDI? This is expedient if the market of the country attracting FDI cannot absorb the volume of products produced by a foreign enterprise and there are many other countries with similar conditions competing for the creation of foreign production unit on their territory. As a rule, these are large countries with low solvent demand or small countries with convenient production conditions and close sales markets.

In the case of a large country with a high solvent demand, the motivation for foreign industrial investors is different. They come to such a country not because special conditions have been created for them, but because they want to play bigger role on the large market, rather than just exporting, and understand that

<sup>4</sup> Calculated by the author on the database: URL: <https://www.worldometers.info/world-population/population-by-country/> and URL: <https://www.imf.org/external/datamapper/NGDPDPC@WEO/OEMDC/ADVEC/WEOWORLD> (accessed on 05.10.2025).

<sup>5</sup> Calculated by the author on the World Bank database "Foreign direct investment, net inflows (BoP, current US\$)". URL: <https://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD> и URL: <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD> (accessed on 05.10.2025).

<sup>6</sup> In 2017, the share of labor income in industrial value added in Germany was 65%, in the USA — 48%, and in Russia in 2018 this figure was 37.4% [29, p. 22–23].

<sup>7</sup> Strategies and prospects of European companies in Russia. Association of European Businesses. 2025. 45 p. (p. 19). URL: [https://aebrus.ru/upload/iblock/912/AEB-Survey-results\\_2025\\_RUS\\_FINAL\\_full.pdf](https://aebrus.ru/upload/iblock/912/AEB-Survey-results_2025_RUS_FINAL_full.pdf) (accessed on 10.06.2025).

<sup>8</sup> URL: <https://www.rbc.ru/interview/economics/07/03/2025/67c71b989a79470c3285a934> (accessed on 21.03.2025).

they can confidently compete with their more advanced technologies than those available in the market. This allows them to generate higher profit rate compared to other markets and exports, as well as increased amount of profit due to increased sales. If this were not the case, MNEs would not have any motivation to make these investments.

With FDI, the benefits of lower costs, increased sales, and increased profits are on the side of the foreign producer compared to exports to that country. At the same time, enterprises created by foreign businesses threaten the viability of poorly competitive local companies that need time and other conditions to adapt to new circumstances.

Consequently, as a temporary measure to protect local businesses until they can compete on an equal footing with global market leaders who enter the country, it is logical to the state impose on foreign investors, wanting to generate increased profits on these markets, the obligation to organize production in the country in the form of a joint venture with a Russian partner, with transfer to the latter of the technology used in the enterprise being created, with the right to own and use it. This requirement is unlikely to be particularly burdensome for investors, because in most cases this technology is not, generally, the most modern one used by the investor in its global business.

The advantage of the free trade policy and the international movement of capital is that as a result of economic globalization, consumers (retail and corporate) have access to completely new products or goods of higher quality and/or at a lower price, than offered by local manufacturers, through imports or from enterprises established in the country by foreign investors.

This is true to the extent that the relevant imports or activities of such enterprises are not stopped. If this happens, then the advantages of using higher foreign technologies that were applied in manufacturing of such goods disappear, and local enterprises that were not allowed access to these technologies remain at

the same level of development. FDI increases the level of the economy of the host country in connection with the use of products with more modern technologies than those available in the country, but does not increase the level of technological development of local companies that do not have access to such technologies. The elimination of this negativity is the essence of ensuring real, and not formal, as proposed by foreign theorists and practitioners, technology transfer.

In moving in this direction, it is important to establish a rule that foreign companies can only establish production facilities in the Russian Federation in the form of joint ventures with Russian partners. This will require their mandatory access to technologies applied. Countries of origin of MNEs may be different, but they will pursue economic benefits anyway. Additionally, it would be expedient to eliminate competition between Russian regions for FDI by offering foreign companies a “single window” solution to coordinate proposals from individual regions, so that their rivalry does not lead to a significant reduction in their income for the sake of the declared success in attracting FDI.

The above shows that MNEs are interested in producing many goods for the domestic market in the Russian Federation, as well as earning more through FDI than in other countries. Therefore, despite the geopolitical complications, many MNEs continue their activities in the Russian Federation in absence of direct prohibitions from the authorities of their countries of origin. Accordingly, if such bans are lifted, an inflow of foreign investment into permitted industries motivated by increased profits can be expected. Financial incentives for incoming FDI are hardly necessary, since the resources of the Russian state will most likely be used to support priority sectors of the national economy. What foreign investors really need is not financial support, but clear and stable working conditions in a highly profitable market for them.

The proposals made generally follow the concept of “rationing, which is a system of restrictions as an integral part of management”



[29, p. 47], when “control over attracted investments is a sought-after ecosystem tool” [30, p. 198]. Their implementation may contribute to execution of the Decree of the President of the Russian Federation on the economic security strategy<sup>9</sup> in terms of “ensuring access to foreign technological solutions in the interests of the national economy” (paragraph 18 (4)) to create “economic conditions for the development and implementation of modern technologies, stimulate innovative development, as well as improve the regulatory framework in this area” (paragraph 15 (3)) due to “lag in the development and implementation of new and promising technologies, insufficient qualifications and key competencies of domestic specialists” (paragraph 12 (12)). This approach to incoming FDI is also perceived as reasonable in some other countries that feel technology lagging behind.<sup>10</sup>

China’s experience in establishing joint ventures with foreign MNEs on its territory has shown its effectiveness [16], does not contradict international treaties within the WTO [17], and foreign companies accept this order for the sake of generating their profits.<sup>11, 12</sup>

## CONCLUSIONS

After the departure of many MNEs from the Russian Federation, Russian companies in some industries have been able to occupy vacant market niches. However, in many

cases, they have failed to provide products of the same quality as those of the foreign manufacturers that left the country. Thus, this has been beneficial for Russian businesses, but consumers have lost the previous quality of products. No one is prohibiting it, and the state encourages Russian enterprises to develop and implement technological innovations, and success has been achieved in a number of areas. At the same time, if foreign companies want to organize production of their goods in Russia, then development of technologies that are absent in the Russian Federation by enterprises in non-strategic industries within framework of joint ventures with foreign companies would be one of the most effective ways for the Russian Federation to increase its technological level. Considering that interest in the Russian market from foreign manufacturing companies of the West and East remains, clarification of national industrial policy in this area could help the development of Russian companies.

This more rational model of industrial cooperation, compared to production facilities completely controlled by foreign MNEs, can help to more quickly overcome the technological development gap, expand the range of industries in which Russian companies, having mastered technologies brought in by foreign MNEs, could develop more advanced solutions, and, having provided the country with high-quality products, enter the global market with them.

Obviously, these proposals can only be additions to more fundamental measures to increase the level of technological maturity of the Russian economy. The study of these measures goes beyond the scope of this article and may be the subject of further research and analysis, including the sectoral preferences of FDI, the stimulation of increased investment in research and development by state and private companies, the development of a specific mechanism to control incoming FDI, conditions for localizing production, and the impact of new approaches to FDI on options for using unengaged Russian capital.

<sup>9</sup> URL: <http://www.kremlin.ru/acts/bank/41921> (accessed on 16.10.2025).

<sup>10</sup> After submitting the article to the editorial board of the magazine, Bloomberg reported that due to the lag of European companies behind the global level of technological development in some industries, the EU is considering joint ventures with foreign, in particular, Chinese, manufacturers of in-demand products, as one of the tools for obtaining appropriate technologies. URL: <https://www.bloomberg.com/news/articles/2025-10-14/eu-considers-forced-tech-transfers-for-new-chinese-investments> (accessed on 16.10.2025).

<sup>11</sup> China Business Climate Survey Report 2025. The American Chamber of Commerce in China. 2025. 102 p. (26, 87). URL: <https://www.amchamchina.org/wp-content/uploads/2025/01/AmCham-China-BCS-2025.pdf> (accessed on 08.08.2025).

<sup>12</sup> European Business in China. Business Confidence Survey 2025. European Union Chamber of Commerce in China. 2025. 60 p. (p. 19). URL: <https://static.poder360.com.br/2025/05/european-commission-commerce-china-2025.pdf> (accessed on 09.08.2025).

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# Non-emission Contour of the National Financial System and the Principle of Cognitive Modeling in Its Stress Testing

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## ABSTRACT

The **relevance** of the study is determined by the fact that in the context of the transformation of the international monetary system and the pressure of sanctions, Russia faces the need to take a proactive position in terms of ensuring the sovereign nature of its national financial and monetary systems. In this context, a team of researchers from the Institute of Innovative Financial Instruments and Technologies at the Plekhanov Russian University of Economics have developed a model for the creation of an investment (reserve) contour for the national financial system, based on the use of multi-commodity and multi-currency price stability indices, while the check of the degree of stability to the external environment and the possibility of practical application of this model is **the purpose** of the study in question. The **methodology** of stress testing of risk factors accompanying the functioning of the model was chosen as the basis for the evidence base. To implement the stress testing procedure, the **cognitive modeling** apparatus was used, which is capable of dealing with weakly formalized situations and expert-based parameters within its interdisciplinarity framework. Based on the generated list of control factors, a cognitive model was created in matrix and graph forms. An analysis of its structural stability and resistance to disturbances was conducted. The main hypothesis of this study is the ability of the proposed model for this issue, circulation and redemption of financial instruments secured by raw materials, currencies of friendly countries and other assets to overcome the main stresses (risks) generated by the control factors selected by the authors. This hypothesis was tested using a scenario approach. Within the framework of this approach, a number of scenarios were tested that corresponded to risk groups associated with the stages of the functioning of financial instruments in the investment (reserve) circuit. The substantive formulation of scenarios and their implementation using the impulse model have allowed us to obtain results in the context of three options for the development of situations. These results have substantiated the stability of the optimistic and basic behavior under stress tests, and confirmed the practical suitability of the developed approach to forming the non-emission (reserve) contour of the national financial system.

**Keywords:** non-emission contour; multi-commodity price stability index; hybrid digital financial assets; scenario analysis; stress testing; cognitive modeling; international monetary system

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## INTRODUCTION

The international monetary system (IMS) is currently undergoing a period of transformation, and the impetus for this transition is the actions of Western countries imposing unprecedented sanctions on Russia. For Russia, this presents an opportunity to decide how to respond to these processes: either “go with the flow” or take an active role in cooperation with partners, particularly the BRICS.

There is no alternative to proactivity. Passive positions can lead to serious disruption of economic life, and attempts to integrate the Russian financial and monetary system into the emerging model of the IMS that corresponds to the interests of the West.

However, taking a proactive approach does not mean implementing radical solutions immediately. Gradualism is required, which, as part of adapting the Russian financial and monetary systems to new conditions, involves consistent and clear steps towards achieving the ultimate goal of maintaining the sovereignty of these systems.

The authors believe that one solution to this problem is the formation of an investment (reserve) framework for the national financial system and the financial instruments that circulate within it. This would help avoid the most significant inflationary risks while maintaining a policy of increased investment.

This could be an important step toward abandoning the standards of the Washington Consensus and contributing to the creation of a new model for the Russian financial and monetary system. Special attention should be paid to the international aspects of the formation of a model, where the consensus development and approval of a method for measuring the value of BRICS countries' payment instruments is of utmost importance. In other words, it is necessary to agree on assets that can serve as the basis for measuring the intrinsic value of joint instruments.<sup>1</sup>

<sup>1</sup> But the agreements within the BRICS are something that our geopolitical opponents fear most. So, US President Donald Trump has actually issued an ultimatum to those countries

An example of such an approach is developed by a team of researchers at the Institute for Innovative Financial Instruments and Technologies (IFIT) at the Plekhanov Russian University of Economics. They propose a model for forming an investment (reserve) framework for the national financial system based on using multi-commodity and multicurrency price stability indices.

As part of solving the problems of testing and practical implementation of this model, the authors conducted a study to identify the degree of stability of the proposed investment (reserve) model based on an analysis of internal and external factors that may affect its functioning and, accordingly, its practicability. The presented work is dedicated to the results of this research.

In terms of confirming scientific novelty, we note that the idea of creating a non-emission investment contour, as well as providing it with real assets, has already been reflected in several publications [1–5]. However, the problem of stability has not been analyzed. In 2024, on the eve of the BRICS summit, options for creating joint financial instruments for the BRICS countries were widely discussed in the information space. So far, this issue has only been considered in separate scientific publications [6, 7].<sup>2</sup> Some scientific papers emphasize the expediency (taking into account the need to ensure the economic security of the country) of actively using cryptocurrencies in Russia's international settlements [8]. At the same time, this approach does not take into account the risks that arise, since the cross-

that consider abandoning the US dollar for calculations and taking steps towards creating an alternative currency. And apparently, the groundwork was laid to some extent, as contrary to all expectations, no such steps were taken during the BRICS summit. Leading states did not push for the introduction of an alternative international settlement system.

<sup>2</sup> Improvement. The international monetary and financial system. A study of the BRICS Presidency, 2024. URL: file:///C:/Users/79037/Downloads/BRICS\_Research\_on\_IMFS.en.ru.pdf (accessed on 30.03.2025); Hidden Facts Could Slow the Rise of the BRICS Payment System. THINK BRICS. 30.10.2024. URL: <https://thinkbrics.substack.com/p/hidden-facts-could-slow-the-rise> (accessed on 30.03.2025).

border movement of the most significant cryptocurrencies is under the control of global institutions [9].

### MATERIALS AND RESEARCH METHODS

The schematic diagram of the reserve circuit of the national financial system proposed by the authors uses multi-commodity indices (MTZ index) and multi-currency indices (MVZ index) as assets, which are used to measure the internal value of financial instruments. These indices reflect the stability of prices either for groups of dual goods (MTZ) or for currencies of friendly countries (MVZ), and they are dimensionless. The indices have the meaning of units of division for baskets of goods / currencies, constructed as a solution to an optimization problem based on minimizing the deviation of the model's value from a selected commodity / currency anchor.

Based on these indices, financial instruments can be issued backed by commodities, currencies of friendly countries and other assets, for which there is a real prospect of becoming the core of the reserve circuit of the national financial system. However, the proposed model is not free from price risks, and the implementation of these risks may call into question the practical suitability of the model. Therefore, at this stage, one of the most important tasks in substantiating the model is proving its viability. The methodology for stress testing research objects, including hybrid digital financial instruments (GFCA), offered by IFIT, will be used as the basis for evidence.

The authors of the study found that the most significant indicator for these instruments, which requires stress testing, is their stability in relation to value equivalents. This includes the dynamics of prices for raw materials, gold, and the ratio between the MTZ index and the price of a benchmark commodity. Additionally, the manipulability of gold and bitcoin prices, as well as those of other important commodities, requires special attention. These factors must

be considered separately, with oil being a primary concern.

The main hypothesis of the study is that a proposed simulation model for issuing, circulating, and repaying financial instruments backed by commodities, foreign currencies, and other assets can overcome the major stresses (or risks) caused by the chosen management factors.

Taking into account the priorities that necessitate stress testing, the basic points of the stress testing concept were identified. One of them is the acceptance of price risk as the main one. However, it should be noted that pro-inflationary risks, which at first glance seem to be the most significant, are not significant in modeling. The very ideology of launching a non-emission circuit implies the absence of such risks due to provision of existing material assets for instruments being produced.

As for risks associated with introduction of GFCA to financial markets of BRICS and probably other friendly countries, special attention should be paid to stress testing of payment systems used to settle transactions involving GFCA.

A cognitive modeling device was selected to implement the stress testing procedure. The features of this methodology include:

- the ability to model subjective descriptions of situations that are poorly structured and contain multidimensional, multi-layered, and partially overlapping problematic situations embedded within the scenario;
- a subjective nature and qualitative description of several factors that significantly influence the development of these situations;
- complex internal structures of links, which sometimes make it difficult to identify them due to their non-obviousness, non-linearity, continuous variability, and strong dependence on the environment in which they are applied.

Currently, the volume of publications on practical applications of cognitive modeling



in the financial sector is insufficient and there are a limited number of scientific articles on this topic. A study of a sample of the query “cognitive technologies” from the first 200 scientific papers published in the eLibrary.ru scientific electronic environment showed that the proportion of practice-oriented publications using cognitive modeling methods in the financial sphere is small. Among these publications, we would like to note, first and foremost, three articles [10–12]. It is worth mentioning the work of A.V. Babikova and N.M. Babikov [13], who examine the issues of cognitive technologies in relation to assessing the digital transformation of banking activities and formulating possible scenarios for event development, taking into account external risks. There is no single paper dedicated to the use of cognitive tools in risk stress testing, but this situation generally indicates the insufficient prevalence of such tools, providing a field for discussion about their implementation in this area [14].

To test the hypothesis proposed in the study, the authors developed and clarified the stages of cognitive modeling, their tasks, and the cognitive tools used [15].

Structurally, the stress testing scheme for the stability of the model for issuance, circulation, and repayment of financial instruments backed by commodities, currencies, friendly countries, and other assets, is presented in the form of two enlarged blocks consisting of a sequence of steps and a feedback loop to perform adaptation procedures for possible adjustments as part of forming stress scenarios and scenario modelling (*Fig.*).

The target factor of the study ( $F_0$ ) is the stability of the model of issuance, circulation and repayment of financial instruments backed by commodities, currencies of friendly countries and other assets — GCFA. The managing factors are: the management of the bitcoin market, which is on the trajectory of becoming a new global reserve ( $F_1$ ); the manipulability of the gold market ( $F_2$ ); the

FLB market ( $F_3$ ); the international commodity market ( $F_4$ ); the Russian commodity market ( $F_5$ ); the functionality of supranational BRICS payment and settlement instruments ( $F_6$ ), which are described in *Table 1*.

When choosing managing factors, the authors proceeded from the need to combine analysis both on a global scale and within the national economy. They also took into account that the most important indicator requiring stress testing was the stability of the proposed financial instruments’ link to value equivalents. This approach became particularly relevant given the transformational processes that characterized the IMS.

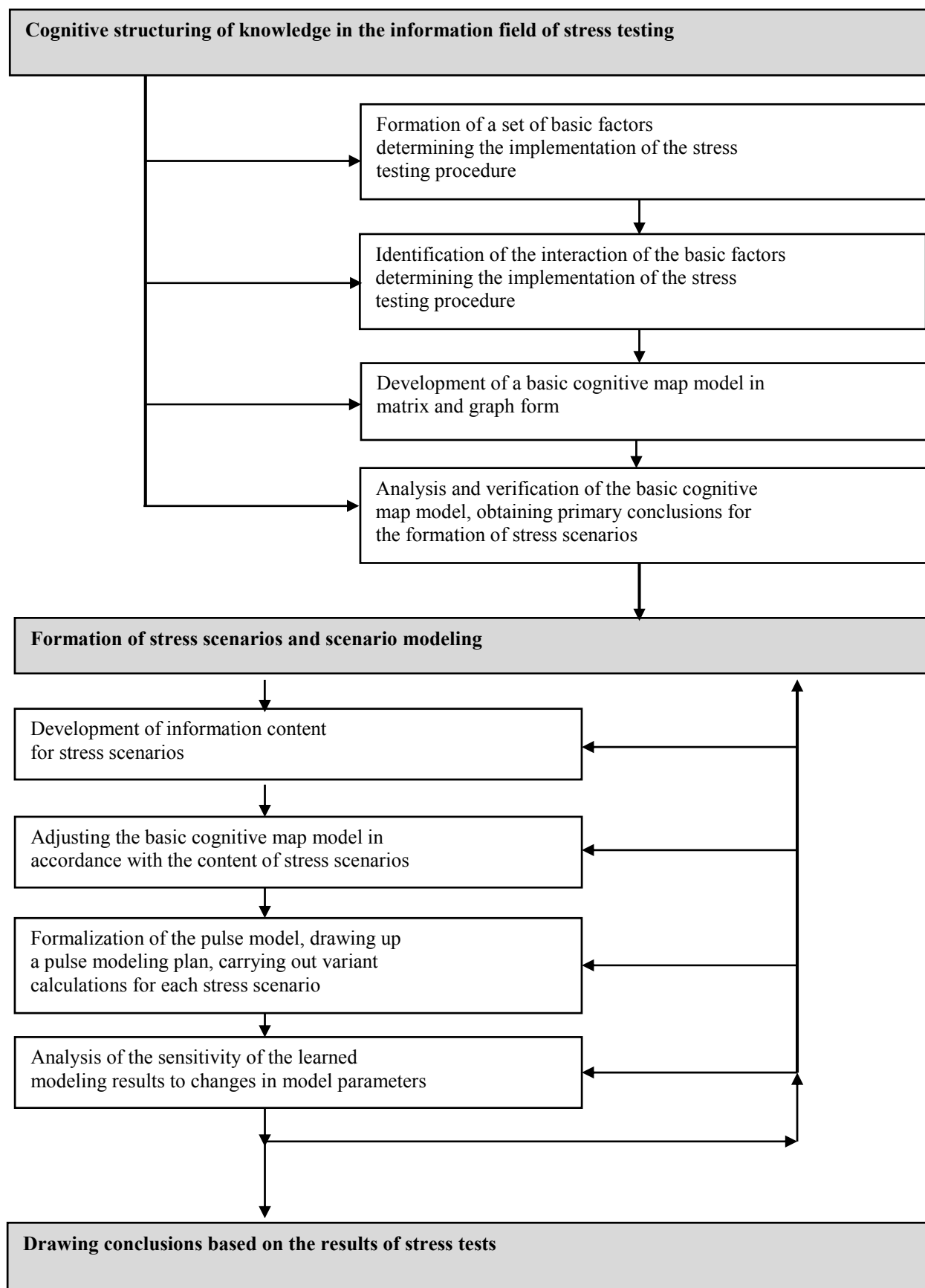
The identification of the interaction between these basic factors that determine the implementation of the stress testing procedure is performed in a matrix and graph representation. The matrix form is based on expert information about direct (+1) and inverse (−1) factors of dimension  $n \times n$ , where  $n$  is the number of selected basic factors by comparing them in pairs. Based on the obtained interaction of factors, a transition was made to the basic cognitive map  $G_b$  in the form of an oriented graph, the set of vertices of which correspond to selected factors connected by arcs, according to the identified relationships between them.

## RESULTS AND DISCUSSION

In accordance with the diagram depicted in *Fig.*, before the transition to the block of scenario formation and scenario modeling is carried out, the resulting system is examined for resistance to disturbances and for structural stability.

The stability of the model to perturbations was checked based on the analysis of the eigenvalues (roots of the characteristic equation) of the matrix form of the cognitive graph  $G_b$  of the map by comparing the calculated largest value of the root modulo one. It has been established that for the matrix of the cognitive graph  $G_b$ , the modulus of the real part of the largest root of





**Fig. The Scheme for Stress Testing the Sustainability of the Model**

Source: Compiled by the authors.

Table 1

**The List of Parameters of the Generated Cognitive Model**

| Code  | Name of the model factor                                                | Indicator                                                                                                    | Purpose of the factor |
|-------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------|
| $F_0$ | Model stability                                                         | Positive trend / Negative trend                                                                              | Target                |
| $F_1$ | Managing the Bitcoin Market                                             | Bitcoin Price                                                                                                | Managing              |
| $F_2$ | Manipulating the Gold Market                                            | The world price of gold                                                                                      | Managing              |
| $F_3$ | Federal Loan Bond (FLB)Market                                           | RGBI (Russian Government Bond Index) – Russian government bond index                                         | Managing              |
| $F_4$ | International raw materials market                                      | GSCI Commodity Index – an indicator of the dynamics of commodity prices and investments in commodity markets | Managing              |
| $F_5$ | The Russian raw materials market                                        | Russian Commodity Index (CCI)                                                                                | Managing              |
| $F_6$ | Functionality of BRICS supranational payment and settlement instruments | The reality of commissioning                                                                                 | Managing              |

Source: Compiled by the authors.

the characteristic equation exceeds the specified value, which, according to the rule formed in [16], indicates the instability of the system to perturbation, justifies the need for its regulation, and requires the procedure for correcting the initial matrix form of the cognitive graph by bringing it to a stable form.

The study of structural stability was carried out by analyzing the positive and negative valence paths present in the cognitive graph  $G_b$  in order to substantiate the definitions of cause-and-effect chains present in the graph form,  $G_b$  their desirability or undesirability in achieving the goals, especially in terms of the absence of connections between vertices in the matrix or graph.

The analysis of cycles (the path from vertex  $F_0$  to vertex  $F_0$ ) in the graph model identified the predominance of positive (reinforcing) feedback cycles over negative (stabilizing) feedback cycles, which allowed us to form a conclusion about the structural instability of the analyzed system.

The resulting cognitive model is a stress testing tool designed to solve the scientific problem of assessing the stability of an imitation model of financial instruments with collateral against external influences exceeding the limits of normal functioning of an open economy. This is illustrated in Fig.

The information content of the stress testing scenarios was developed by the risk groups identified by the authors based on the stages of operation of the GFCA investment (reserve) cycle. This list includes: risks associated with the stability of the MTZ index to gold (anchor) – the stages of placement, circulation, repayment [17, 18]<sup>3</sup>; risks associated with the placement of FLBs as an

<sup>3</sup> Brian Hicks. The Gold Crunch of 2025: Why You May Never Hold a Gold Coin Again (Unless You Act Fast) – Wealth Daily. April 5, 2025. URL: [https://www.wealthdaily.com/the-gold-crunch-of-2025-why-you-may-never-hold-a-gold-coin-again-unless-you-act-fast/?utm\\_optipub=email-article&lctg=3853337&identifier=e578d7bffd2c75cdb42e0e44222a68a8&mmessage\\_id=93351&link\\_id=62cbfbcd569e33477b342913cfcc03b797d4d61a&utm\\_referrer=3](https://www.wealthdaily.com/the-gold-crunch-of-2025-why-you-may-never-hold-a-gold-coin-again-unless-you-act-fast/?utm_optipub=email-article&lctg=3853337&identifier=e578d7bffd2c75cdb42e0e44222a68a8&mmessage_id=93351&link_id=62cbfbcd569e33477b342913cfcc03b797d4d61a&utm_referrer=3) (accessed on 28.04.2025).

Table 2

**Linking the Factors of the Cognitive Model  $G_B$  to Stress Testing Scenarios and Stages of the Functioning of the GFC in the Investment (Reserve) Circuit**

| Scenarios                                                                             | Factors used in priority | Phases                            |
|---------------------------------------------------------------------------------------|--------------------------|-----------------------------------|
| MTZ Index's resistance to gold (anchor)                                               | $F_1, F_2, F_4$          | Placement, circulation, repayment |
| FLB placement as an analogy for the GFC                                               | $F_3$                    | Placement                         |
| Price movement of the anchor commodity (gold)                                         | $F_1, F_2$               | Repayment                         |
| Movement of raw material prices                                                       | $F_4, F_5$               | Repayment                         |
| The degree of functionality of BRICS supranational payment and settlement instruments | $F_6$                    | Placement                         |

Source: Compiled by the authors.

Table 3

**Initial Trends in the Change of Factors of the Cognitive Model  $G_B$**

| Code  | Name of the top                                                         | Indicator                          | Trend Estimate for 2024 (Initial)                      | Optimistic option | Basic option    | Pessimistic option |
|-------|-------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------|-------------------|-----------------|--------------------|
| $F_0$ | Model stability                                                         | Positive trend / Negative trend    | –                                                      | +                 | +               | –                  |
| $F_1$ | Managing the Bitcoin Market                                             | Bitcoin Price                      | Increase in price to \$93,000, i.e. by 110%            | +20%              | +11%            | –10%               |
| $F_2$ | Manipulating the Gold Market                                            | The world price of gold            | Increase in price from \$2,100 to \$2,700, i.e. by 29% | +/-5%             | +11% to \$3,000 | +22% to \$3,300    |
| $F_3$ | FLB Market                                                              | RGBI Index                         | Decrease from 130 to 120, or by 8%                     | +8% to 130        | +4% to 125      | –5% to 114         |
| $F_4$ | International raw materials market                                      | GSCI Index                         | Decrease of 575 to 535, or 7.5%                        | +7.5% to 575      | +5% to 562      | –5% to 508         |
| $F_5$ | The Russian raw materials market                                        | The Russian CCI index              | Decrease from 68.06 to 67.31, or by 1.11%              | +6.3% to 71.56    | +1.77% to 68.5  | –4% to 64.81       |
| $F_6$ | Functionality of BRICS supranational payment and settlement instruments | The reality of putting into action | –                                                      | +                 | +               | –                  |

Source: Compiled by the authors.

Table 4

**The Behavior of Cognitive Model Factors in the Implementation of Three States of the Risk Stress Testing Scenario Related to the Degree of Functionality of the BRICS Payment and Settlement Instruments**

| Name of factor                                                          | Type of factor | Optimistic behavior              | Basic behavior                   | Pessimistic behavior                |
|-------------------------------------------------------------------------|----------------|----------------------------------|----------------------------------|-------------------------------------|
| Model stability                                                         | Target         | Growth                           | Growth                           | Decline                             |
| Managing the Bitcoin Market                                             | Managing       | Growth                           | Growth                           | Decline                             |
| Manipulating the Gold Market                                            | Managing       | Instability with an upward trend | Instability with an upward trend | Stabilization with a downward trend |
| FLB Market                                                              | Managing       | Instability with an upward trend | Instability with an upward trend | Decline                             |
| International raw materials market                                      | Managing       | Growth                           | Growth                           | Decline                             |
| The Russian raw materials market                                        | Managing       | Growth                           | Growth                           | Decline                             |
| Functionality of BRICS supranational payment and settlement instruments | Managing       | Growth                           | Growth                           | Decline                             |

Source: Compiled by the authors.

analogy for GFCA — the stage of placement<sup>4</sup>; risks associated with the movement of the price of the anchored commodity (gold) — the stage of repayment; risks associated with commodity price movements — repayment stage<sup>5</sup>; The risks associated with the degree of functionality of the BRICS payment and settlement instruments are the stage of placement.<sup>6</sup>

Each risk group in the stress scenarios is assigned certain factors in relation to the

stages of functioning of the GFCA in the investment (reserve) circuit (see *Table 2*).

In the course of the study, five groups of scenarios were created corresponding to the above-mentioned risk groups. For each scenario, three options for implementation were identified: optimistic, basic, and pessimistic. To carry out the modeling, initial trends for identified factors corresponding to 2024 were expertly set (see *Table 3*), which were then converted into scores.

The implementation of cognitive modeling for stress scenarios in a system of conceptual models for the issuance, circulation, and repayment of financial instruments backed by commodities, currencies of friendly countries, and other assets, with the aim of ensuring the stability of the GFCA, is based on an impulse model. The general idea behind this model is presented in the study by J. Casti [19].

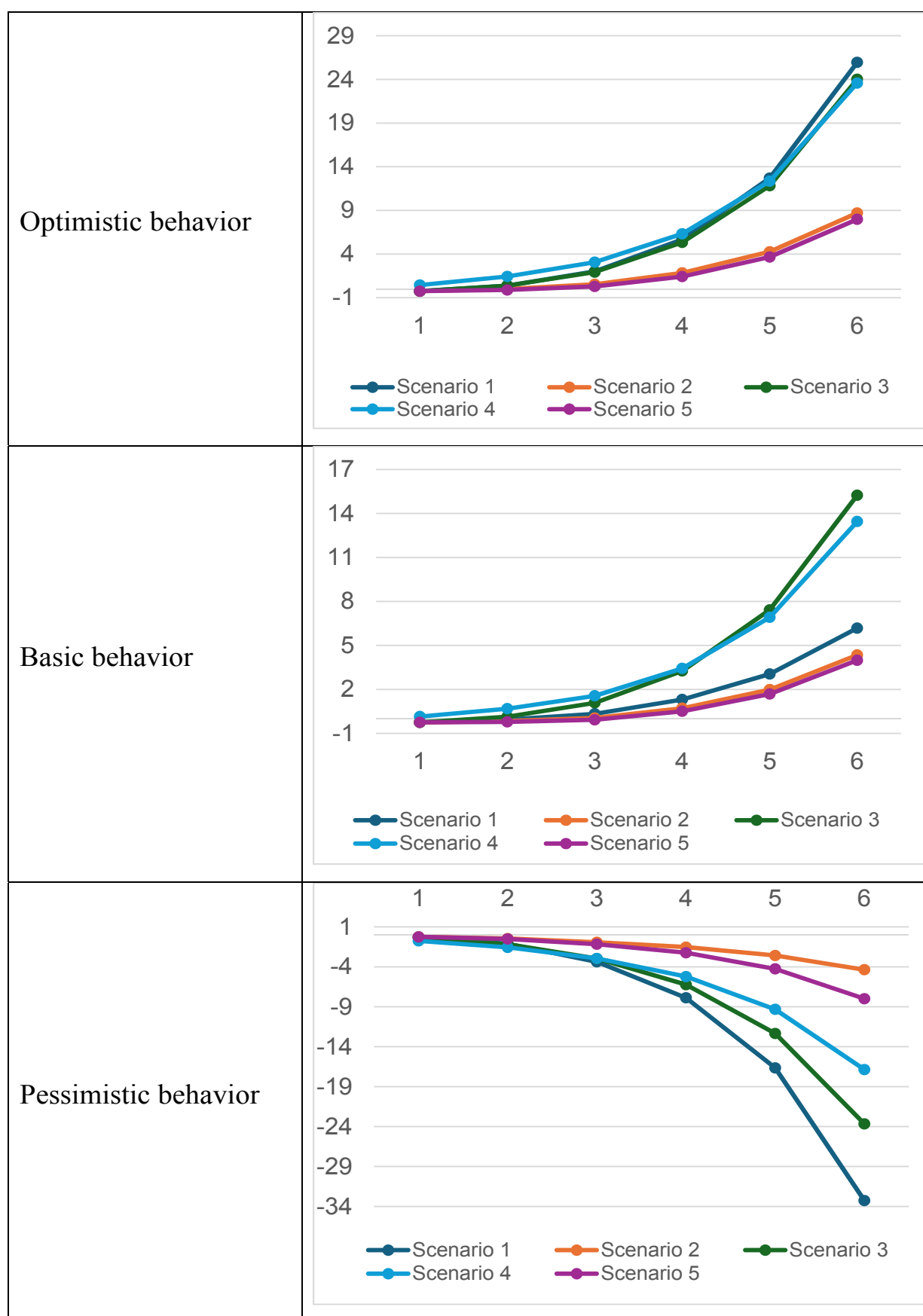
<sup>4</sup> RGBI—Index of government bonds of the Russian Federation — TradingView. URL: <https://ru.tradingview.com/symbols/RUS-RGBI/> (accessed on 28.04.2025).

<sup>5</sup> S&P GSCI | S&P Dow Jones Indices (spglobal.com). URL: <https://www.spglobal.com/spdji/en/indices/commodities/spgsci/#overview> (accessed on 28.04.2025).

<sup>6</sup> Hidden Facts Could Slow the Rise of the BRICS Payment System. THINK BRICS. 30.10.2024. URL: <https://thinkbrics.substack.com/p/hidden-facts-could-slow-the-rise> (accessed on 30.03.2025).

Table 5

## Behavior of the Target Factor under all Scenarios



Source: Compiled by the authors.



During the scenario modeling process, each scenario was presented as an impulse-based formulation, containing disturbing impulses that determined its behavior and corresponding impact vector. The pulse model was based on a basic configuration, with an unchanged target factor and a time horizon of 6 periods.

A special place in the analysis of risks that may be faced during the stages of placement, circulation, and repayment of the GFCA is occupied by the risk associated with the functionality of the BRICS payment and settlement systems. Unlike other risks, this risk does not have a numerical dimension, and therefore, the study of its behavior seems to be the most interesting aspect.

The hypothesis of the study was based on the assumption that introducing certain autonomous payment and settlement systems within the BRICS region over the forecast period is a necessary condition for attracting the national currencies of BRICS countries through financial instruments and organizing their circulation in the financial markets.

Three scenarios were proposed within the selected time period.

1. *Optimistic.* During 2025, the BRICS Bridge system, independent from the West or a similar system in architecture, will be operational, which will allow not only the beginning but also an increase in the placement of financial instruments studied on BRICS financial markets.

2. *Basic.* In 2025, it will be decided to implement the BRICS- Bridge system, which will be independent from the West or similar in architecture. However, the implementation of this decision has been postponed until a later date, allowing for the launch of pilot projects to test the placement of financial instruments on BRICS financial markets.

3. *Pessimistic.* During 2025, discussions and development of various options for establishing joint payment and settlement systems within the BRICS framework will

continue, but no final decision on their implementation will be made. Meanwhile, work will also continue on preparing to introduce the studied financial instruments to the BRICS financial markets.

The implementation of the scenarios described above for stress testing of risks related to the degree of functionality of the BRICS payment and settlement instruments, using an impulse model, assumed the application of a disturbing impulse to the  $F_6$  factor. The results of the modeling of the cognitive model factors are presented in *Table 4*.

The analysis of the results obtained from scenario modeling of stress tests for risks associated with the functionality of BRICS payment and settlement systems leads us to the conclusion that the financial instruments under development, backed by commodities, clearly withstand the stress test in an optimistic scenario, and to a lesser extent in a baseline scenario. This is due to uncertainties regarding the timing of implementation of the BRICS payment system.

Similar studies of risk scenarios were conducted within each identified risk category.

The simulation results were summarized by examining the dynamics of the target factor under the proposed scenarios, considering three different behavior patterns (see *Table 5*).

The resulting behavior of the target factor  $F_0$  (*Table 5*) indicates that, within the framework of the basic and optimistic scenarios, the system demonstrates the sustainability of its development during the implementation of stress tests. Therefore, there is a high probability of effective use of the model itself.

As for the pessimistic scenario, the graph of the target parameter dynamics of the model indicates negative trends. In other words, the proposed financial instruments do not seem to withstand the stress test under the given scenarios.

At the same time, it is important to note the uncertainty surrounding the implementation of geopolitical risks. These risks were not considered as a separate category because of the lack of adequate data and information in the current transition period from one global model of the world order to another.

Given these uncertainties, the results of the stress test in a pessimistic scenario should be interpreted with caution. They can be described as conditionally negative, taking into account the current circumstances.

## CONCLUSIONS

The conducted research allowed us to substantiate the use of stress testing tools to solve the scientific problem of assessing the stability of imitation models of financial instruments with collateral under external influences. It also allowed us to evaluate the possibilities of cognitive modeling and its algorithms for solving this problem and to confirm the ability of the proposed simulation model to overcome the main risks generated by the uncertainty in the external environment.

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**V.V. Vodianova** — conducting a critical analysis of materials, drawing conclusions.

**M.A. Minchenkov** — development of research methodology.

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# Development of Marketing Methods as a Factor in Improving Companies' Financial Condition

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## ABSTRACT

The relevance of the research topic lies in the fact that the demand for goods and services plays a significant role in determining the efficiency and financial stability of companies. It is not enough for a company to simply produce a product. Instead, it is essential to create a customer base in order to sell the product. The purpose of this study is to systematically organize and expand methods of product promotion through theoretical justification and analysis of factors that influence key financial and economic indicators of companies. Based on the set goals, the following research objectives have been identified: analyzing the dynamics and assessing the financial condition of domestic companies, evaluating the business activity and product promotion efficiency of these companies, developing methods for managing company's accounts receivable; and formulating and implementing a product promotion strategy. In the process of solving research problems and achieving objectives, general scientific methods such as generalization and synthesis, comparison, dynamic analysis, calculation of average values, economic efficiency analysis, trend analysis, factor analysis, coefficient methods, matrix methods, and modeling were employed. The results of the study include the calculation of the duration of the production, operating and financial cycles for the period 2016–2023. A significant conclusion was made regarding a sharp increase in the length of the operating and financial cycles, which is attributed to an advanced increase in the accounts receivable turnover period compared to accounts payable. Based on trend analysis, it is predicted that the length of the financial cycle will reach 39 days by 2027. In order to understand the reasons behind the decline in business activity among Russian companies, a factor analysis has been conducted to examine changes in the length of the financial and operational cycles from 2016 to 2023. We also assessed the economic impact of these changes on the length of the financial cycle. However, the food industry has accumulated best practices for creating and implementing credit policies, which has resulted in the reduction in the duration of the financial cycle from 2017 to 2023, with the cycle reaching 6 days by the end of the period. An algorithm for optimizing strategies has been proposed, which involves choosing the promotion strategy that maximizes the return on investment. This article was prepared based on the results of research conducted using budgetary funds under the state assignment of the Financial University.

**Keywords:** financial condition of companies; operational and financial cycle; methods and strategies of promotion; accounts receivable management; promotion channel efficiency

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## INTRODUCTION

Modern market relations are developing in such a way that the demand for goods and services largely determines the effectiveness and financial stability of companies. Therefore, it is not enough to produce a product, it is necessary to provide a customer base for its sale. The effectiveness of measures related to the sale of products is related both to the size of the budget for its promotion and the use of various technologies. The most well-known technologies include brand, advertising, personal promotion (sales), sales promotion, and promotion strategies. In recent decades, Internet technologies have been actively developing to promote products to the market, which make it possible to reach an audience of millions from all over the world.

Promotion costs can reach 40% of the price of goods, which indicates their high importance for strengthening the financial condition of companies and confirms the relevance of the topic of the presented research for modern theory and practice of doing business, both in the world and in Russia.

Strategic issues of promoting goods and services in relation to investments were considered in the works of S. Ivan, F. Kotler, K. Hermavan [1]. The financial condition of the companies was analyzed in the works of V.Y. Didenko, N.I. Morozko [2], T.V. Tazikhina, M.A. Fedotova [3]. The results of the study of business activity of enterprises are reflected in the works of C. Muruganandan, T. S. Rakesh, M. Dharani [4] and other authors. The issues of accounts receivable and payables management were investigated by E. A. Karzayeva [5], O. E. Pirogova [6], A. A. Sofina, A. A. Shirov [7, 8]. The works of V. A. Cherkasov, G. A. Slepushenko and I. B. Migachev [9, 10] are devoted to the problems of business digitalization and its impact on the financial results of companies.

However, in most works there is no relationship between product promotion and the financial condition of companies. The

issues of the influence of market factors on the dynamics of key financial and economic performance indicators of companies have not been sufficiently studied.

The purpose of the research is to systematize and expand the methods of product promotion based on theoretical substantiation and analysis of factors influencing the formation of key financial and economic performance indicators of companies.

Based on the set goal, the following research objectives are highlighted:

- analysis of the dynamics and assessment of the financial condition of domestic companies;
- assessment of business activity and effectiveness of product promotion by domestic companies;
- assessment of business activity and effectiveness of product promotion by domestic food industry companies;
- development of methods for managing accounts receivable of companies;
- formation and implementation of a product promotion strategy.

The object of the study was Russian companies. The subject of the study is the economic relations that arise in the process of product promotion on the market.

## RESEARCH METHODS

In order to achieve the goals and objectives of the study, various general scientific qualitative and quantitative methods were employed. These included methods of generalization and synthesis, comparison, dynamic analysis, and calculation of average indicator values to analyze the financial health of companies.

The trend and factor analysis, coefficients, graphical, and matrix techniques have been applied to assess the business activity and effectiveness of product promotion strategies employed by domestic companies. Additionally, the modeling approach was employed when formulating and implementing product promotion strategies.

Table 1

**Indicators of the Financial Performance of Russian Companies from 2016 to 2024, in %**

| Indicator                               | 22016 | 22017 | 22018 | 22019 | 22020 | 22021 | 22022 | 22023 | 22024 | Annual average deviation |
|-----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------------------------|
| The share of unprofitable organizations | 29.5  | 31.9  | 33.1  | 32.5  | 32.7  | 29.2  | 29.3  | 28.1  | 25.5  | – 0.5                    |
| Profitability of products               | 7.6   | 6.7   | 10.7  | 10.8  | 9.4   | 14.7  | 14.2  | 12.7  | ...   | 0.729                    |
| Return on assets                        | 5.9   | 3.8   | 4.7   | 5.8   | 4.1   | 8.9   | 5.5   | 7.4   | ...   | 0.214                    |
| Current liquidity ratio                 | 124.7 | 124.4 | 126.1 | 124.0 | 129.4 | 133.4 | 135.4 | 150.2 | ...   | 3.643                    |
| The coefficient of autonomy             | 42.5  | 41.7  | 40.6  | 41.4  | 40.7  | 42.7  | 43.3  | 44.9  | ...   | 0.343                    |

Source: Compiled by the authors based on Rosstat data. URL: <https://rosstat.gov.ru/statistics/finance/publications> (accessed on 20.07.2025).

**RESULTS AND DISCUSSION****Analysis of the Dynamics and Assessment of the Financial Condition of Domestic Companies**

In the last decade, domestic companies have faced significant challenges both internally and externally, due to the effects of external sanctions, the Special Military Operation (SMO), and difficulties selling their products in foreign markets. These circumstances have had a significant impact on their financial performance, raising concerns about their ability to maintain financial stability.

The financial well-being of companies is essential for attracting external financing, investing in growth, and addressing social issues. To better understand the financial performance of domestic companies, let's examine the dynamics of key financial indicators from 2016 to 2024 (see *Table 1*).

Despite unprecedented external sanctions against the domestic economy, the share of unprofitable Russian companies tends to decrease. In 2024, it reached the minimum value for 2016–2024–25.5%. The efficiency of economic activity is increasing. During

the study period, the profitability of products increased by 5.1% and reached 12.7% in 2023. Profitability of assets increased by 1.5%, liquidity and autonomy too. Taking into account the current trends, an improvement in the financial performance of domestic companies in 2025–2027 could be expected.

**Assessment of Business Activity and Effectiveness of Product Promotion by Domestic Companies**

At the micro level, the integration of companies into the market environment is determined by the level of business activity and the potential for corporate competitiveness. Business activity can be viewed from a broad or narrow perspective. In a broad sense, it refers to the set of actions a company takes to develop a production and sales system through coordinated interaction with the external environment. This includes all aspects of a company's operations that contribute to its growth and success. In a narrower sense, business activity can refer to the current production and sales activities of a company as measured by its turnover rate.

Table 2

**Business Activity Indicators of Russian Companies from 2015 to 2023**

| Indicator                                                                                   | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Annual average deviation |
|---------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|--------------------------|
| Average turnover period of current assets, days                                             | 158  | 162  | 163  | 161  | 216  | 233  | 211  | 219  | 243  | 10.63                    |
| Average turnover period of accounts payable, days                                           | 81   | 80   | 77   | 76   | 102  | 105  | 93   | 93   | 96   | 1.88                     |
| Average turnover period of accounts receivable, days                                        | 74   | 75   | 77   | 78   | 108  | 112  | 101  | 101  | 108  | 4.25                     |
| Deviation of the average turnover period of accounts payable from accounts receivable, days | 7    | 5    | 0    | – 2  | – 6  | – 7  | – 8  | – 8  | – 12 | – 2.38                   |
| Average inventory turnover period, days                                                     | 14   | 14   | 15   | 15   | 15   | 17   | 16   | 16   | 16   | 0.25                     |
| Operating cycle duration, days                                                              | 88   | 89   | 92   | 93   | 123  | 129  | 117  | 117  | 124  | 4.50                     |
| Length of the financial cycle, days                                                         | 7    | 9    | 15   | 17   | 21   | 24   | 24   | 24   | 28   | 2.63                     |

Source: Calculated by the authors based on Rosstat data. URL: <https://rosstat.gov.ru/statistics/finance/publications> (accessed on 20.07.2025).

In general, it can be argued that a company's business activity reflects its stage of development and its ability to adapt to changing market conditions. This includes an assessment of both quantitative and qualitative aspects. Quantitative indicators include turnover, speed of various current assets, production duration, and operational and financial cycles. Qualitative aspects include the breadth of markets, company reputation, customer satisfaction, and the number of service segments.

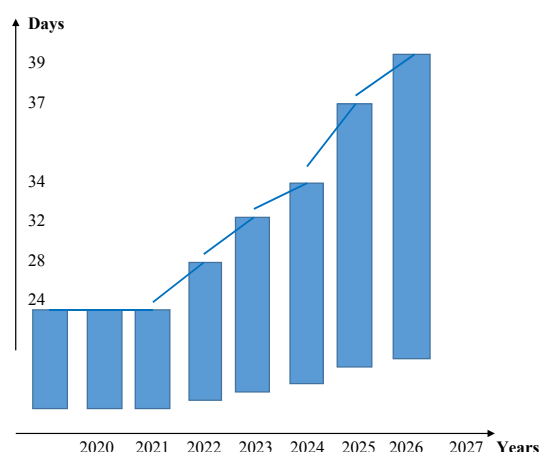
The quantitative and qualitative indicators of business activity reflect a company's marketing efforts. Therefore, changes in these indicators indicate the effectiveness of a company's product promotion.

Let's take a look at the dynamics of domestic company business activity

indicators from 2016 to 2023. The results are presented in *Table 2* below.

On average, in 2016–2023, the average turnover period of current assets increased by 11 days, which required their additional involvement in the company's economic activities. The average turnover period of current assets increased by 24 days in 2023 compared to 2022. This is evidence of deterioration in the business activity of Russian companies.

Of particular concern is the increase in the duration of the operational and financial cycles, which is caused by an outstripping increase in the turnover period of accounts receivable compared to accounts payable. In 2023, the increase in the duration of the operating cycle was 7 days, and the financial cycle was 4 days. However, it is important to know not only the dynamics of the operational and financial



**Fig. 1. The Dynamics and Forecasting of the Financial Cycle Length for the Period 2020–2027**

Source: Author's calculations.

cycles in the past, but also forecasting their duration in the medium term is of great value. Let's make a forecast of the duration of the financial cycle based on the construction of a linear trend equation:

$$Y = 18.7778 + 2.5667 \times t, \quad (1)$$

where  $t$  — time.

Thus, according to the results of trend analysis, in the future the length of the financial cycle will increase by an average of 2.57 days per year, reaching 39 days by 2027. This is 5.6 times higher than the data for 2015. The results of forecasting the duration of the financial cycle for the period up to 2027 are presented in Fig. 1.

Thus, in 2020–2027, the duration of the financial cycle will increase from 24 to 39 days, according to the made calculations, which is evidence of a significant decrease in business activity of companies. It should be noted that in 2020–2022 the duration of the financial cycle did not change and starting in 2023 it began to increase annually by 2–4 days. This was the result of the tightening of both external and internal conditions for the activities of Russian companies.

For a more in-depth understanding of the reasons for the deterioration in business activity of Russian companies, the factor analysis of changes in the duration of the financial and operating cycles in 2016–2023 is conducted, the results are presented in Table 3.

Table 3

**Factor Analysis of Changes in the Length of the Operating and Financial Cycles in 2016–2023 Compared to the Previous Year, Days**

| The Factor                                          | 2016–2015 | 2017–2016 | 2018–2017 | 2019–2018 | 2020–2019 | 2021–2020 | 2022–2021 | 2023–2022 | 2023–2015 |
|-----------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Average turnover period of production stocks        | 0         | + 1       | 0         | 0         | + 2       | – 1       | 0         | 0         | + 2       |
| Average turnover period of accounts payable         | + 1       | + 3       | + 1       | – 26      | – 3       | + 12      | 0         | – 3       | – 15      |
| Average turnover period of accounts receivable      | + 1       | + 2       | + 1       | + 30      | + 4       | – 11      | 0         | + 7       | + 34      |
| General change in the length of the operating cycle | + 1       | + 3       | + 1       | + 30      | + 6       | – 12      | 0         | + 7       | + 36      |
| General change in the length of the financial cycle | + 2       | + 6       | + 2       | + 4       | + 3       | 0         | 0         | + 4       | + 21      |

Source: Author's calculations.

Table 4

## Estimating the Economic Impact of Changing the Length of the Financial Cycle

| Indicator                                                                         | 2017    | 2018    | 2019    | 2020    | 2021    | 2022    | 2023      |
|-----------------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|-----------|
| The average amount of accounts payable, billion rubles                            | 44 481  | 49 229  | 52 615  | 64 073  | 76 121  | 89 192  | 109 468   |
| Average turnover period of accounts payable, days                                 | 77      | 76      | 102     | 105     | 93      | 93      | 96        |
| Average turnover period of accounts receivable, days                              | 77      | 78      | 108     | 112     | 101     | 101     | 108       |
| The economic effect of changing the length of the financial cycle, billion rubles | 0       | -1295.5 | -3077.4 | -4271.5 | -6548.0 | -7669.9 | -13 683.5 |
| Shipped products, billion rubles.                                                 | 205 883 | 195 803 | 181 070 | 187 971 | 249 424 | 297 780 | 306 732   |
| The level of economic effect of changes in the duration of the financial cycle, % | 0       | -0.7    | -1.7    | -2.3    | -2.6    | -2.6    | -4.5      |

Source: Calculated by the authors based on Rosstat data. URL: <https://rosstat.gov.ru/statistics/finance/publications> (accessed on 20.07.2025).

Unfortunately, in 2015–2023, the operating cycle decreased only in 2021, and there was not a single case of a decrease in the duration of the financial cycle compared to the previous year. Only in 2021–2022 the financial cycle did not change and demonstrated relative stability. The main reason is the unjustified and uncontrolled growth of the average turnover period of accounts receivable and its excess over the average turnover period of accounts payable.

In conditions of financial and economic instability, companies resort to accounts payable to finance their current activities. In essence, accounts payable replace civilized business lending. Nevertheless, in 2015–2023, companies reduced the average turnover period of accounts payable by 15 days, while increasing the average turnover period of accounts receivable for the same period by 34 days.

An increase in the duration of the operational and financial cycles is an indicator of a decrease in the effectiveness of product promotion to the market. To

confirm this point of view, the economic effect of changes in the duration of the financial cycle under the influence of changes in the parameters of credit policy and (or) procurement policy will be calculated according to formula (2):

$$EEfc = APav. \times \frac{(Tap - Tar)}{Tap}, \quad (2)$$

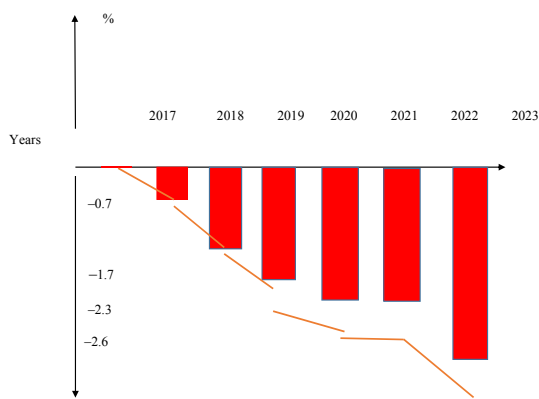
where  $EEfc$  is the economic effect of changes in the length of the financial cycle;  $APav$  is the average accounts payable for the period;  $Tap$  and  $Tag$  are the average repayment periods of accounts payable and receivables.

Additionally, the level of economic effect from changes in the duration of the financial cycle has been calculated using formula (3):

$$Lee = \frac{EEfc}{SP}, \quad (3)$$

where  $Lee$  is the level of economic effect;  $SP$  is the value of shipped products or sales revenue.





**Fig. 2. The Dynamics of the Economic Effect from Changes in the Length of the Financial Cycle from 2017 to 2023 as a Percentage**

Source: Developed by the authors.

A credit policy can be considered effective if the economic effect of a change in the length of the financial cycle is positive. The calculation results are presented in *Table 4*.

Let's imagine the level of economic effect from the change in the duration of the financial cycle in *Fig. 2*.

Consequently, since 2018, there has been a tendency in the country to maintain and increase the negative value of the economic impact of changes in the length of the financial cycle. In 2023, this reached a record low of  $-4.5\%$ . This has caused direct damage to the economy amounting to 13,683.5 billion rubles. To radically improve the current situation, it is necessary to optimize the policy of accounts receivable management by introducing effective methods.

#### **Assessment of Business Activity and Effectiveness of Product Promotion by Domestic Food Industry Companies**

However, not all economic activities in Russia are experiencing a negative trend. There are several positive examples, such as the food production industry. The Russian food industry is known for its high quality, consistent growth, and demand from the population. To evaluate the effectiveness of the credit policy in this industry, the results of made calculations are presented in the *Table 5*.

Consequently, the duration of the financial cycle for food production enterprises decreased by 3 days in 2017–2023, which is a positive trend, that ensures a high impact from the implementation of credit policy. Over the past five years, there has been an increasing trend towards the formation of vertically integrated agricultural holdings and an increase in high-value products. The leading activity area is the expansion of product range, which significantly contributes to the growth of shipments.

#### **Development of Methods for Managing Accounts Receivable**

Accounts receivable belong to the category of non-regulated current assets of a company. Management of this category aims to prevent unjustified increases, which serves as an important indicator of turnover rate of current assets and reduces corporate costs while improving the financial condition of the company. An increase or decrease in accounts receivables has a major impact on turnover of capital invested in current assets.

From a financial management perspective, accounts receivables have a dual nature. On one hand, their growth due to increased sales indicates the possibility of increased potential revenue, increased liquidity and solvency for the company. However, the growth of unwarranted accounts receivable (due to overdue payments, errors in paperwork, contract violations and unscrupulous customers) may lead to loss of liquidity, solvency, and production stoppages.

Despite the overall increase in accounts receivable, the share of overdue accounts receivable tends to decrease. If in 2020 27.9% of companies had overdue accounts receivable, then in 2023 this figure decreased to 26.7% [8]. However, in some types of economic activity it exceeds 50%, including: coke production, water supply, sanitation, waste collection and disposal, pollution control, pipeline transport and some others. In these types of activities, it is especially

Table 5

**Business Activity Indicators of Russian Food Production Companies and Evaluation of the Effectiveness of Their Credit Policies in 2015–2023**

| Indicator                                                                                | 2015 | 2016 | 2017  | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  | Annual average deviation |
|------------------------------------------------------------------------------------------|------|------|-------|-------|-------|-------|-------|-------|-------|--------------------------|
| Return on sales, in %                                                                    | 3.8  | 3.7  | 3.8   | 3.7   | 3.6   | 3.5   | 3.2   | 4.2   | 4.4   | 0.1                      |
| Average turnover period of current assets, days                                          | 100  | 104  | 109   | 113   | 118   | 125   | 121   | 118   | 128   | 3.5                      |
| Average turnover period of accounts payable, days                                        | ...  | ..   | 70    | 74    | 73    | 73    | 83    | 83    | 84    | –0.4                     |
| Average turnover period of accounts receivable, days                                     | 42   | 43   | 46    | 47    | 49    | 50    | 48    | 47    | 51    | 1.0                      |
| Average turnover period of inventories, days                                             | 31   | 31   | 33    | 34    | 35    | 37    | 37    | 37    | 39    | 1.0                      |
| Operating cycle duration, days                                                           | 73   | 74   | 79    | 81    | 84    | 87    | 85    | 84    | 90    | 2.0                      |
| The length of the financial cycle, days                                                  | ...  | ...  | 9     | 7     | 11    | 14    | 2     | 1     | 6     | –1.0                     |
| The average amount of accounts payable, billion rubles                                   |      |      | 863   | 953   | 956   | 1117  | 1216  | 1333  | 1598  | 123                      |
| Revenue from sales, billion rubles                                                       | 5001 | ...  | 4490  | 4716  | 4759  | 5616  | 6733  | 7701  | 9934* |                          |
| The economic effect of the change in the duration of the financial cycle, billion rubles | ...  | ...  | 295.9 | 347.7 | 314.3 | 351.9 | 512.8 | 578.2 | 627.8 | 55.3                     |
| The level of economic effect of changes in the duration of the financial cycle, in %     | ...  | ...  | 6.6   | 7.4   | 6.6   | 6.3   | 7.6   | 7.5   | 6.3   | ...                      |

Source: Calculated by the authors based on Rosstat data. URL: <https://rosstat.gov.ru/statistics/finance/publications> (accessed on 20.07.2025).

Note: \* turnover of organizations.

important to solve the problem of developing and improving the effectiveness of debt management methods.

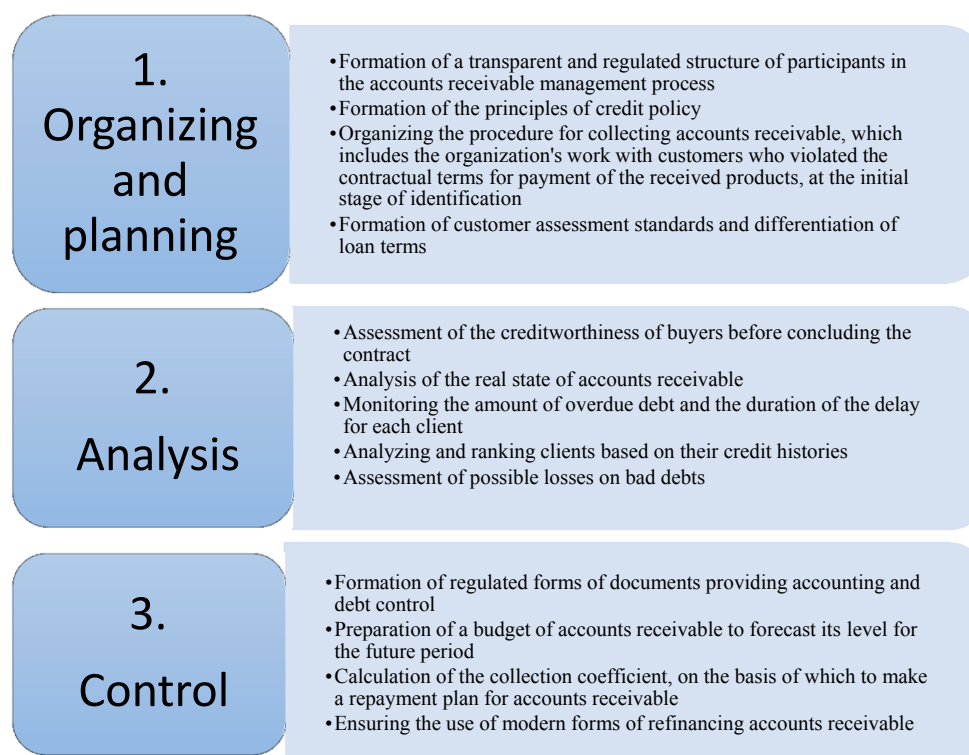
Let's take a closer look at the methods of managing accounts receivable and present them in Fig. 3.

Effective management of accounts receivable and the application of relevant methods by Russian companies is a significant direction for improving their financial well-being, creating additional

opportunities for production development, increasing their reputation, and improving their competitive position in the market.

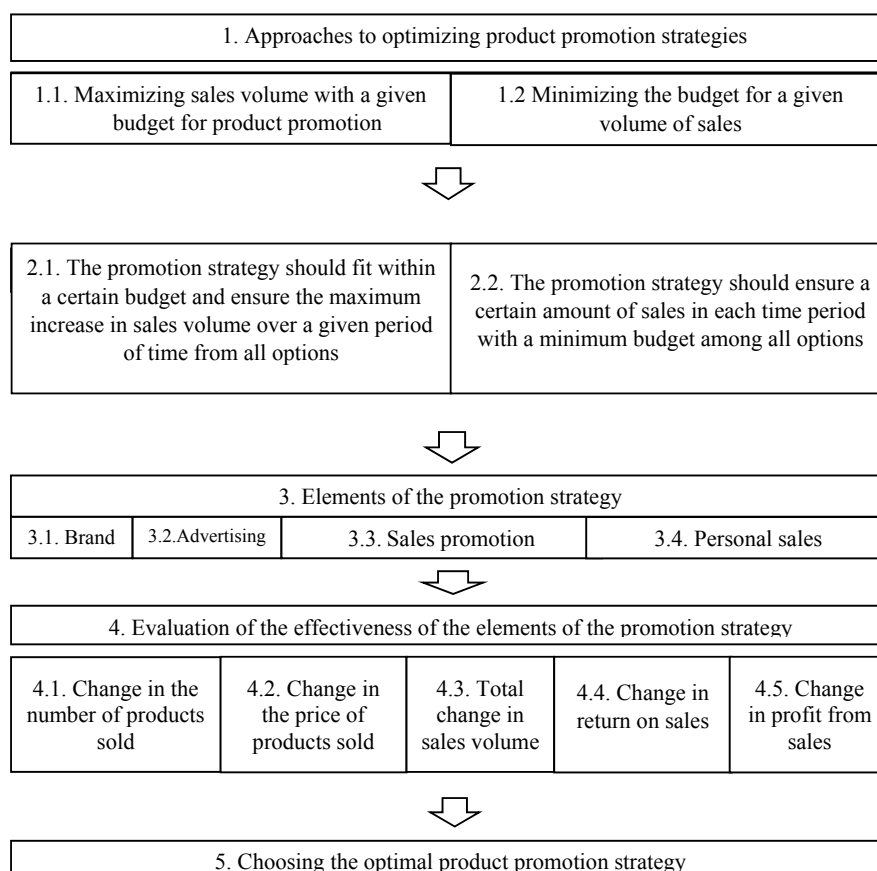
#### **Formation and Implementation of a Product Promotion Strategy**

Promotion can be considered as a set of actions taken by a company to inform the public widely about its products (their advantages, consumer qualities, purchasing opportunities and conditions, etc.), and to



**Fig. 3. Current Methods of Managing Accounts Receivable for Russian Companies**

Source: Compiled by the authors.



**Fig. 4. An Algorithm for Optimizing a Company's Product Promotion Strategy Using Two Approaches**

Source: The authors' calculations using [11–13].

Table 6

**Evaluation of the Effectiveness of Product Promotion Strategies of Russian Companies  
from 2016 to 2023, Percentages**

| Indicators – factors                                                                        | 2017 /<br>2016 | 2018 /<br>2017 | 2019 /<br>2018 | 2020 /<br>2019 | 2021 /<br>2020 | 2022 /<br>2021 | 2023 /<br>2022 |
|---------------------------------------------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Consumer Price Index                                                                        | 102.5          | 104.3          | 103.0          | 104.9          | 108.4          | 111.9          | 107.4          |
| The growth rate<br>of the number of shipped<br>products                                     | 111.7          | 91.2           | 89.8           | 99.0           | 122.4          | 106.7          | 95.9           |
| Growth rate of shipped<br>products                                                          | 114.5          | 95.1           | 92.5           | 103.8          | 132.7          | 119.4          | 103.0          |
| Return on sales*                                                                            | –0.9           | 0.9            | 1.1            | –1.7           | 4.8            | –3.4           | 1.9            |
| The growth rate of profit<br>from sales                                                     | 99.0           | 100.9          | 100.1          | 98.2           | 106.4          | 95.9           | 102.0          |
| Evaluating the effectiveness<br>of channels in implementing<br>a product promotion strategy | Moderate       | Moderate       | Moderate       | Low            | High           | Low            | Moderate       |

Source: The authors' calculations using [7, 8, 14–16].

Note: \* deviation.

Table 7

**The Matrix of Factors Impacting Sales Dynamics and Profit by Period from 2016 to 2023**

| The power of influence<br>of factors | 2016–2019                                                  |                                        | 2019–2023              |                                                         |
|--------------------------------------|------------------------------------------------------------|----------------------------------------|------------------------|---------------------------------------------------------|
|                                      | Direction of influence                                     |                                        | Direction of influence |                                                         |
|                                      | Negative                                                   | Positive                               | Negative               | Positive                                                |
| Weak (up to 1%)                      | –                                                          | Return on sales                        | –                      | Return on sales                                         |
| Moderate (1.1–5%)                    | The growth rate<br>of the number<br>of shipped<br>products | The growth rate of<br>shipped products | –                      | –                                                       |
| Elevated (5.1–10%)                   | –                                                          | –                                      | –                      | Consumer Price Index                                    |
| Severe (10.1% or more)               | –                                                          | –                                      | –                      | The growth rate of the<br>number of shipped<br>products |

Source: Developed by the authors.

encourage potential customers to purchase them. A promotion strategy is a long-term plan developed by the company to achieve its financial and economic goals through measures that encourage potential consumers to buy its products. Optimizing a promotion strategy involves choosing the most effective measures, which will yield the highest return on investment.

Let's look at the algorithm for optimizing a company's promotion strategy for its products and see it in *Fig. 4*.

Thus, the optimization of the product promotion strategy is directly related to the evaluation of the effectiveness of promotion channels. As an indicator of the success of the product's promotion strategy, the growth rate of profits from sales has been used. The effectiveness of product promotion strategies has been classified as high (all factors contribute to the increase of the indicator), moderate (some indicators do not contribute to profit growth), and low (profit decreases). If all channels are effective, this strategy can be considered optimal. Let's assess the effectiveness of each channel in product promotion for domestic companies using factor analysis techniques and present the results in the *Table 6*.

Based on the made calculations, during the period 2016–2023, the price change channel for products was the only channel that demonstrated sustained efficiency. The quantity change channel, on the other hand, was largely ineffective. Inefficiency of advertising, sales promotions and direct sales to customers did not contribute to the development of the companies' production and sales activities or the improvement of their financial performance.

Let's consider the strength and direction of influence of factors on profit from sales dynamics for individual periods, using the matrix method, and present the results in *Table 7*.

Consequently, in 2019–2023, the situation improved compared to 2016–2019, and the sales channels used by domestic companies

demonstrated higher efficiency. This ensured a steady annual growth in the shipped products of the companies, but the profit from sales remained unstable. It has been noted the most significant influence of the price factor on the dynamics of shipped products and profits from sales, which stimulates the growth of inflation, worsens the well-being of the country's population and reduces the availability of high-quality goods and services for low-income citizens [17–20].

In the medium and long term, it is advisable to focus efforts on implementing a product promotion strategy in the areas of expanding the range, increasing the share of innovative products, introducing marketing management of innovative products, developing channels and elements of product promotion, conducting socially oriented campaigns and events to enhance consumer culture of the population [21].

## CONCLUSIONS

As a result of the conducted research, an important conclusion was made about the increase in the duration of the operational and financial cycles, which is due to an outstripping increase in the turnover period of accounts receivable compared with accounts payable. During the period 2015–2023, the duration of the operating cycle increased by 36 days, and the financial cycle by 21 days. This negative trend directly affects the deterioration of the financial condition of domestic companies. Based on trend analysis, the forecast of the duration of the financial cycle has been carried out, which will reach 39 days by 2027. The main reason is the uncontrolled growth of the accounts receivable turnover period.

Nevertheless, the food industry has accumulated positive experience in implementing an effective credit policy. To understand the reasons for the change in business activity of Russian companies, a factor analysis of the duration of financial and operational cycles was carried out and



the economic effect was assessed. The level of economic effect from changes in the length of the financial cycle in food production ranged from 6.3 to 7.6% in the period 2017–2023.

An algorithm for optimizing the product promotion strategy is proposed, which consists in choosing a strategy that gives the maximum effect per unit of invested capital. The growth rate of profit from sales is chosen as the target indicator. In connection with

the current situation, it is proposed to focus efforts on the implementation of a product promotion strategy in the areas of expanding the range, increasing the share of innovative products, introducing marketing management of innovative products, developing channels and elements of product promotion, conducting socially oriented campaigns and events to enhance consumer culture of the population.

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**L. V. Prikhodko** — analysis of the implementation of effective product promotion strategies.

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# Models of Structure Capital Management Based on the Lag Determinants, Including the Cost of Debt and Tax

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## ABSTRACT

The question of the optimal capital structure existence has been a controversial field for scientists for more than 70 years. The development of capital structure theories has prompted scientists to analyze the factors that influence the decision-making on the equity/debt ratio. The applied methods of capital structure management depend on the goals of the company's management and may include ensuring financial stability, profit maximization or ensuring the return on invested capital. At the same time, managerial decision-making regarding the capital structure is based, as a rule, on informal assessments due to the lack of specific tools that allow for making scientifically sound decisions in this area. The **purpose** of the study is to develop a formalized approach to capital structure management by varying lag determinants. A three-factor lag model allows us to determine the corporate capital structure based on the increment of three determinants – return on sales, resource efficiency, and equity multiplier. A five-factor lag model takes into account, in addition to the above, the costs of debt and taxes. The choice of a model for capital structure is based on the availability and objectivity of information for calculation. At the same time, both three-factor and five-factor lag models produce a very similar capital structure for the metallurgical industry. As calculations have shown, the difference in modeling arises due to an increase in the return on sales ( $\Delta ROS$ ) and an interest burden ( $\Delta/b$ ). Moreover, if the increase in the return on sales exceeds  $\Delta/b$ , then the share of equity capital will rise. In order to improve the quality of management decisions regarding the capital structure, it is advisable to carry out forecasting using two models, and in practical activity the obtained results should be used as a guideline for possible changes in the total capital structure. The empirical basis of the study was the reporting and forecast data from the largest companies of the metallurgical industry in the Russian Federation over 2019–2023.

**Keywords:** modeling; optimization; capital structure; profitability; forecasting; lag models

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## INTRODUCTION

In practice, companies independently make decisions about the structure of corporate capital. However, their logic in forming the capital structure and the factors influencing its structure remain not fully understood.

According to some scientists, the use of borrowed capital provides expanded reproduction and brings additional income to companies. This is consistent with the conclusions presented in the works of A. Khan, M.A. Qureshi and P.I. Davidsen, who argue that an increase in the share of debt in the capital structure increases the value of the company [1]. The results of the work of K. Natsir and Yu. Usbardini has shown that the size of a firm and the capital structure have a significant impact on profitability [2].

Other scientists, on the contrary, refute some previous studies. Thus, according to S.L. Nguyen, K.D. Pham, T.V. Truong, and others, there is a negative relationship between long-term debt and profit maximization [3]. Empirical studies confirming the negative relationship between leverage and profitability contradict well-known models, such as the Modigliani-Miller model with taxes, compromise theory, and hierarchical structure theories. However, the provisions of all the mentioned theories are confirmed when a certain measure of leverage is applied individually [4]. N.H. Dang, V.T.V. Tui, and T.V.H. Hoang have revealed that the capital structure is a factor that negatively affects the cost of an enterprise [5].

M.S. Kokoreva, M.S. Stepanova, K.S. Povkh have proved in the course of their research that some companies generally adhere to a policy of “zero debt”, which they are driven to by managerial entrenchment motives [6].

An attempt to assess the impact of the capital structure on the key financial performance of the company was made in the works of T.N. Bay, H. Nguyen, K.T. Pham [7], N. Grinyuk, L. Dokienko, V. Levchenko, V. Tranchuk [8], P.N. Brusov, T.V. Filatova, V.L. Kulik [9]. Their research is based on determining the feasibility of attracting borrowed resources in terms

of balancing financial risk and profitability. N.A. Ramli, H. Latan and G.T. Solovida have established an indirect relationship between the use of borrowed funds and the financial performance of the company [10].

Also debatable is the set of criteria that guide the company when making decisions about the structure of funding sources. The articles by E.A. Nenu, G. Vintil and S.S. Gergin, L. Kurznak, D. Schoenmaker, A. Shramadyu are devoted to this topic [11, 12].

Justifying the applied methods of modeling the capital structure, modern scientists refer to the goals of management, which may be to ensure financial stability, maximize profits by minimizing the cost of capital [13] or ensure returns on invested capital. H. Deangelo in his work “The Riddle of capital structure: what are we missing?” notes the fact that managers do not have sufficient knowledge to optimize the capital structure with any real precision [14].

Research conducted by Russian and foreign scientists in this area shows that the assessment of the cost and risks of investments in Russian companies depends not only on the debt burden and optimal capital structure from the perspective of minimizing its weighted average cost due to increased leverage, but also on other factors. Among them: variable income, frequent payments of income tax, advance payments of income tax [15], the share of profits allocated to dividends, political, sanctions risks, as well as risks associated with corporate governance, expressed in the potential withdrawal of assets by managers from the company and other abuses [16, 17].

The works of D. Schoenmaker, V. Shramade, and B. Kulwizira Lukanim are devoted to the issues of static capital structure, proposing to build some kind of integrated capital structure corresponding to a certain level of risk and ensuring the expected profitability of owners [18, 19].

There are many works devoted to the theories of capital structure, an overview of which is presented in detail in the works of S. Kruk, S.G. Makarova, I.V. Nikitushkina, B.T.T. Tao, T. D.N. Ta and other scientists



[20–22]. However, modern research indicates the uncertainty of the impact of the firm's economic policy on the firm's leverage and the rate of its adjustment [23]. In this regard, the search for the optimal capital structure, focused not only on minimizing the weighted average cost of capital, but also on maximizing profitability and compliance with established values of financial covenants, is becoming particularly relevant.

The aim of the study is to develop a systematic approach to managing a company's capital structure that will ensure a certain level of return on equity, while taking into account various factors such as the cost of debt and taxation.

The specific scientific problem addressed is *the algorithmization of how a company should form its capital structure in the present and future, based on information about past capital structures that have achieved a desired level of return on equity.*

## METHODS

The modeling is based on the traditional theory of capital structure based on the criterion of return on equity (ROE) (maximizing or ensuring a given level) by managing the ratio of equity and borrowed capital.

In the three-factor model, the return on equity ROE is expressed by the dependence

$$ROE = ROS \cdot Y \cdot M, \quad (1)$$

where ROE is the coefficient of return on equity; ROS is the coefficient of return on sales; Y is the coefficient of resource efficiency; M is the multiplier of equity.

It is logical to assume that a change in the values of some determinants included in the ROE should be fully compensated by an increase or decrease in others so that the change in ROE is zero.

Formula (1) can be converted to the form for convenience:

$$R = x \cdot y \cdot z, \quad (2)$$

where R is the return on equity (ROE), x is the ratio of net profit to revenue (ROS), y is the ratio of revenue to assets (Y), and z is the ratio of assets to equity (M). By defining the increment of a function of three variables,<sup>1</sup> we have:

$$\Delta R = R(x + \Delta x, y + \Delta y, z + \Delta z) - R(x, y, z). \quad (3)$$

From the formula of the total increment (3) we deduce:

$$\Delta R = (xyz + \Delta xyz + \Delta x \Delta y z) - xyz + (xy + \Delta xy + x \Delta y + \Delta x \Delta y) \Delta z.$$

Now, from the condition of maintaining a given rate of return on equity ( $\Delta R = 0$ ), we can express  $\Delta z$ :

$$\Delta z = \frac{z(\Delta xy + x \Delta y + \Delta x \Delta y)}{xy + \Delta xy + x \Delta y + \Delta x \Delta y},$$

where

$$\frac{z + \Delta z}{z} = \frac{xy}{(x + \Delta x) \cdot (y + \Delta y)}, \text{ then } \frac{\Delta z}{z} = \frac{xy}{x_1 y_1} - 1.$$

Returning to the original notation, we obtain:

$$\frac{\Delta M}{M_0} = \frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1} - 1. \quad (4)$$

Note that from the formula  $\Delta M = M_1 - M_0$ , where  $M_0$  — is the value of the variable in the reference period;  $M_1$  — is the value of the variable in the base period, it follows that  $M_1 = M_0 + \Delta M$ , that is, the determinant M (as well as other determinants) acquires the status of a lag variable.

Ratio (4) makes it possible to express the desired value of the multiplier  $M_1$  in terms of the ratio of the reference and projected values of profitability of sales and resource efficiency:

$$M_1 = M_0 \cdot \left[ \frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1} \right]. \quad (5)$$

<sup>1</sup> Kremer H.S., ed. Higher Mathematics for economists: a textbook for university students studying economics. 3rd ed. Moscow: UNITY-DANA; 2010.

Formula (6), presented below, allows you to model the capital structure, provided that the change in return on equity, turnover and return on sales are non-zero ( $\Delta R > 0, \Delta ROS \neq 0, \Delta Y \neq 0$ ).

Using the increment formula (3) again, we obtain:

$$\Delta M = M_0 \cdot \left( \frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1} - 1 \right) + \frac{\Delta R}{ROS_1 \Delta Y_1},$$

where

$$M_1 = M_0 \cdot \left[ \frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1} \right] + \frac{\Delta R}{ROS_1 \cdot Y_1}. \quad (6)$$

Thus, in order to model the capital structure from the perspective of ensuring a given level of return on equity based on the increment formula, it is necessary to have information about the capital structure of the reference period ( $M_0$ ), return on sales and resource efficiency of the base and forecast periods [24–26].

The information base for calculating formulas (5) and (6) is the publicly available accounting data. However, the three-factor model does not take into account the impact of the tax burden and the cost of borrowed funds on the resulting *ROE* indicator and, as a result, on the capital structure. Therefore, it is of interest to use a five-factor lag model [27], where tax and interest burden coefficients are added to the previously listed indicators of profitability of sales, resource efficiency and multiplier

$$ROE = ROS \cdot Y \cdot M \cdot T_b \cdot I_b, \quad (7)$$

where  $T_b$  is the tax burden coefficient, calculated as the ratio of net profit to profit before taxation<sup>2</sup>;  $I_b$  is the percentage burden coefficient, calculated as the ratio of profit before taxation to the amount/profit before taxation and interest payable.<sup>3</sup>

To maintain the return on equity ( $\Delta ROE = 0$ ) at the same (reference) level, provided that all indicators ( $ROS, Y, M, I_b$ ),

<sup>2</sup> Tb = page 2400/page 2300 Form 2 “Financial Results Report”.

<sup>3</sup> Ib = page 2300/(page 2300 + page 2330) Form 2 “Financial Results Report”.

except for the tax burden<sup>4</sup> ( $T_b$ ), change after a series of transformations, assuming that the variables in formula (6) have a lag character, we obtain:

$$M_1 = M_0 \cdot \frac{ROS_0}{ROS_1} \cdot \frac{Y_0 I_{b0}}{Y_1 I_{b1}}. \quad (8)$$

If we assume that four indicators ( $ROS, Y, M, I_b$ ) are changing again, and the profitability increment  $\Delta ROE$  is positive, then the new ratio ( $M_1$ ) of total capital to equity will be calculated using the formula:

$$M_1 = \frac{M_0}{ROS_1 Y_1 I_{b1}} \left( \frac{\Delta ROE}{M_0 T_{b0}} + ROS_0 \cdot Y_0 I_{b0} \right). \quad (9)$$

The dependence of the return on equity on the determinants discussed above allowed the authors to develop simple, understandable and practical tools. These tools, based on the increment formula, allow you to manage the capital structure so that when these factors change, a given level of the resulting *ROE* indicator is provided.

This raises a legitimate question about the impact of the cost of debt and taxes on the capital structure. To answer this question, we compared the results of modeling and forecasting the capital structure using the three-factor (excluding the cost of debt and taxes) and the five-factor (including the cost of debt and taxes) Demidova-Bogatov lag model.

### MODELING THE CORPORATE CAPITAL STRUCTURE USING A THREE- AND FIVE-FACTOR LAG MODEL

Let's turn to testing formulas (5) and (8) in the context of modeling the corporate capital structure of companies that are among the world's largest steel producers.<sup>5</sup>

Modeling the capital structure using formula (5) of the three-factor model and formula (8)

<sup>4</sup> The  $T_b$  tax burden ratio has remained constant, as the income tax rate has not changed since 2012.

<sup>5</sup> PJSC Severstal TIN 3528000597 OKVED 24.10, PJSC Novolipetsk Metallurgical Combine TIN 4823006703 OKVED 24.10, PJSC Magnitogorsk Iron and Steel Works TIN 7414003633 OKVED 24.10.

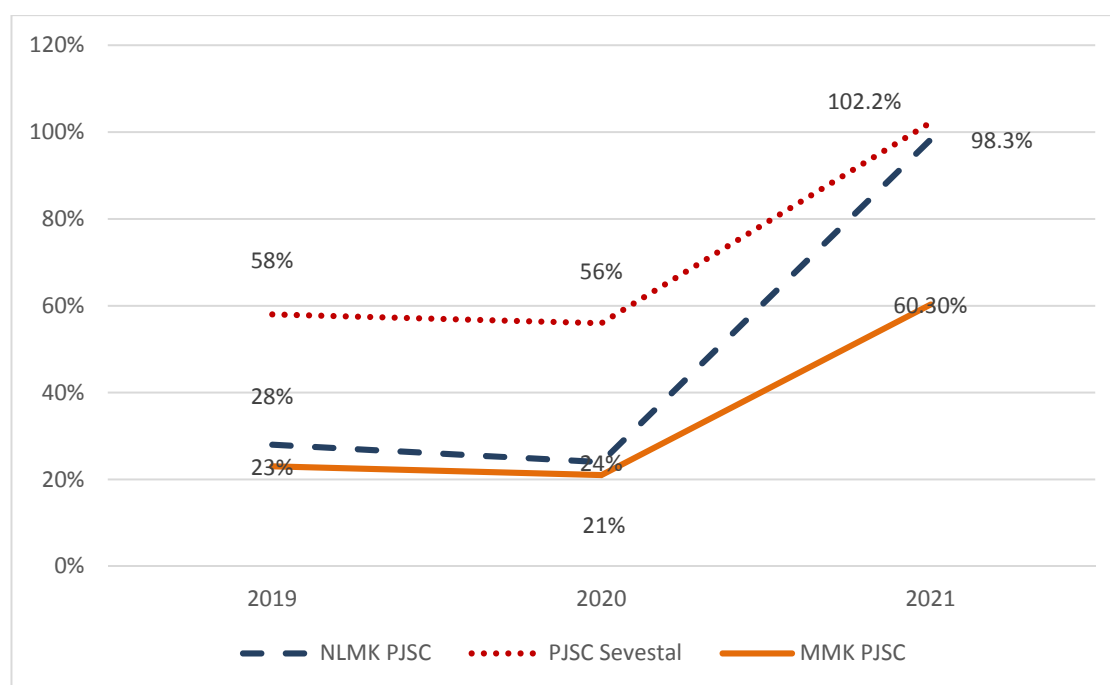


Fig. 1. Return on Equity of PJSC NLMK, PJSC Severstal and PJSC MMK for 2019–2021, in %

Source: Author's calculations.

of the five-factor model involves calculating the multiplier  $M_1$ , provided that the increase in return on equity  $\Delta ROE$  is zero, that is, it allows us to answer the question: “What should be the capital structure in a given period if we want to ensure the level of return on equity as in the reference year?”.

The reference year for the analyzed enterprises will be 2021, as the year with the highest ROE (Fig. 1).

The result of modeling the capital structure that ensures the specified ROE level of NLMK PJSC in 2019–2020, provided that 2021 is taken as the reference year, is presented in Table 1.

The capital structure that meets the requirement to maintain the return on equity at the 2021 level is presented in Table 2.

As can be seen from the data in Table 2, if the company's capital in 2019 consisted of 15.98% of its own and 84.2% of borrowed funds, this would ensure a return on equity at the level of 2021 according to both the three-factor and five-factor models. In 2020, to achieve the ROE level as in 2021, it would be worthwhile to form assets consisting of 10.4% equity and 89.6% borrowed funds, taking into account changes in the interest burden under the five-factor model

and 10.9% equity and 89.1% borrowed under the three-factor model.

The results of applying the three- and five-factor models to determine the capital structure that ensures a given ROE level for NLMK PJSC for 2019 and 2020 are shown in Fig. 2.

The simulation results shown in Fig. 2 confirm the previously obtained data. It is in 2019 that the three-factor and five-factor models for ensuring return on equity at the 2021 level give the same result, rounded to hundredths. If rounded to ten thousandths, the difference is 0.0025%. For equity in 2019, according to the three-factor model, the share of the five-factor model is 0.000004 percentage points less. The difference in equity/debt shares in 2020 is 0.05 percentage points.

The modeling of the capital structure of PJSC Severstal for 2019–2020 was carried out using a similar methodology. 2021 was also chosen as the reference period as the year with the highest ROE = 102.2%.

The results of modeling the capital structure of PJSC Severstal, provided that  $\Delta ROE = 0$  (formulas (5) and (8)), 2019–2020 are shown in Fig. 3.

Table 1

**Modeling of the Capital Structure of NLMK, Assuming  $\Delta ROE = 0$  [Using Formulas (5) and (8)],  
for 2019–2020**

| Years            | Indicators                        | FACT PJSC NLMK | Calculation formula for the three-factor model | The Result of modeling according to formula (5) | Calculation formula for the five-factor model                        | The Result of modeling according to formula (8) |
|------------------|-----------------------------------|----------------|------------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------|
| 2019             | Resource efficiency ratio ( $Y$ ) | 0.8            | $Y = \text{Revenue} / \text{Assets}$           | 0.8                                             | $Y = \text{Revenue} / \text{Assets}$                                 | 0.8                                             |
| 2020             |                                   | 0.77           |                                                | 0.77                                            |                                                                      | 0.77                                            |
| 2021             |                                   | 1.13           |                                                | 1.13                                            |                                                                      | 1.13                                            |
| 2019             | Return on Sales ( $ROS$ ) Ratio   | 0.20           | $ROS = \text{Net profit} / \text{Revenue}$     |                                                 | $ROS = \text{Profit before taxes} + \% / \text{Revenue}$             | 0.24                                            |
| 2020             |                                   | 0.14           |                                                | 0.14                                            |                                                                      | 0.17                                            |
| 2021             |                                   | 0.35           |                                                | 0.35                                            |                                                                      | 0.41                                            |
| 2019             | Percentage Burden Ratio ( $I_b$ ) | 0.95           | Not calculated                                 | –                                               | $I_b = \text{Profit before taxes} / \text{profit before taxes} + \%$ | 0.95                                            |
| 2020             |                                   | 0.92           |                                                | –                                               |                                                                      | 0.92                                            |
| 2021             |                                   | 0.98           |                                                | –                                               |                                                                      | 0.98                                            |
| 2019             | Tax Burden Ratio ( $T_b$ )        | 0.87           | Not calculated                                 | –                                               | Tax burden ratio ( $T_b$ ) = PE / profit before taxes                | 0.87                                            |
| 2020             |                                   | 0.91           |                                                | –                                               |                                                                      | 0.87                                            |
| 2021             |                                   | 0.87           |                                                | –                                               |                                                                      | 0.87                                            |
| 2019             | Equity Multiplier ( $M$ )         | 1.8            | $M = \text{Assets} / \text{Equity}$            | 6.33                                            | $M = \text{Assets} / \text{Own capital}$                             | 6.33                                            |
| 2020             |                                   | 2.2            |                                                | 9.16                                            |                                                                      | 9.58                                            |
| 2021             |                                   | 2.49           |                                                | 2.49                                            |                                                                      | 2.49                                            |
| 2019             | Return on equity ( $ROE$ ) ratio  | 0.279          | $ROE = X \cdot Y \cdot M$                      | 0.98                                            | $ROE = X \cdot Y \cdot M \cdot T_b \cdot I_b$                        | 0.98                                            |
| 2020             |                                   | 0.24           |                                                | 0.98                                            |                                                                      | 0.98                                            |
| 2021 (reference) |                                   | 0.98           |                                                | 0.98                                            |                                                                      | 0.98                                            |

Source: Compiled by the authors.

As can be seen in the figure, if the company's capital in 2019 consisted of 20.8% of its own and 79.2% of borrowed funds, this would ensure a return on equity at the level of 2021 when modeled using a three-factor model. The five-factor model provides a capital structure consisting of 20.7% of own funds and 79.3% of borrowed funds. In 2020, to achieve the  $ROE$  level, as in 2021, it would be worthwhile to form assets consisting of 20.7% of own and 79.3% of borrowed funds, taking into account changes in

the interest burden under the five-factor model and 20.8% of own funds and 79.2% of borrowed funds under the three-factor model.

The capital structure obtained using the three-factor model in both 2019 and 2020 differs very slightly from the structure obtained using the five-factor model. In 2019, the difference is 0.1 percentage points, and in 2020–1.4 percentage points.

The results of modeling the capital structure providing a given level of  $ROE = 60.3\%$  of MMK

Table 2

## The Capital Structure of NLMK to Maintain ROE, in 2019–2020

| Indicator                              | Years       | Fact             | A Three-factor model | A Five-factor model |
|----------------------------------------|-------------|------------------|----------------------|---------------------|
| Multiplier, coefficient                | 2019        | 1.8              | 6.33                 | 6.33                |
|                                        | 2020        | 2.2              | 9.16                 | 9.58                |
| Total capital, thousand rubles.        | 2019        | 537 183 756      | 537 183 756          | 537 183 756         |
|                                        | 2020        | 569 499 288      | 569 499 288          | 569 499 288         |
| Equity, thousand rubles.               | 2019        | 299 472 372      | 84 824 924           | 84 827 334          |
|                                        | 2020        | 255 738 358      | 62 154 504           | 59 421 760          |
| Borrowed capital, thousand rubles.     | 2019        | 237 711 384      | 452 358 832          | 452 356 422         |
|                                        | 2020        | 313 760 930      | 507 344 784          | 510 077 528         |
| <b>Capital structure, Equity/BC, %</b> | <b>2019</b> | <b>55.7/44.3</b> | <b>15.8/84.2</b>     | <b>15.8/84.2</b>    |
|                                        | <b>2020</b> | <b>44.9/55.1</b> | <b>10.9/89.1</b>     | <b>10.4/89.6</b>    |
| ROE, ratio                             | 2019        | 0.28             | 0.98                 | 0.98                |
| ROE, ratio                             | 2020        | 0.24             | 0.98                 | 0.98                |

Source: Compiled by the authors.

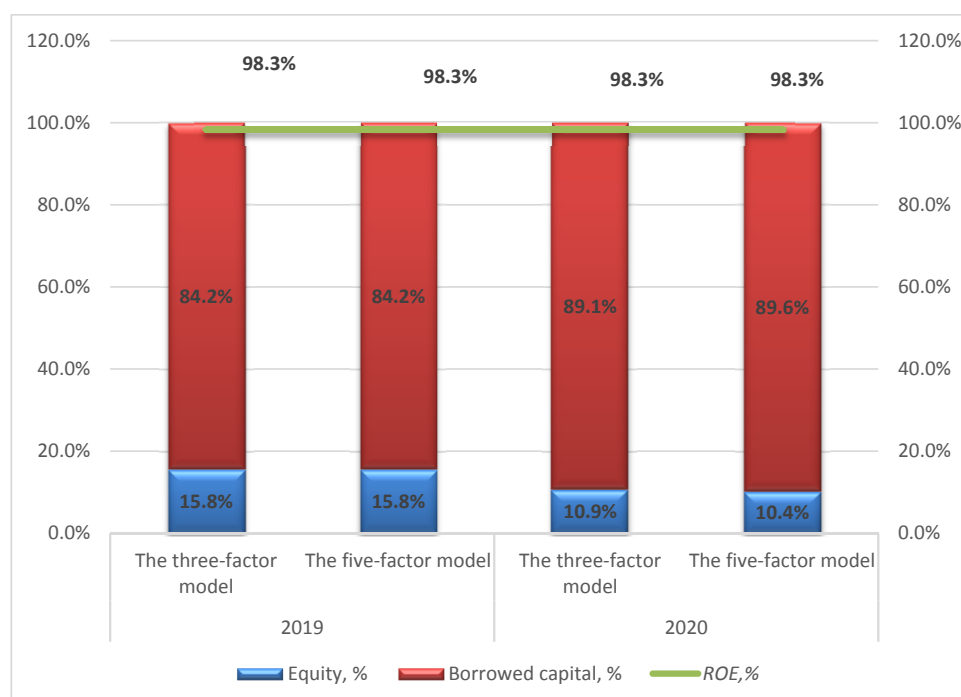


Fig. 2. NLMK's Capital Structure for 2019 and 2020 Using a Three-Factor and Five-Factor Lag Model  
 $\Delta ROE = 0$

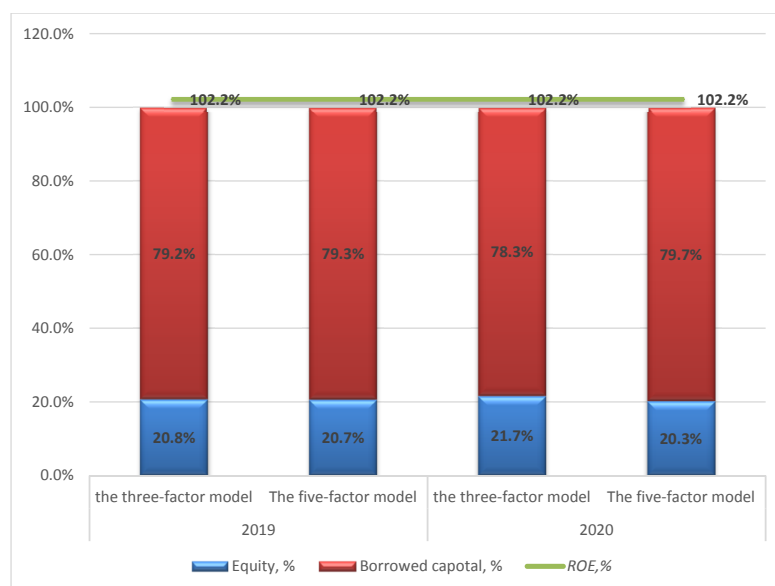
Source: Author's calculations.

PJSC according to formulas (6) and (9) in 2019–2020 are shown in Fig. 4

As can be seen from Fig. 4, similar results were obtained for MMK PJSC using the three- and five-factor models. The capital structure

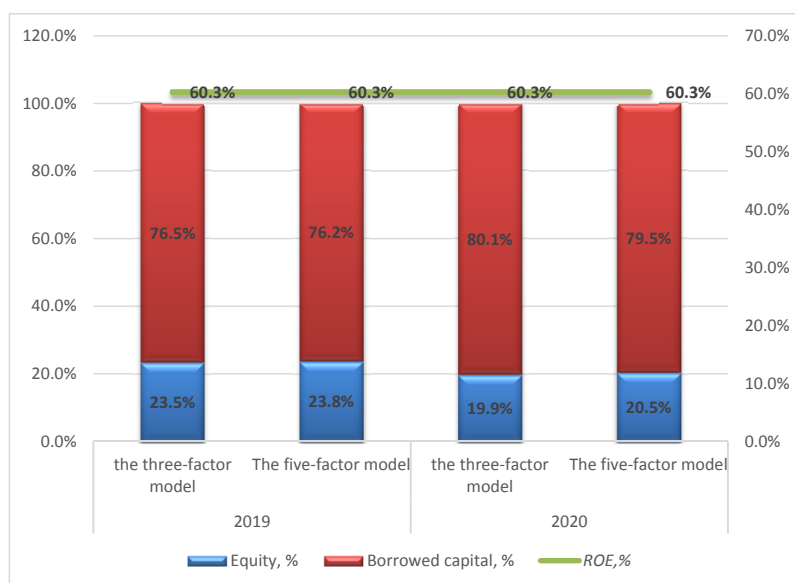
has minor differences, namely: in 2019, the share of equity in the total capital of the company differs by 0.3 percentage points or 0.39% from that calculated using the five-factor model. In 2020, the difference in





**Fig. 3. Severstal's Capital Structure Model in 2019 and 2020 Using a Three-Factor and Five-Factor Lag Model  $\Delta ROE = 0$**

Source: Author's calculations.



**Fig. 4. MMK's Capital Structure Model in 2019 and 2020 Using a Three-Factor and Five-Factor Lag Model  $\Delta ROE = 0$**

Source: Author's calculations.

the capital structure is 0.6 percentage points or 0.75%.

Thus, modeling using a three-factor and a five-factor model gives a very close result. The capital structure calculated using the five-factor model differs by less than 2% from the modeling results based on the three-factor model. At the same time, calculations using the five-factor model are more laborious and

require information about the amounts of taxes and interest paid for the use of borrowed funds. This information is not always fully presented in the forms of public financial statements.

Therefore, in financial management, we believe that it is more appropriate to use formulas based on the three-factor model for initial decisions regarding changes in the

Table 3

**Economic Indicators for Forecasting NLMK's  
Capital Structure in 2023**

| Indicators                           | Years | Indicator value |
|--------------------------------------|-------|-----------------|
| Total capital, thousand rubles.      | 2021  | 704 458 010     |
| Forecast                             | 2023  | 704 458 010     |
| Revenue, thousand rubles.            | 2021  | 792 927 899     |
| Forecast                             | 2023  | 713 635 109     |
| Net profit (PE), thousand rubles.    | 2021  | 278 191 581     |
| Forecast                             | 2023  | 225 691 129     |
| Coefficient Y (resource utilization) | 2021  | 1.13            |
| Forecast                             | 2023  | 1.01            |
| Ratio ROS (EBIT margin of sales)     | 2021  | 0.41            |
| Forecast                             | 2023  | 0.37            |
| Ratio ROE (return on equity)         | 2021  | 0.98            |
| Plan                                 | 2023  | 1.10            |
| Profit before taxes                  | 2021  | 319 460 630     |
| Forecast                             | 2023  | 256 467 192     |
| Interest payable                     | 2021  | 5 392 327       |
| Forecast                             | 2023  | 7 577 799       |
| Coef. Ib (percentage burden)         | 2021  | 0.98            |
| Forecast                             | 2023  | 0.97            |
| Coef. Tb (tax burden)                | 2021  | 0.87            |
| Forecast                             | 2023  | 0.88            |

Source: Compiled by the authors.

corporate capital structure, as it is simpler and more information-based.

We also assume that when forecasting the capital structure, the use of both three- and five-factor models would give a similar result.

### FORECASTING THE CAPITAL STRUCTURE

Forecasting the capital structure of PJSC NLMK, PJSC Severstal and PJSC MMK using the formula

$$M_1 = M_0 \cdot \left[ \frac{ROS_0 \cdot Y_0}{ROS_1 \cdot Y_1} \right] + \frac{\Delta R}{ROS_1 \cdot Y_1},$$

allowing for the modeling capital structure, subject to the changes of return on equity, turnover, and return on sales ( $\Delta ROE \neq 0$ ,  $\Delta ROS \neq 0$ ,  $\Delta Y \neq 0$ ) for the three-factor model and the following formula lag five-factor model

$$M_1 = \frac{M_0}{ROS_1 Y_1 I_{b1}} \left( \frac{\Delta ROE}{M_0 T_{b0}} + ROS_0 \cdot Y_0 I_{b0} \right),$$

assuming that all indicators are changing, except for the tax burden

$$(\Delta ROE \neq 0, \Delta ROS \neq 0, \Delta Y \neq 0, \Delta I_b \neq 0, \Delta T_b = 0).$$

The following assumptions were made here:

- the increments of the values included in formulas (5) and (8) are calculated using the usual formula:  $\Delta F = F_1 - F_0$ ;
- revenue in the forecast period, namely in 2023, will decrease by 10% relative to the reference level of 2021<sup>6</sup>;
- EBIT margin of sales will be 37%<sup>7</sup>;
- the set ROE rate of return is 110%.

These assumptions will lead to changes in turnover, profit, tax and interest burden. Economic indicators for forecasting NLM's capital structure are presented in Table 3.

Table 4 shows the results of forecasting and the capital structure that will ensure the specified level of return on equity of NLMK PJSC in the forecast period (2023).

The capital structure that ensures a given level of return on equity of NLMK PJSC is presented in Table 5.

Fig. 5 shows the results of forecasting and comparing NLM's capital structure using a three- and five-factor model.

<sup>6</sup> This forecast was presented by the RIA Novosti news agency based on the results of 6 months of 2023. In addition, analysts believe that it is clearer to compare the figures of 2023 with a successful 2021, when there were no sanctions yet and production was recovering rapidly after the pandemic. URL: <https://www.prometall.info/> (accessed on 09.01.2024).

<sup>7</sup> Kuznetsov E. And the latter became the first. What does the reporting of key industry players show? Vedomosti. Capital. URL: <https://www.vedomosti.ru/kapital/investments/article/s/2023/12/15/1011112-metallurgi-raskrili-karti> (accessed on 17.01.2024).

Table 4

Forecasting of NLMK's Capital Structure, Assuming  $\Delta ROE \neq 0$ , 2023

| Indicators          | Fact PJSC NLMK 2021 | A Three-factor model        | The Result of modeling according to formula (6) | A Five-factor model                             | The Result of modeling according to formula (9) |
|---------------------|---------------------|-----------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| $Y_0$               | 1.13                | $Y_1$                       | 1.01                                            | $Y_1$                                           | 1.01                                            |
| Net profit margin 0 | 0.35                | Net profit margin 1         | 0.32                                            | Operation profit margin 1                       | 0.37                                            |
| $lb_0$              | 0.98                | Not counted                 | –                                               | $lb_1$                                          | 0.97                                            |
| $Tb_0$              | 0.87                | Not counted                 | –                                               | $Tb_0$                                          | 0.87                                            |
| $M_0$               | 2.49                | $M_1$                       | 3.43                                            | $M_1$                                           | 3.47                                            |
| $ROE_0$             | 0.98                | $ROE_1 = X \cdot Y \cdot M$ | 1.1                                             | $ROE_1 = X \cdot Y \cdot M \cdot T_b \cdot I_b$ | 1.1                                             |

Source: Compiled by the authors.

Table 5

NLMK's Capital Structure Ensuring the Specified  $ROE$  Level, 2023

| Indicator                          | Fact 2021 ("zero") | A Three-factor model | A Five-factor model |
|------------------------------------|--------------------|----------------------|---------------------|
| Multiplier, coefficient            | 2.49               | 3.43                 | 3.37                |
| Total capital, thousand rubles.    | 704 458 010        | 704 458 010          | 704 458 010         |
| Equity, thousand rubles.           | 282 876 522        | 205 173 753          | 203 082 184         |
| Borrowed capital, thousand rubles. | 421 581 488        | 499 284 257          | 501 375 826         |
| Capital structure, Equity/BC, %    | 40.2/59.8          | 29.1/70.9            | 28.8/71.2           |
| ROE, ratio                         | 0.98               | 1.1                  | 1.1                 |

Source: Compiled by the authors.

When forecasting the capital structure, it was taken into account that revenue in the forecast period would decrease by 10% relative to the reference level of 2021, the return on sales on *EBIT* would be 37%, and the required rate of return on equity would be 110%, that is,  $\Delta ROE = ROE_1 - ROE_0 = 1,1 - 0,98 = 0,12$  or 12%.

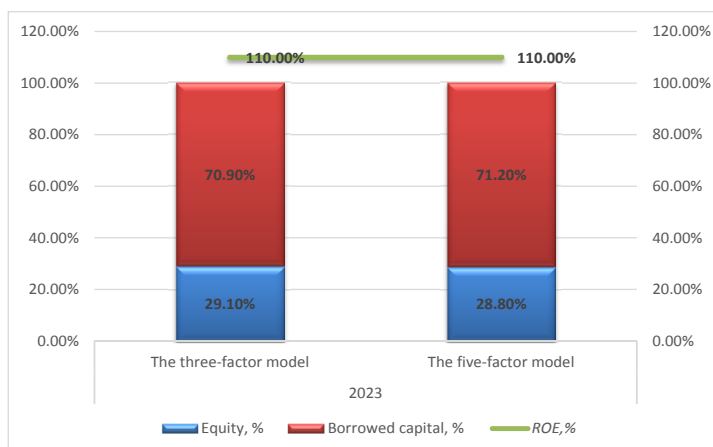
Based on the forecast, we conclude that ensuring a given level of return on equity in 2023 can be achieved through the following capital structure:

- 70.9% of borrowed funds and 29.1% of own funds according to the three-factor lag model;

- 71.2% of borrowed and 28.8% of own funds according to the five-factor lag model.

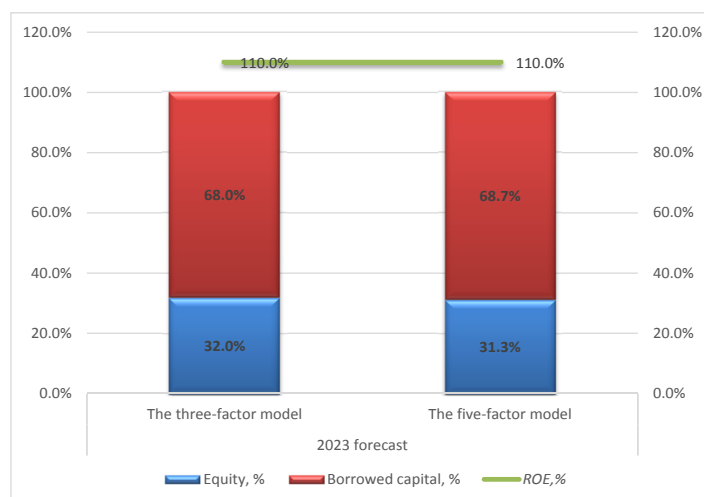
The difference in equity/debt shares using the three-factor and five-factor models is 0.3 percentage points.

A similar methodology was used to forecast the capital structure of PJSC Severstal and PJSC MMK.



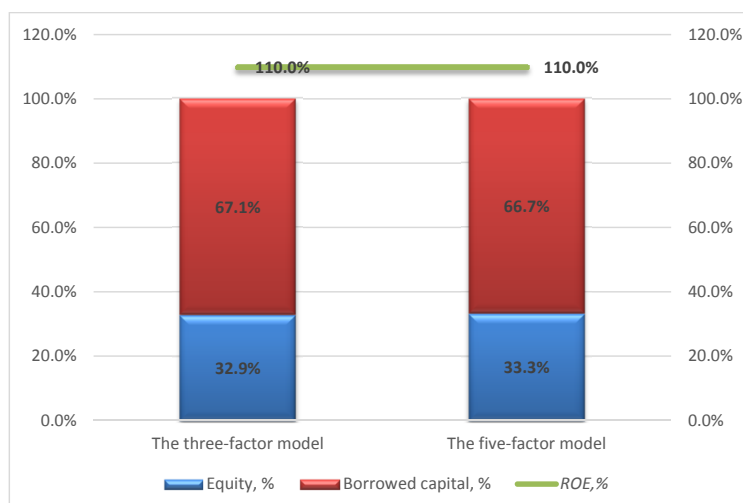
**Fig. 5. Forecasting NLMK's Capital Structure,  $\Delta ROE \neq 0$**

Source: Author's calculations.



**Fig. 6. Forecasting Severstal's Capital Structure,  $\Delta ROE \neq 0$**

Source: Author's calculations.



**Fig. 7. Forecasting MMK's Capital Structure,  $\Delta ROE \neq 0$**

Source: Author's calculations.

Table 6

**The Capital Structure of PJSC NLMK, PJSC Severstal and PJSC NLMK  
Using a Three- and Five-Factor Lag Model,  $ROE = 110\%$**

| Company        | The Capital structure<br>a three-factor model<br>(EC/BC, in %) |      | The Capital structure<br>a five-factor model<br>(EC/BC, in %) |      | The Difference<br>in the capital structure<br>between a three- and<br>a five-factor model,<br>in abs. units |
|----------------|----------------------------------------------------------------|------|---------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------|
|                | EC                                                             | BC   | EC                                                            | BC   |                                                                                                             |
| NLMK PJSC      | 29.1                                                           | 70.9 | 28.8                                                          | 71.2 | 0.3                                                                                                         |
| PJSC Severstal | 32.0                                                           | 68.0 | 31.3                                                          | 68.7 | 0.7                                                                                                         |
| MMK PJSC       | 32.9                                                           | 67.1 | 33.3                                                          | 67.7 | 0.4                                                                                                         |

Source: Compiled by the authors.

Figure 6 shows the results of forecasting and comparing the capital structure of PJSC Severstal using a three- and five-factor model.

Based on the conducted forecasting using the increment formula, ensuring a given level of return on equity in 2023 can be achieved through the following capital structure:

- 68.0% of borrowed and 32.0% of own funds according to the three-factor model;
- 68.7% of borrowed and 31.3% of own funds according to the five-factor model.

The difference in the capital structure using the three-factor and five-factor models is 0.7 percentage points, or 1.0% for borrowed capital and 2.2% for equity.

The graph shows the results of forecasting and comparing the capital structure of MMK PJSC using these models (Fig. 7).

Based on the forecast, we conclude that ensuring a given level of return on equity in 2023 can be achieved through the following capital structure:

- 67.1% of borrowed and 32.9% of own funds according to the three-factor model;
- 66.7% of borrowed and 33.3% of own funds according to the five-factor model.

The difference in the capital structure using the three-factor and five-factor models is 0.4 percentage points, or 0.6% for borrowed capital and 1.2% for equity.

We summarize the results in Table 6.

## DISCUSSIONS

When modeling the capital structure using formulas (5) and (8) for  $\Delta ROE = 0$ , as well as when forecasting formulas (6) and (9) for  $\Delta ROE \neq 0$ , the difference in the capital structure using the three- and five-factor models is less than 2%.

It can be assumed that the difference in the capital structure depends on the  $\Delta ROE$ , namely: the greater the  $\Delta ROE$ , the greater the difference in the capital structure when using the three- and five-factor models. Thus, for NLMK PJSC, when modeling the capital structure,  $\Delta ROE = 1.1 - 0.98\% = 0.12$ . For Severstal PJSC,  $\Delta ROE = 1.1 - 1.02 = 0.08$ . For MMK PJSC,  $\Delta ROE = 1.1 - 0.6\% = 0.5$ .

To test this hypothesis, we will forecast the capital structure under the condition of the same percentage growth in  $ROE$  relative to the “zero” period for all analyzed companies.

The lowest  $\Delta ROE$  is noted for PJSC Severstal. The  $ROE_{2021}$  coefficient, which we assume for the “zero” period, is 1.02, and the desired  $ROE_{2023}$  is 1.1. The difference is 0.08 percentage points or 8.16%.

Let's assume the same  $ROE$  growth in the forecast period for PJSC NLMK (Table 7) and MMK PJSC (Table. 8) and we will forecast the capital structure on these terms.

With an increase in  $ROE$  by the same amount, namely by 0.08, the difference in the capital



Table 7

**Forecasting the Capital Structure of PJSC NLMK  $\Delta ROE = 0.08$  in Relation to the “Zero” Period**

| Indicator                                     | Fact 2021 (“zero”) | A Three-factor model | A Five-factor model |
|-----------------------------------------------|--------------------|----------------------|---------------------|
| Multiplier, coefficient                       | 2.49               | 3.32                 | 3.35                |
| Total capital, thousand rubles.               | 704 458 010        | 704 458 010          | 704 458 010         |
| Equity, thousand rubles.                      | 282 876 522        | 212 227 778          | 210 745 663         |
| Borrowed capital, thousand rubles.            | 421 581 488        | 492 230 232          | 493 712 347         |
| Capital structure, Equity/Borrowed Capital, % | 40.2/59.8          | 30.1/69.9            | 29.8/70.2           |
| ROE, ratio of HC                              | 0.98               | 1.06                 | 1.06                |

Source: Compiled by the authors.

Table 8

**Forecasting the Capital Structure of PJSC MMK  $\Delta ROE = 0.08$  in Relation to the “Zero” Period**

| Indicator                                     | Fact 2021 (“zero”) | A Three-factor model | A Five-factor model |
|-----------------------------------------------|--------------------|----------------------|---------------------|
| Multiplier, coefficient                       | 1.58               | 1.89                 | 1.86                |
| Total capital, thousand rubles.               | 578 009 427        | 578 009 427          | 578 009 427         |
| Equity, thousand rubles.                      | 366 198 262        | 306 123 277          | 310 233 196         |
| Borrowed capital, thousand rubles.            | 211 811 165        | 271 886 150          | 267 776 231         |
| Capital structure, Equity/Borrowed Capital, % | 63.4/36.6          | 53.0/47.0            | 53.7/46.3           |
| ROE, ratio                                    | 0.6                | 0.68                 | 0.68                |

Source: Compiled by the authors.

structure when using the three- and five-factor models is:

- for NLMK PJSC — 0.3 percentage points;
- for PJSC Severstal — 0.7 percentage points;
- for MMK PJSC — 0.7 percentage points.

If we assume that  $\Delta ROE = 0.1$  and calculate the capital structure of NLMK PJSC, then we will see that there will be a difference of 0.3 percentage points according to the two models, since the capital structure will consist of 29.6% of own funds and 70.4% borrowed according to the three-factor model and 29.3% of own and 70.7% borrowed funds according to the five-factor model. The capital structure of PJSC Severstal will be represented by the

ratio of 31.4% of equity and 68.6% of debt under the three-factor model and 30.7% of equity and 69.3% of debt under the five-factor model. The difference in the capital structure is 0.7 percentage points. The capital structure of MMK PJSC, which was modeled using two models, results in 51.7% of its own funds and 48.3% borrowed under the three-factor model and 52.4% of its own and 47.6% borrowed under the five-factor model. The difference is 0.7 percentage points.

It is interesting to consider the option of a negative  $\Delta ROE$ , for example,  $-0.1$ .

The difference in NLMK's capital structure when modeled using the three- and five-factor models is 0.4 percentage points; for Severstal,

Table 9

The Results of Modeling the Capital Structure of PJSC NLMK, PJSC Severstal and PJSC MMK,  
 $ROE = 1.1$ ,  $\Delta ROE = 0.08$ ,  $\Delta ROE = 0.1$ ,  $\Delta ROE = -0.1$

| Com-<br>pany           | $ROE_0$ | $ROE = 1.1$        |      |                    |      | $\Delta ROE = 0.08$ |      |                    |      | $\Delta ROE = 0.1$ |      |                    |      | $\Delta ROE = -0.1$ |      |                    |      |
|------------------------|---------|--------------------|------|--------------------|------|---------------------|------|--------------------|------|--------------------|------|--------------------|------|---------------------|------|--------------------|------|
|                        |         | a 3-fact.<br>model |      | a 5-fact.<br>model |      | a 3-fact.<br>model  |      | a 5-fact.<br>model |      | a 3-fact.<br>model |      | a 5-fact.<br>model |      | a 3-fact.<br>model  |      | a 5-fact.<br>model |      |
|                        |         | EC                 | DC   | EC                 | DC   | EC                  | DC   | EC                 | DC   | EC                 | DC   | EC                 | DC   | EC                  | DC   | EC                 | DC   |
| NLMK<br>PJSC           | 0.98    | 29.1               | 70.9 | 28.8               | 71.2 | 30.1                | 69.9 | 29.8               | 70.2 | 29.6               | 70.4 | 29.3               | 70.7 | 36.4                | 65.6 | 36.0               | 64.0 |
| PJSC<br>Sever-<br>stal | 1.02    | 32.0               | 68.0 | 31.3               | 68.7 | 32.0                | 68.0 | 31.3               | 68.7 | 31.4               | 68.6 | 30.7               | 69.3 | 38.2                | 61.8 | 37.3               | 62.7 |
| MMK<br>PJSC            | 0.6     | 32.9               | 67.1 | 33.3               | 66.7 | 53.0                | 47.0 | 53.7               | 46.3 | 51.7               | 48.3 | 52.4               | 47.6 | 71.9                | 28.1 | 72.9               | 27.1 |

Source: Compiled by the authors.

Table 10

#### $\Delta ROS$ Used in Calculations Under 3-Factor and 5-Factor Models

| Indicator      | $ROS_0$ by<br>Net profit<br>margin <sub>0</sub> | $ROS_1$ by<br>Net profit<br>margin <sub>1</sub> | $\Delta ROS$ for<br>the 3-factor<br>model | $ROS_0$ by EBIT<br>Earnings<br>before<br>interests and<br>taxes <sub>0</sub> | $ROS_1$ by EBIT<br>Earnings<br>before<br>interests and<br>taxes <sub>1</sub> | $\Delta ROS$ for<br>the 5-factor<br>model |
|----------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------|
| NLMK PJSC      | 0.35                                            | 0.32                                            | -0.03                                     | 0.41                                                                         | 0.37                                                                         | -0.04                                     |
| PJSC Severstal | 0.35                                            | 0.32                                            | -0.03                                     | 0.4                                                                          | 0.37                                                                         | -0.03                                     |
| MMK PJSC       | 0.28                                            | 0.30                                            | 0.015                                     | 0.35                                                                         | 0.37                                                                         | 0.024                                     |

Source: Compiled by the authors.

it is 0.9 percentage points; and for MMK, it is 1.0 percentage points.

Let's summarize the results. When analyzing changes in the capital structure in modeling using three-factor and five-factor lag models for three companies and four different ways to change  $ROE$ , the following options were considered:

No. 1 — the same  $ROE$  level was set for all companies = 1.1 regardless of the base period;

No. 2 — for all companies  $\Delta ROE = 0.08$  compared to the base 2021;

No. 3 — for all companies  $\Delta ROE = 0.1$  compared to the base 2021;

No. 4 — for all companies  $\Delta ROE = -0.1$  compared to the base 2021.

The results of capital structure modeling for all  $ROE$  variation options are presented in Table 9.

The information presented in Table 9 allows us to draw the following conclusions.

For two companies (NLMK PJSC and Severstal PJSC) for all options for changing the return on equity, the five-factor lag model shows a larger share of borrowed capital compared to the three-factor one. This is due to the presence of tax and interest burden coefficients in the five-factor model, the values of which are less than or equal to one. The other three indicators (return on sales, asset turnover, and multiplier) are present in both models.  $\Delta ROS$  for both net profit and  $EBIT$  for these

Table 11

**The Difference in the Capital Structure When Forecasting Using Three- and Five-Factor Lag Model  
(Four Variants of  $\Delta ROE$ )**

| Company        | ROE <sub>0</sub> | ROE 1,1     |       |                                              | ΔROE = 0.08 |      |                                              | ΔROE = 0.1  |      |                                                         | ΔROE = −0.1    |      |                                                         | Average ΔROE |
|----------------|------------------|-------------|-------|----------------------------------------------|-------------|------|----------------------------------------------|-------------|------|---------------------------------------------------------|----------------|------|---------------------------------------------------------|--------------|
|                |                  | ΔROE        |       | Difference in capital structure, abs. units. | ΔROE        |      | Difference in capital structure, abs. units. | ΔROE        |      | The Difference in the capital structure, in abs. units. | ΔROE           |      | The Difference in the capital structure, in abs. units. |              |
|                |                  | abs. units. | %     |                                              | abs. units. | %    |                                              | abs. units. | %    |                                                         | in abs. units. | %    |                                                         |              |
| NLMK PJSC      | 0.98             | 0.12        | 12.25 | 0.3                                          | 0.08        | 8.16 | 0.3                                          | 0.1         | 10.2 | 0.3                                                     | −0.1           | 10.2 | 0.4                                                     | 0.33         |
| PJSC Severstal | 1.02             | 0.08        | 7.84  | 0.7                                          | 0.08        | 7.84 | 0.7                                          | 0.1         | 9.8  | 0.7                                                     | −0.1           | 9.8  | 0.9                                                     | 0.75         |
| MMK PJSC       | 0.6              | 0.5         | 83.3  | 0.4                                          | 0.08        | 13.3 | 0.7                                          | 0.1         | 16.7 | 0.7                                                     | −0.1           | 16.7 | 1.0                                                     | 0.7          |

Source: Compiled by the authors.

Table 12

**Changes in  $\Delta ROS$ ,  $\Delta Y$  and  $\Delta I_b$  for the Analyzed Companies**

| Company        | Indicator    | A 3-factor model | A 5-factor model | The average capital structure difference between a 3-factor and a five-factor model |
|----------------|--------------|------------------|------------------|-------------------------------------------------------------------------------------|
| NLMK PJSC      | $\Delta ROS$ | -0.03            | -0.04            | 0.33                                                                                |
|                | $\Delta Y$   | -0.12            | -0.12            |                                                                                     |
|                | $\Delta I_b$ | -                | -0.01            |                                                                                     |
| PJSC Severstal | $\Delta ROS$ | -0.03            | -0.03            | 0.75                                                                                |
|                | $\Delta Y$   | -0.13            | -0.13            |                                                                                     |
|                | $\Delta I_b$ | -                | -0.03            |                                                                                     |
| MMK PJSC       | $\Delta ROS$ | 0.0015           | 0.024            | 0.7                                                                                 |
|                | $\Delta Y$   | -0.14            | -0.14            |                                                                                     |
|                | $\Delta I_b$ | -                | 0                |                                                                                     |

Source: Compiled by the authors.

companies has a negative value of -0.03. For MMK PJSC, the value of  $\Delta ROS$  is positive when forecasting, that is, the expected return on sales is 37%, which is more than the achieved value in the “base” 2021, therefore, the share of equity in the structure of the company’s total capital increases during forecasting. This is because  $\Delta ROS$  compensates for the effect of tax and interest burden coefficients less than 1.

For clarity, information about  $\Delta ROS$  used in calculations based on three- and five-factor models is systematized in Table 10.

Comparison of the data presented in Tables 9 and 10 allow us to conclude that with an increase in return on sales, the share of equity in the company’s total capital structure increases, and against the background of a decrease in return on sales, the share of

borrowed capital increases to ensure a given return on equity (the multiplier  $M$  increases).

The difference in the capital structure in forecasting using the three- and five-factor lag models is presented in *Table 11*.

Within a single company, with different options for changing  $ROE$ , there is a similarity in the magnitude of the difference in the capital structure when forecasting using three-factor and five-factor models. Thus, for NLMK PJSC, the difference in the capital structure predicted using three- and five-factor models averages 0.33 percentage points, that is, on average, at different levels of desired  $ROE$ , the share of borrowed capital in modeling using the five-factor model is 0.33 percentage points more than the three-factor model, and equity is the same amount less. According to PJSC Severstal, the difference in the capital structure when modeling using the three- and five-factor models averages 0.75 percentage points. According to MMK, the difference in the capital structure when using 3- and 5-factor lag models is 0.7 percentage points. This allows us to conclude that forecasting the capital structure using 3- and 5-factor models shows a slight (less than one percentage point) difference in the structure of total capital. Since for each company individually, fluctuations in the capital structure when forecasting using three- and five-factor models with a change in the set value of  $ROE$  are relatively stable, and  $\Delta ROE$  are different, therefore, the assumption that the difference in the capital structure when forecasting using different models depends on  $\Delta ROE$  has not been confirmed. This means that the forecast result is influenced by the values of changes in internal indicators, namely:  $\Delta ROS$ ,  $\Delta Y$ ,  $\Delta I_b$ ,  $\Delta T_b$ .

Generalized information on changes in return on sales  $\Delta ROS$ , asset turnover  $\Delta Y$  and the percentage burden coefficient  $\Delta I_b$  for the analyzed companies is presented in *Table 12*. In the five-factor model, when forecasting the capital structure, the tax burden coefficient  $\Delta T_b$  taken equal to the "base" period, i.e.  $\Delta T_b = 0$ , since the income tax rate in Russia has not changed since 2012 and is 20%. Therefore, the dynamics of this indicator is not given in *Table 12*.

Resource allocation  $Y$  is calculated equally in both the three-factor and five-factor models, namely as the ratio of revenue to assets (total capital). Therefore, the difference in modeling is due to  $\Delta ROS$  and  $\Delta I_b$ . Moreover, if  $\Delta ROS$  (increase in return on sales) is greater than  $\Delta I_b$  (increase in interest burden), then the share of equity will increase. In addition, the capital structure calculated using the five-factor lag model provides a slightly higher share of borrowed capital than when modeling using the three-factor model against the background of lower return on sales.

## CONCLUSIONS

1. The choice of a model for forecasting the capital structure should be based on the availability and objectivity of information for calculation. As the three-factor and five-factor lag models produce a very similar result for the capital structure, it would be more appropriate to use a three-factor model in situations where information is limited. This is because the data for calculating indicators is contained in accounting statements and only two indicators need to be predicted: expected return on sales and asset turnover.

2. In order to consider the impact of debt costs and the tax burden on the capital structure, while achieving a given level of return on equity, it is recommended to use a five-factor lag model. However, the accuracy of the model will depend on the accuracy of forecasts for four key indicators: return on sales, asset turnover, interest rate and tax burden. The calculation and forecasting of these indicators require information about changes in interest rates, tax rates, market prices and costs, which can make calculations more complex.

3. The difference in equity and debt capital shares when modeling using the three- and five-factor models varies for each company. Regardless of how  $ROE$  (return on equity) changes, the trend of the capital structure remains the same. Therefore, we believe it is necessary to perform forecasting using both models, and in practice, the obtained forecast results should be used as a range for possible changes in the total capital structure.

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# The Study of Stochastic Ranking Scales for Financial Risks of Different Levels of Catastrophicity

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## ABSTRACT

The concept of stochastic order between random variables has been formed and developed in science since the middle of the 20th century. However, it was only in the last decade that these concepts began to penetrate into risk management applications and into the actuarial field. This has made it possible for them to become an actively developing area, allowing us to compare the risk factors themselves, as well as the level of hazards (risks) associated with them. **The purpose** of this work is to develop recommendations for solving the problem of comparing various risks and to propose methods for comparing risks with different degrees of catastrophicity. The relations of stochastic and dispersion orders in a set of risks are investigated. As **a result**, a study of these orders is carried out using risk measures  $VaR$ , as well as risk measures  $VaR^{(t)}$  ( $VaR$  to the power of  $t$ ), introduced into scientific use in recent years. The description of these orders is analyzed using the stop loss **method** of risk transformation, as well as the danger rate **method**. In addition, in this study, for well-known examples of loss distributions are given that find wide application in risk management and actuarial science. Simple methods are obtained to allow one to compare risks under these distributions, which are expressed through the parameters of these distributions. The results and methods presented in this work may be of interest to both practitioners and researchers involved in the problems of risk management and the actuarial fields.

**Keywords:** stochastic order; dispersion order; stop loss risk transformation; danger rate; risk measure  $VaR$ ; risk measure  $VaR$  to the power of  $t$ ; spreads  $VaR$  and  $VaR$  to the power of  $t$

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## INTRODUCTION

Due to their expertise in statistics, finance, and business, risk managers help companies assess risks and create policies to minimize them. They help reduce the financial impact of risks on companies and their customers.

One of the main tasks of risk managers is assessing risks and developing strategies to minimize their cost. This is why businesses need risk managers to ensure their operations are safe and profitable.

Risk comparison is at the heart of the risk management profession. Every business faces different risks, and risk managers must place these risks in order to manage them effectively.

There are two reasons why some risks may be more preferable than others. One reason is that some risks are greater in magnitude, while others have a wider range of possible outcomes. A wider range means that there is a higher probability of extreme outcomes, which can make the risk seem more unpredictable.

However, it's important to clarify what we mean by "lighter tail" and "heavier tail". We cannot expect that one risk will always have values that are less than those of another risk, as this would be impossible to predict.

Ultimately, risk managers need to carefully consider all the factors involved in each risk in order to make informed decisions about how to manage them. But from the perspective of possible significant, in a certain sense, realizable losses, one risk may be more preferable than another. The heaviness of the tail can also be measured using different metrics, and this can lead to different risk comparison scales.

When we can measure the risk associated with different random variables, our goal is to formalize the idea that one risk is more dangerous than another. We could base our comparison on a single measure of risk, but the result is too rough. Instead, we prefer to use a wide range of risk measures, which leads to different orders among random variables representing risks. These orders are called stochastic orders, and they allow us to compare probabilistic measurements.

The easiest way to rank risky situations is to calculate a measure of risk and sort random prospects according to its values. However, in many cases, even if a risk measure seems reasonable in the given context, the values of associated parameters, such as confidence probabilities and distortion functions  $VaR$  and  $ES$ , are not uniquely determined by the problem at hand. Therefore, risk managers often want more than a simple comparison based on a single risk measure. They may request that the risk be more favorable under any of a range of specified risk measures. This leads to a partial order, rather than a complete order (i.e., the risk manager no longer has an order for every pair of risks). This is known as a stochastic order.

The so-called stochastic order is undoubtedly well-known and seems to be the most intuitive stochastic order. It was introduced back in Lehmann [1] and analyzed by Kamae et al. [2]. However, in recent decades, a large number of other orders have emerged, mainly based on the motivation of various fields of application (statistics, queue theory, reliability theory, economics, biomathematics, actuarial science, physics, etc.). They generated a huge amount of literature, culminating in a bibliography in Mosler, Scarsini [3] and books by Shaked, Shantikumar [4], and Müller, Stoyan [5].

In recent decades, this interest has grown to such an extent that partial orders have become one of the most important tools for comparing the riskiness of various random situations. Interesting actuarial applications of stochastic orders are discussed in books by Goovaerts et al. [6] and Kaas et al. [7].

In this paper, we continue to study some partial orders in a variety of risks using both the well-known risk measure  $VaR$  and a relatively new family of risk measures " $VaR$  to the power of  $t$ " (see Minasyan [8, 9]).

## STOCHASTIC ORDER RELATIONSHIPS BETWEEN RISKS

### Partial Orders between Distribution Functions

Most of the order relations that we consider in this paper are partial orders on the set

of distribution functions. Let's clarify this concept.

### Definition 1

Let  $\Psi$  be the set of one — dimensional distribution functions of various random variables representing the risk factors we are interested in. The binary relation, which we will denote by  $(\leq)$ , is a partial order on  $\Psi$  if for any elements of the distribution functions of random variables  $X, Y$  and  $Z: F_X, F_Y$  and  $F_Z$  the following properties are true:

- (i) if  $F_X \leq F_Y$  and  $F_Y \leq F_Z$ , then  $F_X \leq F_Z$  (transitivity);
- (ii)  $F_X \leq F_X$  (reflexivity);
- (iii) if  $F_X \leq F_Y$  and  $F_Y \leq F_X$ , then  $F_X \equiv F_Y$  (antisymmetry).

If, moreover, for any given pair  $F_X$  and  $F_Y$  elements  $\Psi$  either  $F_X \leq F_Y$  or  $F_Y \leq F_X$ , then such an order is considered a complete order.

Although the order relations used are often defined on sets of distribution functions, it is often convenient not to distinguish between the order relation for distribution functions and the corresponding relation for random variables.

Expanding the notation, we write  $X \leq Y$ , but in fact we mean  $F_X \leq F_Y$ . In other words, when we say that the risk  $X$  is less than the risk  $Y$  with respect to the stochastic order, we are actually arguing that this order is true for the corresponding distribution functions of these risks. Therefore, the joint distribution of  $X$  and  $Y$  does not matter here. Only their one-dimensional distributions are important. If  $X \leq Y$ , then  $X \leq \tilde{Y}$  it is also true for any random variable with the same one-dimensional distribution as  $Y$ .

In such situations, we should not assume that the random variables being compared are defined on the same probability space. However, the question then remains: can we construct versions of random variables of interest that satisfy some additional properties on the same probability space?

### Stochastic Dominance and $VaR$

To compare a pair of risks  $X$  and  $Y$ , it seems natural to resort to the concept  $VaR$  and consider  $X$  less dangerous than  $Y$  if

$VaR[X, p_0] \leq VaR[Y, p_0]$ , for a given level of confidence probability  $p_0$ . However, sometimes it is difficult to choose such  $p_0$  that exactly matches your concerns about these risks, and it is possible that both  $VaR[X, p_0] \leq VaR[Y, p_0]$  and  $VaR[X, p_1] \geq VaR[Y, p_1]$  at the same time for two levels of confidence probabilities  $p_0$  and  $p_1$ . Therefore, it seems reasonable to adopt the following criterion: we place  $X$  before  $Y$  (it is less dangerous) if  $VaR$  for  $X$  is less than the corresponding  $VaR$  for  $Y$ , for any confidence probability level  $p$ .

### Definition 2

Let  $X$  and  $Y$  be two random variables. Then they say that  $X$  is no more than  $Y$  in the sense of stochastic dominance, and denote this as  $X \leq_{ST} Y$ , if the inequality  $VaR[X, p] \leq VaR[Y, p]$  is satisfied for all  $p \in [0, 1]$ .

Let's start with a few simple but important points.

### Remark 1

A comparison  $X \leq_{ST} Y$  is true only if the inequality  $F_X(x) \geq F_Y(x)$  holds for all  $x \in R$ .

The proof of this fact obviously follows from the definition of the risk measure  $VaR$ .

### Remark 2

If  $Pr[X \leq Y] = 1$ , then  $X \leq_{ST} Y$ .

(Hereafter,  $Pr[A]$  denotes the probability of event  $A$ ).

### Proof

It follows from  $Pr[X \leq Y] = 1$  that  $F_X(x) \geq F_Y(x)$  for any  $x$ . Therefore, inequality  $VaR[X, p] \leq VaR[Y, p]$  is satisfied for all  $p \in [0, 1]$ , which means  $X \leq_{ST} Y$ .

### Remark 3

Obviously, the comparison  $X \leq_{ST} Y$  is true only if  $-Y \leq_{ST} -X$ .

The following statement, proved by Kaas et al. [10], is also true.

### Statement 1

Two random variables  $X$  and  $Y$  satisfy the relation  $X \leq_{ST} Y$  if and only if there exist



random variables  $\tilde{X}$  and  $\tilde{Y}$  are such that  $X = {}_d\tilde{X}$  and  $Y = {}_d\tilde{Y}$  and with  $Pr[X \leq Y] = 1$ . (For the proof, see Kaas et al. [10]).

Here, the designation  $X = {}_d\tilde{X}$  means that  $X$  and  $\tilde{X}$  coincide in distribution.

Stochastic dominance and related properties are used in modern insurance to determine premium levels for insurance of various risks. In risk management, it is used in determining the order (priority) of risk management, as well as in determining the funds allocated to manage a particular risk.

In reinsurance of a set of risks, these methods are used to determine the reinsurance level at which reinsurance of each of the risks will be implemented.

The standard references on stochastic order  $\leq_{ST}$ , including appendices, are books by Lehmann [11], Marshall, Olkin [12], Ross [13] and Stoyan [14].

### Examples of Stochastic Dominance for Risks with Different Distribution Functions

**Example 1.** Risks with an even distribution of losses.

Let us denote the set of random variables uniformly distributed on the segment  $[a, b]$  through  $Uni[a, b]$ . And let's consider two risks  $X$  and  $Y$ , moreover,  $X \in Uni[a, b]$  and  $Y \in Uni[c, d]$ .

In this case, it is possible to prove (see Appendix 1) the validity of the following sentence.

#### Proposal 1

Suppose we have two potential risks  $X$  and  $Y$ , additionally  $X \in Uni[a, b]$ , and  $Y \in Uni[c, d]$ .

The relationship  $X \leq_{ST} Y$  is true if and only if one of the following situations is met:

1)  $b \leq c$ , that is, if the right end of the segment is  $[a, b]$  is to the left of the left end of the segment  $[a, b]$ ;

2)  $b \geq c$ ,  $b - a \geq d - c$  and  $d \geq b$ , that is, if the length of the segment  $[a, b]$  is greater than the length of the segment  $[c, d]$ , the left end of the segment  $[c, d]$  it is located to the right of the right end of the segment  $[a, b]$ , and the right end of the segment  $[c, d]$  it is located to the right of the right end of the segment  $[a, b]$ .

3)  $b \geq c \geq a$ ,  $b - a \leq d - c$ , that is, if the length of the segment is  $[a, b]$  less than the length of the segment  $[c, d]$ , and the left end of the segment  $[c, d]$  is located inside the segment  $[a, b]$ .

**Example 2.** Risks with a shifted exponential loss distribution.

Let's denote the set of random variables with the following distribution function:

$$F(x) = 1 - \exp(-k(x-a)), \text{ if } x \geq a \\ F(x) = 0, \text{ in other cases,}$$

where  $k > 0$ , and  $a \in R$  through  $Exp(k, a)$  (in particular, when  $a = 0$ , the usual exponential distribution with a parameter  $k > 0$  is obtained). And consider two risks  $X$  and  $Y$ , moreover  $X \in Exp(k_1, a_1)$ , and  $Y \in Exp(k_2, a_2)$ .

First, we obtain the expression for  $Var[X, p]$ .

According to the definition  $Var[X, p]$ ,  $p = Pr[X < Var[X, p]] = 1 - \exp(-k(Var[X, p] - a))$ , means,  $1 - p = \exp(-k(Var[X, p] - a))$ , which means that

$$Var[X, p] = a - \frac{\ln(1-p)}{k}. \quad (1)$$

The ratio  $X \leq_{ST} Y$  is equivalent to the inequality  $Var[X, p] \leq Var[Y, p]$  for all  $p$  from the interval  $[0, 1]$ , which, according to formula (1), is equivalent to fulfilling the inequality

$$a_1 - \frac{\ln(1-p)}{k_1} \leq a_2 - \frac{\ln(1-p)}{k_2} \quad (2)$$

For any  $p$  from  $[0, 1]$ .

Let us choose, in particular,  $p = 0$ , then from inequality (2) we obtain  $a_1 \leq a_2$ .

However, then inequality (2) equals the inequality

$$\frac{1}{k_1} - \frac{1}{k_2} \leq \frac{a_1 - a_2}{\ln(1-p)}.$$

But it's easy to understand that the right-hand side of this inequality is a function of the variable  $p$ , which takes only positive values, filling in the interval  $(0, +\infty)$ .

Hence, in order to fulfill inequality (2) for all  $p$  from the interval  $[0, 1]$ , it is necessary and sufficient that the inequality be fulfilled

$$\frac{1}{k_1} - \frac{1}{k_2} \leq 0 \text{ or } k_2 \leq k_1.$$

Thus, the following proposal is true.

### Proposal 2

Let's consider we have two risks  $X$  and  $Y$ , moreover  $X \in \text{Exp}(k_1, a_1)$ , and  $Y \in \text{Exp}(k_2, a_2)$ .

Then the ratio  $X \leq_{ST} Y$  is satisfied only if the following conditions  $a_1 \leq a_2$  and  $k_2 \leq k_1$  are met.

**Example 3.** Risks with a normal loss distribution.

Let's denote the set of random variables with a normal loss distribution with parameters  $m$  and  $s$  by  $\text{Nor}(m, s)$ . And consider two risks  $X$  and  $Y$ , moreover  $X \in \text{Nor}(m_1, s_1)$ , and  $Y \in \text{Nor}(m_2, s_2)$ .

As is known (see, for example, [14]), if  $X \in \text{Nor}(m, s)$ , then

$$\text{VaR}[X, p] = m + k_p s,$$

where  $k_p$  — quantile of a standard normal distribution with confidence probability  $p$ .

The ratio  $X \leq_{ST} Y$  is equivalent to the inequality  $\text{VaR}[X, p] \leq \text{VaR}[Y, p]$

for all  $p$  from the interval  $[0, 1]$ . Which is equivalent to fulfilling the inequality  $m_1 + k_p s_1 \leq m_2 + k_p s_2$  for any  $p$  in the range  $[0, 1]$ .

It follows that

$$k_p [s_1 - s_2] \leq m_2 - m_1. \quad (3)$$

Consider the first case: 1)  $s_1 > s_2$ . Then inequality (3) is equivalent to fulfilling the inequality

$$k_p \leq \frac{m_2 - m_1}{s_1 - s_2}$$

for any  $p$  in the range  $[0, 1]$ , which is impossible based on the properties of the quantile of the standard normal distribution. Consider the second case: 2)  $s_1 < s_2$ , then inequality (3) is equivalent to fulfilling the inequality

$$k_p \geq \frac{m_2 - m_1}{s_1 - s_2}$$

for any  $p$  in the range  $[0, 1]$ , which is also impossible based on the properties of the quantile of the standard normal distribution.

Consider the third case: 3)  $s_1 = s_2$ . Then from inequality (3) we obtain  $m_2 \geq m_1$ .

Thus, the following proposal 3 is true.

### Proposal 3

Let's consider that we have two risks  $X$  and  $Y$ , moreover

$X \in \text{Nor}(m_1, s_1)$ , and  $Y \in \text{Nor}(m_2, s_2)$ .

Then:

If  $s_1 \neq s_2$ , then risks  $X$  and  $Y$  stochastically not comparable;

If  $s_1 = s_2$ , then  $X \leq_{ST} Y$  if and only if  $m_2 \geq m_1$ .

That is, normally distributed risks are comparable from the point of view of stochastic comparison, only if the volatility of these risks is equal, and in this case one of the risks does not exceed the other, if the expected loss on it does not exceed the expected loss on the second.

**Example 4.** Risks with a triangular distribution of losses.

Let's denote the set of random variables with a triangular distribution on the segment  $[a, b]$  and a mode  $m$  through  $\text{Tr}[a, b, m]$ . And consider the two risks  $X$  and  $Y$ , where  $X \in \text{Tr}[a, b, m_1]$  and  $Y \in \text{Tr}[a, b, m_2]$ , meanwhile  $m_1 < m_2$ .

In this case, it is possible to prove (see Appendix 2) the validity of the following sentence.

### Proposal 4

Let us have two risks  $X$  and  $Y$ , where  $X \in \text{Tr}[a, b, m_1]$ , and  $Y \in \text{Tr}[a, b, m_2]$ . Meanwhile  $m_1 < m_2$ .

Then the relation  $X \leq_{ST} Y$  holds in two cases:

$$\begin{aligned} &\text{if } m_1 < m_2 \leq a(1-p) + pb; \\ &\text{if } a(1-p) + pb \leq m_1 < m_2. \end{aligned}$$

In the third case, when

$$m_1 \leq a(1-p) + pb \leq m_2,$$

relation  $X \leq_{ST} Y$  is not true, and dominance  $Y \leq_{ST} X$  can be either performed or not — depending on the ration of parameters  $a, b, m_1, m_2$ .

It is interesting how the stochastic dominance ratio can be expressed in terms of risk “ $VaR$  to the power of  $t$ ”,  $VaR^{(t)}[X, p]$  introduced and investigated in [8]. For any true value  $t \geq 1$ . The answer to this question is given in the following statement:

**Statement 2**

If  $X \leq_{ST} Y$ , then inequality

$VaR^{(t)}[X, p] \leq VaR^{(t)}[Y, p]$  is true under all  $t \geq 1$  for all  $p \in [0, 1]$ .

If inequality  $VaR^{(t)}[X, p] \leq VaR^{(t)}[Y, p]$  is true under at least one value  $t = t_0 \geq 1$  for all  $p \in [0, 1]$ , then  $X \leq_{ST} Y$ .

The proof of the claim can be found in *Appendix 3*.

It follows from statement 2 that risk  $VaR^{(t)}$  are applicable to determine the stochastic dominance of risks. And the risk  $X$  is less risky than  $Y$  in the sense of stochastic dominance if the inequality  $VaR^{(t)}[X, p] \leq VaR^{(t)}[Y, p]$  is true for at least one value  $t = t_0 \geq 1$  for all  $p \in [0, 1]$ .

Based on this, it is natural to introduce a definition:

**Definition 3**

Let  $X$  and  $Y$  be two random variables representing the corresponding risk factors. Then it is said  $X$  to be less than  $Y$  in the sense of stochastic dominance of degree  $t$ , and denoted as  $X \leq_{ST^{(t)}} Y$ , if the inequality  $VaR^{(t)}[X, p] \leq VaR^{(t)}[Y, p]$  is satisfied for all  $p \in [0, 1]$ .

Then Statement 1 can be reformulated as follows:

**Statement 3**

If  $X \leq_{ST} Y$ , then comparison  $X \leq_{ST^{(t)}} Y$  is true for all  $t \geq 1$ .

If comparison  $X \leq_{ST^{(t)}} Y$  is true for at least one value  $t = t_0 \geq 1$ , then  $X \leq_{ST} Y$ .

Stochastic dominance can also be characterized by relative inverse distribution functions defined as  $x \rightarrow VaR[X, F_Y(x)]$ .

This is nothing more than  $VaR$  from  $X$  at the level of confidence probability  $p = F_Y(x)$ .

In [14], the following Statement (propositions 3.3.2 and 3.3.3) was proved,

representing necessary and sufficient conditions for stochastic dominance.

**Statement 4**

For two risks  $X$  и  $Y$ , the ratio  $X \leq_{ST} Y$  is true if and only if  $VaR[X, F_Y(x)] \leq x$  for all  $x$ .

Let  $X$  and  $Y$  risks with continuous distribution functions. In this case, the ratio is  $X \leq_{ST} Y$  true if and only if  $F_X(VaR[Y, p]) \geq p$  for all  $0 < p < 1$ .

Combining statements 4 and 3, we can conclude that the following Statement is true.

**Statement 5**

Let  $X$  and  $Y$  — be random variables with continuous distribution functions. If at least one of the conditions is met:

$VaR[X, F_Y(x)] \leq x$  for all  $x$ ;

$F_X(VaR[Y, p]) \geq p$  for all  $0 < p < 1$ ,

Then comparison  $X \leq_{ST^{(t)}} Y$  is true under all  $t \geq 1$ .

If comparison  $X \leq_{ST^{(t)}} Y$  is true for at least one value  $t = t_0 \geq 1$ , then the following two conditions will be fulfilled simultaneously:

$VaR[X, F_Y(x)] \leq x$  for all  $x$ ;

$F_X(VaR[Y, p]) \geq p$  for all  $0 < p < 1$ .

In [14] the following Statement is presented:

**Statement 6**

For any random variables  $X$  and  $Y$ , the comparison  $X \leq_{ST} Y$  is true if and only if the inequality  $r_g[X] \leq r_g[Y]$  holds for all measures of distortion risk  $r_g$  with a nonzero distortion function  $g$ .

Then the validity of the following statement follows from statement 3:

**Statement 7**

For any random variables  $X$  and  $Y$  the comparison  $X \leq_{ST^{(t)}} Y$  is true if and only if the inequality  $r_g[X] \leq r_g[Y]$  holds for all measures of distortion risk  $r_g$  with a non-zero distortion function  $g$ .

That is, if a comparison  $X \leq_{ST^{(t)}} Y$  is true for some  $t$ , then those making decisions about comparing risks based on  $X \leq_{ST^{(t)}} Y$  will prefer risk  $X$  over risk  $Y$ , and, for any measure, risk

of distortion  $r_g$  with  $g \neq 0$  and vice versa. The following Statement is given in [14] (Statement 3.3.4):

**Statement 8**

For any random variables  $X$  and  $Y$ , a comparison  $X \leq_{ST} Y$  is true if and only if the inequality  $E[v(X)] \leq E[v(Y)]$  holds for all non-decreasing functions  $v$ , for which these expected values exist.

Then the validity of the following statement follows from statement 3:

**Statement 9**

For any random variables  $X$  and  $Y$ , a comparison  $X \leq_{ST^{(t)}} Y$  is true if and only if the inequality  $E[v(X)] \leq E[v(Y)]$  holds for all non-decreasing functions  $v$  for which these expected values exist.

**PREMIUMS ON STOP-LOSS  
CONTRACTS FOR DIFFERENT RISKS  
AND THE STOCHASTIC ORDER  
BETWEEN THEM**

In the financial and insurance industries, so-called stop-loss contracts are often used, which allow you to receive compensation when a certain risk value  $X$  exceeds a certain threshold value  $t$ . The value (where  $Y_+ = \max\{Y, 0\}$ ) represents the size of the excess itself over the threshold  $t$ .

**Definition 4**

The function  $p_X(t) = E[(X - t)_+]$  is called stop loss conversion  $X$ .

Premiums for stop-loss contracts are calculated based on the value of the stop-loss conversion. For more information on the use and calculation of stop-loss premiums, see Kaas [16].

It is useful to provide some properties of the “stop loss”  $p_X$  conversion (see [14] property 1.7.2).

**Property**

Let's consider that  $E[|X|] < +\infty$ . The stop-loss conversion  $X$  has the following properties:

(i) it is decreasing and convex;

(ii)  $\lim_{t \rightarrow \infty} p_X(t) = 0$  and  $\lim_{t \rightarrow -\infty} \{p_X(t) + t\} = E[X]$ .

The next result regarding the order ratio  $\leq_{ST}$  is related to the stop loss conversion.

**Statement 10** (See [14])

Given two random variables  $X$  and  $Y$ ,  $X \leq_{ST} Y$  if and only if  $p_Y - p_X$  does not increase in the area  $(-\infty, +\infty)$ .

Statement 2 implies the validity of the following statement:

**Statement 11**

For given two random variables  $X$  and  $Y$   $X \leq_{ST^{(t)}} Y$  for a certain  $t$  if and only if  $p_Y - p_X$  does not increase in the range  $(-\infty, +\infty)$ .

It is interesting to interpret the latest statements from the perspective of risk management.

They point out that when  $X \leq_{ST^{(t)}} Y$  is true, the difference between their respective stop loss premiums decreases as the threshold level  $t$  increases. Since  $\lim_{t \rightarrow +\infty} (E[(Y - t)_+] - E[(X - t)_+]) = 0$ , the largest difference between premiums occurs when  $t = 0$  (and is equal to  $E[Y] - E[X]$ ). And this difference decreases as the threshold level increases. Thus, evaluating stop-loss contracts for risks that are comparable in accordance with the order  $\leq_{ST^{(t)}}$  leads to very different premiums at small thresholds, but this difference will decrease as this level increases.

**Comparing deficits with stochastic dominance:  
The order of variance**

Now we will take a different path, and we will compare deficits instead of risks  $X$  and  $Y$ . This leads to the following definition.

**Definition 5**

For these two risks  $X$  and  $Y$ , it is said that  $X$  is lower than  $Y$  in the order of variance, and denoted as  $X \leq_{\text{DISP}} Y$

if  $(X - \text{VaR}[X, p])_+ \leq_{ST} (Y - \text{VaR}[Y, p])_+$  for all  $0 < p < 1$ .

Early references to the relation of order  $\leq_{\text{DISP}}$  are related to the works of Doksum [17], Deshpande, Kochar [18]. See also Bartoszewicz [19, 20], Munoz-Perez [21] and Landsberger, Meilijson [22, 23].



**Remark**

The relation  $\leq_{\text{DISP}}$  is reflexive and transitive, but not antisymmetric on the set of distribution functions. Indeed, if  $X \leq_{\text{DISP}} Y$  and  $Y \leq_{\text{DISP}} X$  are both true at the same time, it means that  $Y = {}_d X + c$  for some constant  $c$ . This is easily seen from the fact that

$$(X' - \text{VaR}[X', p]) = {}_d (X - \text{VaR}[X, p])$$

if  $X' = {}_d X + c$ .

Using the concept of “ $\text{VaR}$  to the power of  $t$ ”, we introduce a more general concept of the order of variance of degree  $t$  for any  $t \geq 1$ .

**Definition 6**

For these two risks  $X$  and  $Y$ , we will say that  $X$  is less than  $Y$  in the order of variance of degree  $t$ ,  $t \geq 1$ , and denote as  $X \leq_{\text{DISP}^{(t)}} Y$ , if and only if  $(X - \text{VaR}^{(t)}[X, p])_+ \leq_{ST} (Y - \text{VaR}^{(t)}[Y, p])_+$  for all  $0 < p < 1$ .

It is interesting how the ratio of the dispersed order can be expressed in terms of the ratio of the dispersed order of degree  $t$  for any real value  $t \geq 1$ .

**Statement 12**

If  $X \prec_{\text{DISP}} Y$ , then ratio  $X \leq_{\text{DISP}^{(t)}} Y$  is true for all  $t \geq 1$ . If the ratio  $X \leq_{\text{DISP}^{(t)}} Y$  is true for at least one  $t = t_0 \geq 1$  value, then  $X \leq_{\text{DISP}} Y$ .

The proof is given in *Appendix 4*.

It follows from *Statement 1* that risk measures  $\text{VaR}^{(t)}$  are applicable to determine the stochastic dominance of risks. And the risk  $X$  is less risky than  $Y$  in the sense of stochastic dominance if the inequality  $\text{VaR}^{(t)}[X, p] \leq \text{VaR}^{(t)}[Y, p]$  is true for at least one  $t = t_0 \geq 1$  value for all  $p \in [0, 1]$ .

## ORDER OF VARIANCE AND SPREADS $\text{VaR}$

Some stochastic orders are based on the distances between the corresponding  $\text{VaR}$  basic random variables. The dispersion order has this property related to the difference between  $\text{VaR}$  (see [14], Property 3.3.60).

**Property**

For given two random variables  $X$  and  $Y$ ,  $X \leq_{\text{DISP}} Y$  is true if and only if

$\text{VaR}[X, p_2] - \text{VaR}[X, p_1] \leq \text{VaR}[Y, p_2] - \text{VaR}[Y, p_1]$  each time  $0 < p_1 \leq p_2 < 1$ , or equivalently if  $\text{VaR}[Y, p] - \text{VaR}[X, p]$  increases by  $p \in (0, 1)$ .

It can be seen from this property that  $\leq_{\text{DISP}}$  is indeed the order of variance.

Risk measures  $\text{VaR}^{(t)}$  have a similar property.

**Statement 13**

For given two random variables  $X$  and  $Y$ ,  $X \leq_{\text{DISP}} Y$  is true if and only if

$$\begin{aligned} \text{VaR}^{(t)}[X, p_2] - \text{VaR}^{(t)}[X, p_1] &\leq \\ &\leq \text{VaR}^{(t)}[Y, p_2] - \text{VaR}^{(t)}[Y, p_1] \end{aligned}$$

for any  $t \geq 1$  every time when  $0 < p_1 \leq p_2 < 1$  or, equivalently, if and only if

$\text{VaR}^{(t)}[Y, p] - \text{VaR}^{(t)}[X, p]$  increases by  $p \in (0, 1)$ .

The proof is given in *Appendix 5*.

The following useful Statement follows from the previous Property:

**Statement 14**

For the given two random variables  $X$  and  $Y$ , which satisfy the relation  $X \leq_{\text{DISP}^{(t)}} Y$  is true for a certain  $t \geq 1$  value, the relation is also true  $X \leq_{\text{ST}} Y$  if the value of the left boundary point of the value carrier  $Y$  is greater than or equal to the value of the left boundary point of the value carrier  $X$ .

**Proof**

If  $X \leq_{\text{DISP}^{(t)}} Y$ , then it follows from the previous statement that

$$\begin{aligned} \text{VaR}^{(t)}[Y, p] - \text{VaR}^{(t)}[X, p] &\geq \\ &\geq \text{VaR}^{(t)}[Y, 0] - \text{VaR}^{(t)}[X, 0] \geq 0. \end{aligned}$$

Moreover, the latter inequality obviously follows from the fact that the value of the left boundary point of the magnitude carrier  $Y$  is greater than or equal to the value of the left boundary point of the magnitude carrier  $X$  and the meaning of the risk measure  $\text{VaR}^{(t)}$ .

### Examples of Variance Dominance for Risks with Different Distribution Functions

**Example 5.** Risks with an even distribution of losses. Let's consider two risks  $X$  and  $Y$ , moreover  $X \in \text{Uni}[a, b]$ , and  $Y \in \text{Uni}[c, d]$ .



But for risks with distributions from  $Uni[a, b]$ , the formula  $VaR[X, p] = a + (b - a)p$  is true.

Therefore,

$$VaR[Y, p] - VaR[X, p] = c + (d - c)p - a - (b - a)p = c - a + (a + d - (b + c))p.$$

It can be seen that this is a function of the variable  $p$  is non-decreasing if and only if  $a + d \geq b + c$ , i.e.  $d - c \geq b - a$ .

Thus, the following Proposal is valid:

### Proposal 5

Let's consider we have two risks  $X$  and  $Y$ , moreover  $X \in Uni[a, b]$ , and  $Y \in Uni[c, d]$ .

In this case, the ratio  $X \leq_{DISP} Y$  is fulfilled if and only if  $d - c \geq b - a$ , i.e. the length of the segment  $[c, d]$  is not less than the length of the  $[a, b]$  segment.

**Example 6.** Risks with a shifted exponential loss distribution.

Let's consider two risks  $X$  and  $Y$ , moreover  $X \in Exp(k_1, a_1)$ , and  $Y \in Exp(k_2, a_2)$ .

As we know,

$$\text{for } X \in Exp(k, a) \quad VaR[X, p] = a - \frac{\ln(1-p)}{k}.$$

Therefore,

$$VaR[Y, p] - VaR[X, p] = a_2 - a_1 + \ln(1-p) \left( \frac{1}{k_1} - \frac{1}{k_2} \right).$$

It can be seen from this that this function of the variable  $p$  is non-decreasing if and only if  $k_2 \leq k_1$ .

Thus, the following Proposal is true:

### Proposal 6

Let's consider we have two risks  $X$  and  $Y$ , moreover  $X \in Nor(m_1, s_1)$ , and  $Y \in Exp(k_2, a_2)$ .

Then the relation  $X \leq_{DISP} Y$  holds if and only if  $k_2 \leq k_1$ .

**Example 3.** Risks with a normal distribution of losses.

Let's consider two risks  $X$  and  $Y$ , moreover  $X \in Nor(m_1, s_1)$ , and  $Y \in Nor(m_2, s_2)$ .

As we know, (see Example [14]) if  $X \in Nor(m, s)$ , then  $VaR[X, p] = m + k_p s$ .

Therefore,

$$VaR[Y, p] - VaR[X, p] = m_2 - m_1 + k_p(s_2 - s_1).$$

It can be seen from this that, since the quantile  $k_p$  is an increasing function of  $p$ , this

function of the variable  $p$  is non-decreasing if and only if  $s_2 \geq s_1$ .

Thus, the following Proposal is true:

### Proposal 7

Let's consider we have two risks  $X$  and  $Y$ , moreover  $X \in Nor(m_1, s_1)$ , and  $Y \in Nor(m_2, s_2)$ .

Then the relation  $X \leq_{DISP} Y$  holds if and only if  $s_2 \geq s_1$ .

**Example 4.** Risks with a triangular distribution of losses.

Let's consider two risks  $X$  and  $Y$ , moreover  $X \in Tr[a, b, m_1]$ , and  $Y \in Tr[a, b, m_2]$ .

It can be proved (see Appendix 6) that the following Proposal is true:

### Proposal 8

Let's consider we have two risks  $X$  and  $Y$ , moreover  $X \in Tr[a, b, m_1]$  and  $Y \in Tr[a, b, m_2]$ .

Then the relation  $X \leq_{DISP} Y$  holds only if  $m_1 < m_2$ .

## THE HAZARD RATE AND THE ORDER OF DISPERSION

When the possibility of a large loss is assessed, the importance of the value of the dual distribution function (survival function)  $\bar{F}_X(x)$  is obvious, which estimates the probability of a loss of  $X$  exceeding the value of  $x$ . Many studies have noted the importance of a value called the hazard rate (see, for example, [24]), which can help in estimating the weight of the right tail of the loss distribution.

**Definition 7.** With a non-negative value of random losses  $X$ , with a distribution density  $f_X(x)$ , the value of the hazard rate is defined as a function of

$$r_X(x) = \frac{f_X(x)}{\bar{F}_X(x)}, \quad x \geq 0.$$

In reliability theory, the hazard rate is called the failure rate, and in life insurance, the mortality rate.

From the definition, it is easy to get such an idea for the danger rate:

$$r_X(x) = \lim_{\Delta x \rightarrow 0} \Pr[x < X \leq x + \Delta x | X > x] / \Delta x,$$

where  $Pr[A|B]$  is used to denote the conditional probability of event  $A$ , provided that event  $B$  is executed.

From the latter ratio, the following interpretation of the danger rate follows: it determines the probability of danger in  $x$  ("failures") under the condition of a favorable combination of circumstances ("survival") to  $x$ . Intuitively speaking, if  $r_x$  turns out to be small, then the distribution becomes with a heavy tail, if it turns out to be large, then the loss distribution becomes a distribution with a light tail.

From the latter ratio, the following two ratios are obtained, linking the values

$$r_x(x) = -\frac{1}{\bar{F}_x(x)} \frac{d}{dx} \bar{F}_x(x),$$

$$\bar{F}_x(x) = \exp\left(-\int_0^x r_x(t) dt\right), x \geq 0, \quad (4)$$

from which it follows that the hazard rate uniquely characterizes the distribution of danger. And vice versa: knowing the law of loss distribution, it is possible to calculate the hazard rate, for example, if the magnitude of the hazard  $X$  obeys a Pareto distribution with parameters  $a > 0, t > 0, X \in Par(a, t)$ , then it turns out that the hazard rate is equal (see, for example, [14])

$$r_x(x) = \frac{a}{t+x}. \quad (5)$$

We see that  $r_x$  is strictly decreasing from  $r_x(0) = \frac{a}{t}$  to  $r_x(+\infty) = 0$ .

If  $r_x(x) = k = \text{const}$ , then from formulas (1) it turns out that

$$F_x(x) = e^{-kx}, \text{ if } x \geq 0,$$

$$F_x(x) = 0, \text{ if } x < 0,$$

that is, the random variable obeys an exponential distribution with a parameter called intensity  $X \in Exp(k)$ . That is, a special case of the constancy of the hazard rate is realized in the case of exponentially distributed random loss values and coincides with the intensity of such values.

The dispersion order has this property related to the difference between  $VaR$  (see [14], property 3.3.62).

### Property

For given two random variables  $X$  and  $Y$ ,  $X \leq_{\text{DISP}} Y$  is valid if and only if

$$r_Y(VaR[Y, p]) \leq r_X(VaR[X, p]) \text{ for all } 0 < p < 1.$$

**Example 7.** Risks with an exponential distribution.

Let's consider two risks  $X$  and  $Y$ , moreover  $X \in Exp(k_1)$ , and  $Y \in Exp(k_2)$ .

Then it follows from the previous property that  $X \leq_{\text{DISP}} Y$  is true if and only if  $k_2 \leq k_1$ .

**Example 8.** Risks with Pareto loss allocation.

Let's consider two risks  $X$  and  $Y$ , moreover  $X \in Par(a_1, t_1)$ , and  $Y \in Par(a_2, t_2)$ .

Then it follows from formula (5) and the previous property that  $X \leq_{\text{DISP}} Y$  is true if and only if the inequality

$$\frac{a_2}{t_2 + VaR[Y, p]} \leq \frac{a_1}{t_1 + VaR[X, p]} \quad (6)$$

holds under all  $0 < p < 1$ .

We obtain an expression for the risk measure  $VaR$  for any random variable  $X \in Par(a, t)$ .

According to the definition  $VaR[X, p]$ , we have  $\bar{F}_x(VaR[X, p]) = 1 - p$ , i.e.

$$\left(1 + \frac{VaR[X, p]}{t}\right)^{-a} = 1 - p, \text{ which means that}$$

$$VaR[X, p] = t((1 - p)^{1/a} - 1).$$

Using this result, we can rewrite inequality (6) as

$$\frac{a_2}{t_2(1 - p)^{-1/a_2}} \leq \frac{a_1}{t_1(1 - p)^{-1/a_1}}. \quad (7)$$

Let's consider the function

$$g(a, t) = \frac{a}{t(1 - p)^{-1/a}} = \frac{a}{t} (1 - p)^{1/a}.$$

It is obvious that for the variable  $t$  it is a non-increasing function, and for the variable  $a$  it is a non-decreasing function, from which follows the next Proposal.

### Proposal 9

Let's consider two risks  $X$  and  $Y$ , moreover  $X \in Par(a_1, t_1)$ , and  $Y \in Par(a_2, t_2)$ .

Then the ratio  $X \leq_{\text{DISP}} Y$  holds if and only if  $a_1 \geq a_2$  and  $t_1 \leq t_2$ .

It turns out that the generalization of the latter property to general relations  $\leq_{DISP^{(t)}}$  is also true at any  $t \geq 1$ .

### Statement 15

For given two random variables  $X$  and  $Y$ ,  $X \leq_{DISP^{(t)}} Y$  is true if and only if

$$r_Y(VaR^{(t)}[Y, p]) \leq r_X(VaR^{(t)}[X, p]).$$

For all  $0 < p < 1$ . (The proof is given in Appendix 7).

## CONCLUSIONS

The intuitive concept of stochastic order between random variables has been developed in probability theory since the middle of the XX<sup>th</sup> century. This has led to the introduction of several related concepts of stochastic order, which have been studied in scientific literature. However, it was not until the 1990s that these concepts began to be applied in risk management and actuarial fields, making it possible to compare risk factors and the level of

associated hazards. This allowed practitioners and researchers in these fields to not only obtain estimates of potential losses, but also to compare risk factors themselves and determine the level of risk associated with them. In addition, it has been found that various types of stochastic orders, which can be applied to a variety of risks we are interested in, can be described using risk measures such as Value at Risk ( $VaR$ ).

This paper is devoted to the description of some types of stochastic order between risks  $VaR$  and the study of their relationships with risk measures and measures of catastrophic risks  $VaR$  to the degree of  $t$ ,  $VaR^{(t)}$ . In addition, for well-known examples of loss distributions that find wide applications in risk management and actuarial science, necessary and sufficient conditions have been obtained to compare risks subject to these distributions.

The results and methods of this work may be of interest to both practitioners and scientists involved in risk management and the actuarial field.

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## APPENDICES

## Appendix 1

Obviously, if the inequality  $b \leq c$  is fulfilled, i.e. the distribution carrier  $Uni[a, b]$  is entirely located below the distribution carrier  $Uni[c, d]$ , then the inequality  $VaR[X, p] \leq VaR[Y, p]$  will be met for all  $p \in [0, 1]$ , which means  $X \leq_{ST} Y$ . Now let's assume that  $b > c$ . However, the ratio  $X \leq_{ST} Y$  is equivalent to the inequality  $VaR[X, p] \leq VaR[Y, p]$  for all  $p$  from the interval  $[0, 1]$ .

However, as is well known (for example, [15] Appendix 2), the formula  $VaR[X, p] = a + (b - a)p$  is true for risks with distributions from  $Uni[a, b]$ . So, we have  $a + (b - a)p \leq c + (d - c)p$ , i. e.  $p[b - a - (d - c)] \leq c - a$ .

Let's consider two possible cases:

1) assume that  $b - a \geq d - c$ , i.e., the length of the segment  $[a, b]$  is greater than the length of the segment  $[c, d]$ .

Then we get that the inequality  $p \leq \frac{c - a}{(b - a) - (d - c)}$  must hold for any  $p \in [0, 1]$ , and this can only be true

if the inequality  $\frac{c - a}{(b - a) - (d - c)} \geq 1$  is fulfilled, which is equivalent to  $d \geq b$ ;

2) assume that  $b - a < d - c$ , i.e., the length of the segment  $[a, b]$  is less than the length of the segment  $[c, d]$ .

Then we get that the inequality  $p \geq \frac{c - a}{(b - a) - (d - c)}$  must hold for any  $p \in [0, 1]$ , and this can only be true

if the inequality  $\frac{c - a}{(b - a) - (d - c)} \leq 0$  is fulfilled, which is equivalent to  $c \geq a$ .

Thus, Proposal 1 is true.

## Appendix 2

The ratio  $X \leq_{ST} Y$  is equivalent to the inequality  $VaR[X, p] \leq VaR[Y, p]$  for all  $p$  from the interval  $[0, 1]$ . But, as is well known (for example, [15] Appendix 3), in the case of risks with distributions from  $Tr[a, b, m]$  the formula  $VaR[X, p] = b - \text{sqr}[(1 - p)(b - a)(b - m)]$ , if  $m \leq a(1 - p) + pb$  and  $VaR[X, p] = a + \text{sqr}[p(b - a)(v - a)]$ , is true if  $m > a(1 - p) + pb$ . (Hereafter  $\text{sqr}[X]$  is the notation for the square root of  $X$ .)  $m_1 < m_2 \leq a(1 - p) + pb$ .

In this case, the inequality  $VaR[X, p] \leq VaR[Y, p]$  is equivalent to the inequality

$$b - \sqrt{(1 - p)(b - a)(b - m_1)} \leq b - \sqrt{(1 - p)(b - a)(b - m_2)},$$

which, in turn, is equivalent to equitable inequality  $m_1 \leq m_2$ .  $a(1 - p) + pb \leq m_1 < m_2$ .

In this case, the inequality  $VaR[X, p] \leq VaR[Y, p]$  is equivalent to the inequality

$$a + \sqrt{p(b - a)(m_1 - a)} \leq a + \sqrt{p(b - a)(m_2 - a)},$$

which, in turn, is equivalent to equitable inequality  $m_1 \leq m_2$ .  $m_1 \leq a(1 - p) + pb \leq m_2$ . In this case, the inequality  $VaR[X, p] \leq VaR[Y, p]$  is equivalent to the inequality

$$b - \sqrt{(1 - p)(b - a)(b - m_1)} \leq a + \sqrt{p(b - a)(m_2 - a)} \text{ or } \sqrt{p(b - a)(m_2 - a)} + \sqrt{(1 - p)(b - a)(b - m_1)} \geq b - a,$$

however, at  $p = 0$  we get the inequality  $\sqrt{(b - a)(b - m_1)} \geq b - a$ , which is equivalent to the obviously incorrect inequality  $m_1 \leq a$ . Thus, the ratio  $X \leq_{ST} Y$  is not executed. But then may be the ratio  $Y \leq_{ST} X$ ? is executed? However, this ratio is equivalent to fulfilling the inequality

$$b - \sqrt{(1 - p)(b - a)(b - m_1)} \leq a + \sqrt{p(b - a)(m_2 - a)}$$

for all  $p$  from the range  $[0, 1]$ . Or inequalities  $\sqrt{p(b - a)(m_2 - a)} + \sqrt{(1 - p)(b - a)(b - m_1)} \leq b - a$ , which, using elementary transformations of squaring both parts and reducing similar terms, reduces to the inequality

$$2\sqrt{(m_2 - a)(b - m_1)}\sqrt{p(1 - p)} \leq p(b + a - m_1 - m_2) + m_1 - a.$$



However, a numerical study shows that depending on the ratio of the parameter values  $a, b, m_1, m_2$  it can either be performed for all  $p$  from the interval  $[0, 1]$ , or not performed for certain values of  $p$  from this interval.

For example, when  $a = 0, b = 100, m_1 = m_2 = 50$  this inequality amounts to inequality  $2\sqrt{50 \cdot 50} \sqrt{p(1-p)} \leq 50$ , which is equivalent to the inequality  $(p - \frac{1}{2})^2 \geq 0$ , which obviously holds for all values of  $p$ .

However, when  $a = 0, b = 100, m_1 = 1, m_2 = 99$  this inequality amounts to inequality  $2\sqrt{99 \cdot 99} \sqrt{p(1-p)} \leq 1$ , which is equivalent to the inequality  $2\sqrt{50 \cdot 50} \sqrt{p(1-p)} \leq 50$ , which is equivalent to the inequality  $p^2 - p + \frac{1}{4 \cdot 99^2} \geq 0$ , which obviously does not hold on the set of  $p$  values from the interval

$$(p_1, p_2) \subset [0, 1], p_1 = \frac{1}{2}(1 - \sqrt{1 - \frac{1}{99^2}}), p_2 = \frac{1}{2}(1 + \sqrt{1 - \frac{1}{99^2}}).$$

Thus, the validity of proposition 4 is proved.

### Appendix 3

An arbitrary real number  $t \geq 1$  can be represented as  $t = k + e$ , where  $k$  is a natural number, and  $a$  is a real number, and  $0 \leq e < 1$ . Obviously,  $k$  is an integer part of the number  $t$ , and  $e$  is its fractional part.

Then, according to [8], the following representation  $VaR^{(t)}[X, p] = VaR[X, 1 - (1-p)^k(1-ep)]$  is true: However, since, according to definition 1, the inequality  $VaR[X, q] \leq VaR[Y, q]$  is fulfilled for all

$q \in [0, 1]$ , it must also be fulfilled if  $q = 1 - (1-p)^k(1-ep)$ ,

i.e.  $VaR[X, 1 - (1-p)^k(1-ep)] \leq VaR[Y, 1 - (1-p)^k(1-ep)]$

for all  $p \in [0, 1]$ , so, and  $VaR^{(t)}[X, p] \leq VaR^{(t)}[Y, p]$ .

Statement (i) is proved.

Now let's move on to the proof of statement (ii). First, consider the case of a natural degree. That is, let's assume that for some natural number  $n_0$ , the inequality  $VaR^{(n_0)}[X, p] \leq VaR^{(n_0)}[Y, p]$  is true for all  $p \in [0, 1]$ .

However, using the formula for  $VaR$  to the power of  $t$ , we have:

$$VaR[X, 1 - (1-p)^{n_0}] \leq VaR[Y, 1 - (1-p)^{n_0}] \text{ for all } p \in [0, 1].$$

But for any  $q \in [0, 1]$  there is such  $p \in [0, 1]$ , that  $q = 1 - (1-p)^{n_0}$ .

Namely, this is  $p = 1 - (1-q)^{1/n_0}$ . So then the inequality  $VaR[X, q] \leq VaR[Y, q]$  is true at any  $q \in [0, 1]$ . It means that  $X \leq_{ST} Y$ .

For an arbitrary  $t_0 \geq 1$ , it can be represented as  $t_0 = k + e$ , where  $k$  is the integer part of the number  $t_0$ , and  $e$  is its fractional part.

If, for some  $t_0$ , the inequality  $VaR^{(t_0)}[X, p] \leq VaR^{(t_0)}[Y, p]$  holds for all  $p \in [0, 1]$  then, using the representation (2) proved in [8], we obtain that  $VaR[X, 1 - (1-p)^k(1-ep)] \leq VaR[Y, 1 - (1-p)^k(1-ep)]$  for all  $p \in [0, 1]$ .

But for any  $q \in [0, 1]$  there is a single number  $p \in [0, 1]$  that  $q = 1 - (1-p)^k(1-ep)$ , i.e.  $(1-p)^k(1-ep) = 1 - q$ .

This follows from the fact that the function  $f(p) = (1-p)^k(1-ep)$  for any  $k \geq 1$  and  $e \in [0, 1]$  is a continuous non-increasing function  $f(0) = 1$  and  $f(1) = 0$

That is, this function performs a one-to-one mapping of the segment  $[0, 1]$  onto itself. Which, in turn, follows from the fact that  $f'(p) = -k(1-p)^{k-1}(1-ep) - e(1-p)^k = -(1-p)^{k-1}[k(1-ep) + e(1-p)] \leq 0$ .

So then the inequality  $VaR[X, q] \leq VaR[Y, q]$  is executed at any  $q \in [0, 1]$ . Which means,  $X \leq_{ST} Y$ .

### Appendix 4

For an arbitrary real number  $t \geq 1$ , it can be represented as  $t = k + e$ , where  $k$  is a natural number and  $e$  is a real number, and  $0 \leq e < 1$ . Obviously,  $k$  is an integer part of the number  $t$ , and  $e$  is its fractional part.

Then, according to [8], the representation is valid:

$$VaR^{(t)}[X, p] = VaR[X, 1 - (1-p)^k(1-ep)].$$

However, since according to the definition of 2, if  $X \leq_{DISP} Y$ , the ratio

$$(X - VaR[X, q])_+ \leq_{ST} (Y - VaR[Y, q])_+ \text{ for all } 0 < q < 1.$$

But then it must also be satisfied with a particular meaning  $q = 1 - (1 - p)^k(1 - ep)$ , i.e.  $(X - VaR[X, 1 - (1 - p)^k(1 - ep)])_+ \leq_{ST} (Y - VaR[Y, 1 - (1 - p)^k(1 - ep)])_+$  for all  $p \in [0, 1]$ , and therefore  $X \leq_{DISP^{(t)}} Y$ .

Statement (i) is proved.

Now let's move on to the proof of statement (ii). First, consider the case of a natural degree. That is, let's assume that for some natural value  $n_0$ , the ratio is true  $X \leq_{DISP^{(n_0)}} Y$ . It means that  $(X - VaR^{(n_0)}[X, q])_+ \leq_{ST} (Y - VaR^{(n_0)}[Y, q])_+$

Then we get:

$$(X - VaR[X, 1 - (1 - q)^{n_0}])_+ \leq_{ST} (Y - VaR[Y, 1 - (1 - q)^{n_0}])_+ \text{ for all } q \in [0, 1].$$

But for any  $p \in [0, 1]$  there is such  $q \in [0, 1]$ , that  $p = 1 - (1 - q)^{n_0}$ .

Namely, it is  $q = 1 - (1 - p)^{1/n_0}$ . In this way, then the ratio  $(X - VaR[X, p])_+ \leq_{ST} (Y - VaR[Y, p])_+$  holds for any  $p \in [0, 1]$ . Which means,  $X \leq_{DISP} Y$ .

For an arbitrary real number  $t_0 \geq 1$ , it can be represented as  $t_0 = k + e$ , where  $k$  is the integer part of the number  $t_0$ , and  $e$  is its fractional part.

If, for some  $t_0$ , the relation is true for all  $p \in [0, 1]$ , then  $(X - VaR^{(t_0)}[X, q])_+ \leq_{ST} (Y - VaR^{(t_0)}[Y, q])_+$ .

Then we get:

$$(X - VaR[X, 1 - (1 - q)^k(1 - eq)])_+ \leq_{ST} (Y - VaR[Y, 1 - (1 - q)^k(1 - eq)])_+ \text{ for all } q \in [0, 1].$$

But there is a single number  $q \in [0, 1]$  for any  $p \in [0, 1]$ , which is  $p = 1 - (1 - q)^k(1 - eq)$ , i.e.  $(1 - q)^k(1 - eq) = 1 - p$ .

This follows from the fact that the function  $f(q) = (1 - q)^k(1 - eq)$  for any  $k \geq 1$  and  $e \in [0, 1]$  is a continuous non-increasing function, and  $f(0) = 1$  and  $f(1) = 0$ . That is, this function performs a one-to-one mapping of the segment  $[0, 1]$  onto itself. Which, in turn, follows from the fact that

$$f'(q) = -k(1 - q)^{k-1}(1 - eq) - e(1 - q)^k = -(1 - q)^{k-1}[k(1 - eq) + e(1 - q)] \leq 0.$$

Thus, then the ratio  $(X - VaR[X, p])_+ \leq_{ST} (Y - VaR[Y, p])_+$  holds for any  $p \in [0, 1]$ . Which means  $X \leq_{DISP} Y$ .

## Appendix 5

For an arbitrary  $t \geq 1$ , it can be represented as  $t = k + e$ , where  $k$  is the integer part of the number  $t$ , and  $e$  is its fractional part.

Consider a random variable  $X_p^{(t)} = (X - VaR^{(t)}[X, p])_+$ .

Then  $VaR^{(t)}[X_p^{(t)}, q] = VaR[X_p^{(t)}, 1 - (1 - q)^k(1 - eq)] = 0$ , if  $q \leq p$  and  $VaR^{(t)}[X_p^{(t)}, q] = VaR^{(t)}[X, q] - VaR^{(t)}[X, p]$ , if  $q > p$ .

However  $X \leq_{DISP} Y$ , if and only if  $X_p^{(1)} \leq_{ST} Y_p^{(1)}$ , according to statement 2, is equivalent to the ratio  $X_p^{(t)} \leq_{ST} Y_p^{(t)}$ , i.e.  $VaR^{(t)}[X_p^{(t)}, q] \leq VaR^{(t)}[Y_p^{(t)}, q]$  for arbitrary  $t \geq 1$  and  $0 < q < 1$ . And this, in turn, is equivalent to  $VaR^{(t)}[X, q] - VaR^{(t)}[X, p] \leq VaR^{(t)}[Y, q] - VaR^{(t)}[Y, p]$  under any  $0 < p < q < 1$ .

## Appendix 6

The ratio  $X \leq_{ST} Y$  is equivalent to the inequality  $VaR[X, p] \leq VaR[Y, p]$  for all  $p$  from the interval  $[0, 1]$ . But, as is well known (for example, [15] Appendix 3), in the case of the formula  $VaR[X, p] = b - \sqrt{p(1-p)(b-a)(b-m)}$ , if  $m \leq a(1-p) + pb$ , and  $VaR[X, p] = a + \sqrt{p(1-p)(b-a)(b-m)}$  if  $m > a(1-p) + pb$  is true for risks with distributions from  $Tr[a, b, m]$

1) Let's consider three cases:  $m_1 < m_2 \leq a(1-p) + pb$  then

$$\begin{aligned} VaR[Y, p] - VaR[X, p] &= \sqrt{(1-p)(b-a)(b-m_1)} - \sqrt{(1-p)(b-a)(b-m_2)} = \\ &= \sqrt{(1-p)(b-a)}(\sqrt{b-m_1} - \sqrt{b-m_2}) \geq 0. \end{aligned}$$

From this it can be seen that this function of the variable  $p$  is non-decreasing and therefore  $X \leq_{DISP} Y$ ;

2)  $a(1-p) + pb \leq m_1 < m_2$ . In this case

$$\begin{aligned} VaR[Y, p] - VaR[X, p] &= \sqrt{p(b-a)(m_2-a)} - \sqrt{p(b-a)(m_1-a)} = \\ &= \sqrt{p(b-a)}(\sqrt{m_2-a} - \sqrt{m_1-a}) \geq 0. \end{aligned}$$

From this it can be seen that this function of the variable  $p$  is non-decreasing and therefore  $X \leq_{DISP} Y$ ;

3)  $m_1 \leq a(1-p) + pb \leq m_2$ .

In this case

$$\begin{aligned} VaR[Y, p] - VaR[X, p] &= a + \sqrt{p(b-a)(m_2-a)} - b + \sqrt{(1-p)(b-a)(b-m_1)} = \\ &= a - b + \sqrt{b-a}(\sqrt{p(m_2-a)} - \sqrt{(1-p)(b-m_1)}). \end{aligned}$$

Let's consider the function

$$f(p) = \sqrt{x_0 p} + \sqrt{(1-p)x_1}, x_0 = m_2 - a, x_1 = b - m_1.$$

Then

$$f'(p) = \frac{\sqrt{x_0}}{2\sqrt{p}} - \frac{\sqrt{x_1}}{2\sqrt{1-p}} = \frac{\sqrt{x_0(1-p)} - \sqrt{x_1 p}}{2\sqrt{p(1-p)}},$$

therefore, the inequality  $f'(p) \geq 0$

Is equivalent to the inequality  $\sqrt{x_0(1-p)} \geq \sqrt{x_1 p}$ , which means that  $p \leq \frac{x_0}{x_1 + x_0} = \frac{m_2 - a}{b - m_1 + m_2 - a}$ .

However, in case (3), the inequalities  $m_1 \leq a(1-p) + pb \leq m_2$  hold which are equivalent to the inequalities

$$\frac{m_1 - a}{b - a} \leq p \leq \frac{m_2 - a}{b - a} \text{ and because the fairness of inequality } \frac{m_2 - a}{b - m_1 + m_2 - a} \leq \frac{m_2 - a}{b - a} \text{ is obvious, then according}$$

to the property the ratio  $X \leq_{DISP} Y$  hold.

## Appendix 7

From statement 13 and the formula  $VaR^{(t)}[X, p] = VaR[X, 1 - (1-p)^m(1-ep)]$ , where the number  $t$  is represented as the sum of its integer and fractional parts  $t = m + e, 0 \leq e < 1$  (see [8]), it follows that

$$\begin{aligned} 0 &\leq \frac{d}{dp}(VaR^{(t)}[Y, p] - VaR^{(t)}[X, p]) = \frac{m(1-p)^{m-1}(1-ep) + e(1-p)^m}{f_Y(VaR^{(t)}[Y, p])} - \\ &- \frac{m(1-p)^{m-1}(1-ep) + e(1-p)^m}{f_X(VaR^{(t)}[X, p])} = (1-p)^{m-1}(m(1-ep) + e(1-p)) \left( \frac{1}{f_Y(VaR^{(t)}[Y, p])} - \frac{1}{f_X(VaR^{(t)}[X, p])} \right). \end{aligned}$$

And since  $(1-p)^{m-1}(m(1-ep) + e(1-p)) \geq 0$  at  $0 < p < 1$ , it follows that  $f_Y(VaR^{(t)}[Y, p]) \leq f_X(VaR^{(t)}[X, p])$ , which means that

$$\frac{f_Y(VaR^{(t)}[Y, p])}{(1-p)^m(1-ep)} \leq \frac{f_X(VaR^{(t)}[X, p])}{(1-p)^m(1-ep)}.$$

However, since, by definition,  $VaR^{(t)}[X, p] = \bar{F}_X(VaR^{(t)}[X, p]) = (1-p)^m(1-ep)$ , this means that

$$\frac{f_Y(VaR^{(t)}[Y, p])}{\bar{F}_Y(VaR^{(t)}[Y, p])} \leq \frac{f_X(VaR^{(t)}[X, p])}{\bar{F}_X(VaR^{(t)}[X, p])}.$$

And therefore, using the definition of the hazard rate, we obtain:  $r_Y(VaR^{(t)}[Y, p]) \leq r_X(VaR^{(t)}[X, p])$ .

# The Impact of Investment Behavior and Risk Appetite on Investment Decisions of Rural Investors

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## ABSTRACT

The research aims to investigate the impact of investment behavior and risk appetite on investment decision-making for rural investors, with frequent analysis of the demographic characteristics of rural investors. The research was based on a cross-sectional research design in which the data was collected from the rural areas of Haryana and Punjab; 486 individual investors' data was collected using structured questionnaires from all 22 districts of Haryana and seven districts of Punjab. Frequency analysis of the demographic characteristics has been performed using SPSS version 26. For testing the reliability and validity of the questionnaire, the Cronbach alpha test, Composite reliability, and Discriminant validity and hypothesis testing have been done using Structural Equation Modelling [SEM] with Smart PLS 4. The results of the study reveal that investment behavior has a significant impact on investment decision-making. This implies that rural investors make decisions based on their behavioral aspects, i.e., needs, objectives, the history of particular assets. The results also show that risk appetite does not significantly affect the decision-making process of rural investors, implying that regardless of its level, it is not the major factor in investment decision-making.

**Keywords:** investment behaviour; risk appetite; investment decision-making; rural investors; structural equation modelling

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## INTRODUCTION

In the financial markets, investors are generally known as consumers. The study of the behavior and patterns of individual investors typically helps banking and financial institutions develop and place their products and services according to the behavior of individual investors. There have been studies on individual investment behaviour of the investors, patterns, and decision-making process. Due to the abundant information available in a short period, investors are aware of their investment choices, making it challenging for financial institutions and service providers to develop plans and policies to attract investors [1]. Some researchers have revealed that most investors behave irrationally when making investment decisions. According to the behavioural finance theory, the psychological and personal interests of individual investors impact the investment behavior of investors [2]. An extensive amount of research has already been done before on the variables affecting the investing behavior of individuals behavior, but the research on the investment behavior

of rural investors is sparse. There has been a study of the rural investors in which only four villages have been researched and in a recent survey of the investment behavior of the rural investors has been conducted only on the agrarian class of the rural areas [3]. No other prominent research has been done on the investment behavior among these investors.

Rural areas are the backbone of the country; as per the World Bank's report on the rural population, around 64% of the total population resides in rural areas. The research on the investment behavior of the rural people is significantly lower. There are various factors which impact the income and investment of the rural people which need to be studied. Financial institutions and service providers want to know more about these factors, including the motivation behind rural investments, risk appetite, knowledge about other investment options, factors influencing rural investors, and how risk appetite influences decision-making. The government and policymakers are also interested in understanding investment behavior as it changes every generation [4]. The uncertainties and psychological

factors affecting investment behavior will help policymakers and governments design and implement different policies. So, the arguments presented above provide a solid reason for us to research the investment behavior of rural investors. The central point of this article is to examine the various factors affecting the behavioral, emotional, and demographic aspects of rural investors. This research will add to the knowledge in the existing literature. This research will collect data from rural investors who invest and hold various assets through a survey of India's rural areas. Four hundred and eighty-six responses were considered for this research. The regression and structural Equation Modelling [SEM] techniques from Smart-PLS statistics have been used to identify the factors affecting investment behavior. The findings will enhance the literature on behavioral studies in three areas. This research is different from the current literature in the selection of the respondents; this research has taken rural people who are investing in any asset class from the villages, and none of the investors are from the urban population [5]. Thus, this research will help to identify the accurate picture of rural investors. Secondly, emotional and demographic factors are considered when analyzing the factors affecting rural investors' investment behavior and decision-making. Third, this research will narrow the gap in the knowledge of the investment behavior of rural investors, which will help the government and policymakers introduce different rules and regulations for the further growth of the country.

### PROBLEM STATEMENT

The various socioeconomic factors have affected the unanimity of the investment behavior, risk appetite, and decision-making among rural investors. There needs to be a complete understanding of the elements that block the development of the financial support system and strategies, thereby hindering wealth growth and rural investors' economic inclusion. The investment behavior of any person has been shaped by cultural, educational, and other socio-economic factors. By understanding all these factors, various initiatives such as education and design of financial products inculcate the different needs of the rural people. Additionally, the knowledge of their risk appetite can help the financial institutions create their investment products which align with rural people

tolerance levels. The way to make sensible investment decisions has been affected by factors such as the sources of information and the level of literacy, which increases their chances of earning.

The necessity of working on this problem has been gaining attention because of the economic growth, which can empower the rural investors with different financial knowledge, providing various investment options to the specific requirements of the rural investors. This will help the government in reducing income inequality and raised their standard of living by which the financial institutions and companies will provide their services and products, further increasing the consumption and boosting economic growth in the country.

This research will answer the following questions about the rural people:

RQ1: What is the impact of investment behavior on the decision-making of rural investors?

RQ2: How does the risk appetite impact the decision-making of rural investors?

### LITERATURE REVIEW

#### Investment Behaviour

The researchers analyzed the theories of reasoned action and planned behavior to study the behavioral patterns of investors. The theory of planned behavior judges and predicts the behavior of the individuals examined by their intention; the research tells us that the variables that affect the intention are the attitude and the nature of that individual's perception to believe that they have control over their actions [6]. The research on behavioral investments generally depends on applying the theory of planned behavior. The meaning of the attitude in the Harriman model stands for the perception, convictions, emotions, hopes, and fears. The authors of psychology suggest that to change behavior, the attitudes must first change [7]. The investors' understanding of the financial products plays a crucial role in choosing different investment avenues. The mindset of the individual investor also affects the decision-making. The investor's understanding is molded by their experiences and challenging situations they feel during their investment journey, with the knowledge that the individual change can alter the investors' behavior. Researchers have found that several factors influence individuals' attitudes and thinking



towards investments. These factors include investors' knowledge, experience, wealth, sociological factors, and qualifications. Attitude plays a crucial role in assessing the investment behavior of individuals; the changes in their actions while investing can be reflected in the attitude and behavior of the investors [8].

#### **Investment Behaviour and Investment Decision-making**

Demographic factors have quite a significant influence on individual investment behavior. It has been documented that the investor's gender is one of the demographic factor influencing them, with men being more aware of investing than women. Behavioral indicators can be seen in the investment attitudes of the individual investors managing and planning their finances [9]. The investor's intention to invest influences the investment behavior of the individuals. While examining individual investment behavior, the demographics, awareness of the investors, and the risk appetite of the investors impact their decision-making behavior. The study also tells us that if investors have a positive attitude towards money, this positively affects the intention of the investors in the future [10]. The researchers have explored the correlation between investment intentions, risk aversion, and investment decisions. Perception of risk is directly linked to the understanding of financial products and their need to invest in particular stocks. Good economic behavior of individuals includes savings, investments, and the management of personal finances. Effective use of savings is the best way to gain wealth appreciation for future needs, influencing their decision-making [11]. So, the first hypothesis of this research is:

H1: Investment behavior has a positive impact on the Investment decision-making of rural investors.

#### **Risk Appetite**

Every investment decision involves inherent risks for the investor. Risk is determined as the unexpected outcome of the investment choices that an individual investor will take, and risk tolerance is the capacity to handle the negative impact which happens [12]. Risk plays a very crucial role in the investment journey of any individual investor or financial company, especially when the risk associated with the various investments is ignored. As stated earlier, demographic factors such as gender, income, and education impact

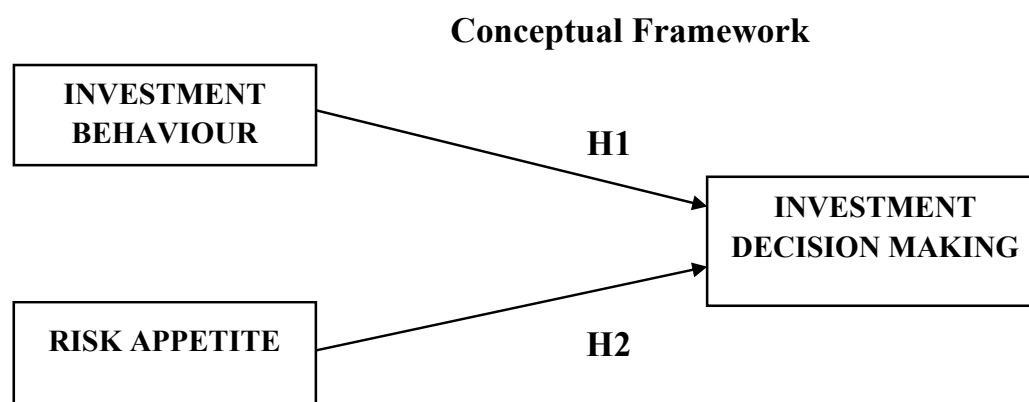
the risk appetite of individuals, as well as occupation, which also affects it. For example, self-employed people tend to exhibit a higher risk tolerance than those who are employed on a salary. Researchers have discovered that risk perception varies according to financial literacy and gender. However, the study also found that the marital status of the individual investor does not influence risk perception [13].

#### **Risk Appetite and Investment Decision Making**

The researcher found that men take less financial risk than women. In another study, the researcher found no relationship between the gender and risk appetite among the investors [14]. Various authors' literature has found that the investor's risk appetite increases with age. In the study on the role of age in investment behavior, the researchers found that younger people have more time to build their wealth than older people, and there is a significant correlation between the investor income level and investment mindset [15]. Investors generally go through rough phases when they have fewer resources for investment, and the chances of losses in various asset classes are much higher [16]. In another study, the researchers have found that married investors have a lower risk appetite than single investors. The reason behind the low-risk appetite of married investors is that they have the responsibilities towards their families and dependents, which influences their investment choices. Education also significantly influences the investors' investment behavior; as the level of investors' education increases, the risk appetite to invest in a riskier asset also increases [17]. Family members can influence the behavior of individual investors, especially in family-owned businesses, where the family plays a significant role in investment decision-making. Among the family members, the head of the family has a great influence on the decision-making, and the allocation of the savings and investment avenues depends on the decisions [18, 19]; other than family influence, social factors also play a massive role in the decision-making, which shapes their attitude and perception of the society. Hence, the study's second hypothesis is:

H2: There is a positive impact of risk appetite on the investment decision-making of rural investors.

The above *Fig. 1* illustrates the proposed relationships between investment behaviour, risk appetite, and investment decision-making. In this



**Fig. 1. Conceptual Framework**

Source: Author's presentation.

model, investment decision-making is treated as a dependent variable, influenced by two key independent variables—investment behaviour and risk appetite. Hypothesis H1 states that investment behaviour has a positive impact on investment decision-making. This implies that individuals who exhibit informed, disciplined, and rational investment behaviour are more likely to make effective and sound investment decisions. Hypothesis H2 proposes that risk appetite also has a positive impact on investment decision-making. It suggests that individuals who are more willing to take risks are more likely to engage in investment activities and make proactive financial decisions.

### RESEARCH METHODOLOGY

The responses were collected using a standardized survey design and a Google form from the rural investors. Data was collected using the purposive sampling technique. The data was gathered from the rural areas in Haryana and Punjab. We selected investors with at least two years of investment experience to effectively measure their behaviour. One hundred questionnaires were distributed among the rural investors in four districts of Haryana. The responses were collected by visiting their homes and pesticide and fertilizer shops that the rural people usually visit for their work. Google form links were sent to more than 500 rural people. Of these, 386 people submitted their responses from the 18 districts in Haryana and 7 districts in Punjab. As per the Census (2011), there are 6,841 villages in Haryana and 12,729 villages in Punjab. Two to three villages were selected from each district for data collection.

The sample was taken from each district and divided proportionately by the total rural population of the state, and calculated by district-wise rural populations. Analysis was conducted on a total of 486 responses. The data was collected between September 2023 and February 2024. At least ten responses were required for each item on the questionnaire, so our responses are adequate as we have 31 items, excluding demographics. The sample comprises rural investors from different age groups, with varying annual incomes, marital statuses, occupations, genders, and education backgrounds.

The research framework for this research was measured using a well-structured questionnaire. The questionnaire was adapted from a previous validated study [20–22]. The questionnaire has also been translated into the Hindi language and validated by an expert in the Hindi language for ease of use and understanding.

Structural Equation Modelling (SEM) is a multidimensional quantitative technique that defines the correlation between variables. This approach helps people to measure theoretical models. It completes the requirement of researchers to examine the constructs that emerge from the different variables and how they are related to each other. The researchers have to determine at which level the theoretical model is reliable for the data. SEM helps the researcher to dive deep into hypothesis testing and draw out the current state of information by finding complex relationships between constructs. In this context, the SEM extends other multidimensional techniques, such as regression and factor analysis. SEM is considered a very effective technique for investigating correlations between

Table 1

## Demographic Characteristics

| Variable              | Category                   | Frequency  | Percentage, % |
|-----------------------|----------------------------|------------|---------------|
| Gender                | Male                       | 337        | 69.3          |
|                       | Female                     | 149        | 30.7          |
|                       | <b>Total</b>               | <b>486</b> | <b>100</b>    |
| Age                   | 20–30 years                | 164        | 33.7          |
|                       | 31–40 years                | 142        | 29.2          |
|                       | 41–50 years                | 103        | 21.2          |
|                       | Above 50 years             | 77         | 15.8          |
|                       | <b>Total</b>               | <b>486</b> | <b>100</b>    |
| Marital Status        | Married                    | 363        | 74.7          |
|                       | Unmarried                  | 123        | 25.3          |
|                       | <b>Total</b>               | <b>486</b> | <b>100</b>    |
| Education             | Higher, Secondary or Less  | 151        | 31.1          |
|                       | Diploma                    | 30         | 6.2           |
|                       | Bachelor's Degree          | 160        | 32.9          |
|                       | Master's Degree or Higher  | 145        | 29.8          |
|                       | <b>Total</b>               | <b>486</b> | <b>100</b>    |
| Occupation            | Business                   | 48         | 9.9           |
|                       | Self-employed              | 104        | 21.4          |
|                       | Employed in government     | 55         | 11.3          |
|                       | Employed in private sector | 82         | 16.9          |
|                       | Professional               | 40         | 8.2           |
|                       | Farmer                     | 134        | 27.6          |
|                       | Retired                    | 23         | 4.7           |
|                       | <b>Total</b>               | <b>486</b> | <b>100</b>    |
| Annual Income         | Below two lakhs            | 177        | 36.4          |
|                       | two lakhs to 5 lakhs       | 178        | 36.6          |
|                       | five lakhs to 10 lakhs     | 90         | 18.5          |
|                       | Above ten lakhs            | 41         | 8.4           |
|                       | <b>Total</b>               | <b>486</b> | <b>100</b>    |
| Investment Experience | 2–5 years                  | 236        | 48.9          |
|                       | 5–8 years                  | 116        | 23.9          |
|                       | 8–10 years                 | 46         | 9.5           |
|                       | More than ten years        | 88         | 18.1          |
|                       | <b>Total</b>               | <b>486</b> | <b>100</b>    |

Source: SPSS Output.

the dependent variable and several independent variables. It is beneficial for creating better models and measuring them effectively, as well as interpreting the results [23].

## DATA ANALYSIS

In Table 1, there are seven items under which various categories were taken for analyzing the demographic variables of the rural investors. The male investors make up 69.3% of whole sample and females are 30.7%. The behaviour, i.e., the confidence and conviction in holding or investing in any asset class, is higher in men than in women, as mentioned in literature [24]. From this data we can interpret that the female population holds less or no assets on their own, and the male counterpart has a bigger in the asset pattern in rural areas, Age-wise, 33.7% of the ample is between 20 and 30 years old, 29.2% are between 31 and 40, 21.2% between 41 and 50, and 15.8% of people are over 50. The age of investors has a vital role in determining their investment behaviour, risk appetite and various investment choices, as noted in literature [25]. It is noted that the investors' awareness increases as they grow older. They take less risk as age increases. Almost  $\frac{3}{4}$  of the sample belong to married people, and the other  $\frac{1}{3}$  belong to unmarried individuals; marriage changes the behavior, increasing chances for individuals to invest in assets. Decision-making also includes the consent of their partner if they want to invest somewhere. The majority of people are undergraduates, i.e., 32.9%, and 31% of people studied until the 12<sup>th</sup> grade or less, then 29.8% of people were postgraduates or more, and a significantly smaller number of people opted for a diploma course. Farmers constitute the highest number, accounting for almost 27.6% of population, followed by self-employed individuals who either do seasonal work or temporary jobs for themselves, accounting for 21.4%. Private employees account for 16.9% of the sample, after which government employees account for only 11.3%. Business people account for around 9.9%. Professionals like lawyers, doctors, CA's account for 8.2%, and there are also retired people who account for 4.7%. Income-wise, 73% of people earn less than or equal to 5 lakhs a year, half of them earn less than 2 lakhs, while the other half earn between 2 and 5 lakhs. Then 18.5% of people earn 5 to 10 lakhs and only 8.4% of

Table 2

**Factor Loading**

| Indicator | IB    | IDM   | RA    |
|-----------|-------|-------|-------|
| IB1       | 0.776 |       |       |
| IB3       | 0.757 |       |       |
| IB6       | 0.752 |       |       |
| IB7       | 0.801 |       |       |
| IB8       | 0.779 |       |       |
| IB9       | 0.727 |       |       |
| IB12      | 0.744 |       |       |
| IB13      | 0.698 |       |       |
| IDM1      |       | 0.730 |       |
| IDM2      |       | 0.768 |       |
| IDM3      |       | 0.789 |       |
| IDM5      |       | 0.703 |       |
| IDM8      |       | 0.740 |       |
| RA1       |       |       | 0.690 |
| RA2       |       |       | 0.725 |
| RA3       |       |       | 0.817 |
| RA4       |       |       | 0.640 |
| RA5       |       |       | 0.739 |

Source: Smart-PLS Output.

people earn more than 10 lakhs. As the sample for investment experience was taken with more than two years of experience, so the percentage of people who are having the experience of 2–5 years of investing various assets are the majority (48.9%). Next comes 5–8 years with 23.9%, and more than 10 years of experience account for 18.1% of sample while 9.5% of people have 5–8 years experience.

**Factor Loading**

In *Table 2*, the factor loading indicates how much the item reflects the underlying construct, providing information about its correlation coefficient and the factor. The authors suggest that a factor loading exceeding 0.50 is preferable [26]. All items exceeded this threshold. Nevertheless, nine investment behavior items and three investment decision-making items were removed to improve composite reliability and Average Variance Extracted (AVE).

Table 3

**Multicollinearity**

| Indicator | VIF   |
|-----------|-------|
| IB1       | 2.001 |
| IB3       | 1.925 |
| IB6       | 1.952 |
| IB7       | 2.332 |
| IB8       | 1.965 |
| IB9       | 1.721 |
| IB12      | 1.911 |
| IB13      | 1.825 |
| IDM1      | 1.538 |
| IDM2      | 1.523 |
| IDM3      | 1.651 |
| IDM5      | 1.499 |
| IDM8      | 1.493 |
| RA1       | 1.482 |
| RA2       | 1.546 |
| RA3       | 1.676 |
| RA4       | 1.262 |
| RA5       | 1.589 |

Source: Smart-PLS Output.

**VIF Multicollinearity**

Variance inflation factor (VIF) is a statistical concept that measures the severity of multicollinearity in regression analysis. Multicollinearity occurs when two or more independent variables exhibit significant correlation, which means that one or more of the independent variables can be estimated linearly using one or more other independent variables. VIF should be less than or equal to 5 based on the general guidelines [27], but our VIF value, as shown in *Table 3* below, is lower than 3. This indicates that our data does not have any collinearity problems.

**Measurement Model**

*Figure 2* represents the measurement model perspective with path coefficients indicating the strength and direction of relationships between variables. The path from Investment Behaviour (IB) to Investment Decision Making (IDM) is 0.674,

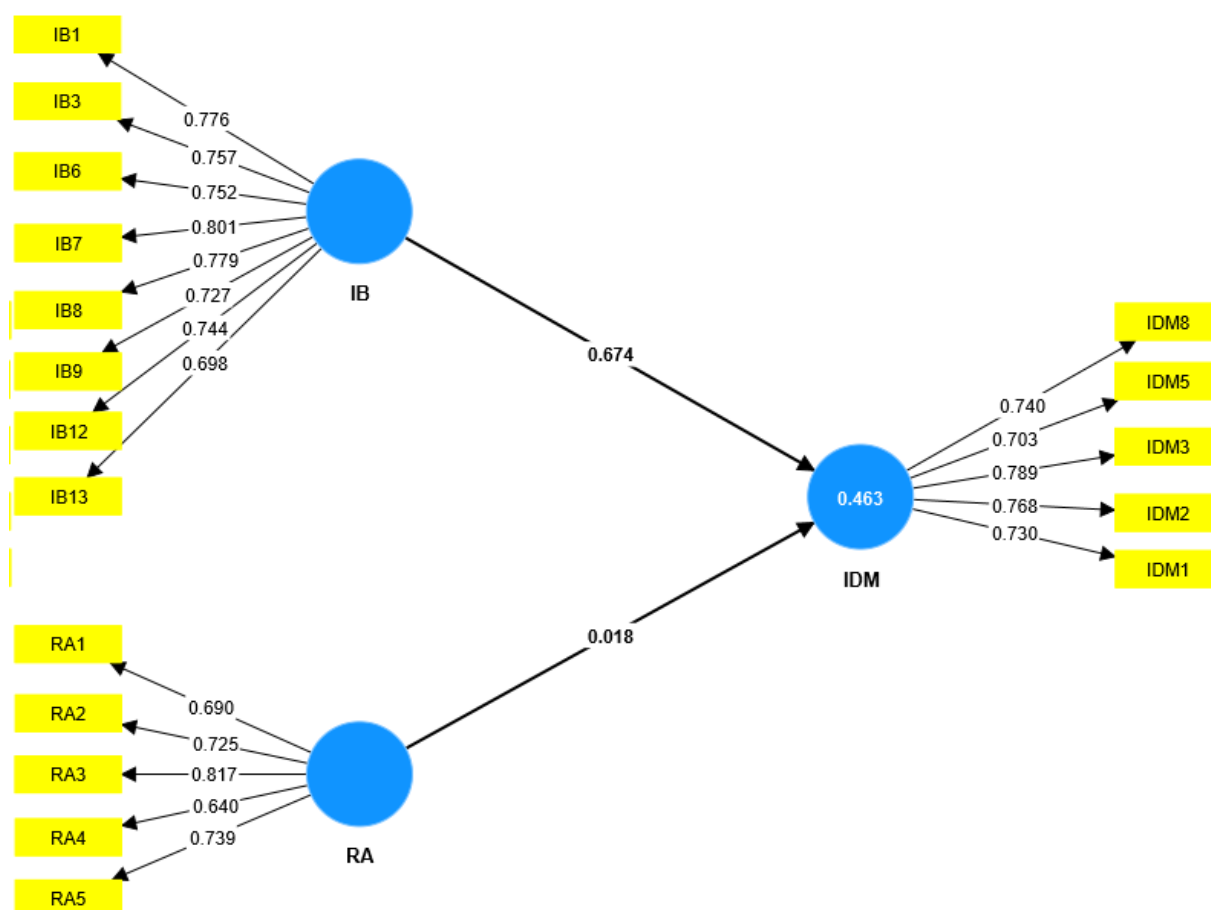


Fig. 2. Measurement Model

Source: Smart-PLS Output.

indicating a strong positive influence. This implies that individuals with more structured or informed investment behaviour are more likely to make effective investment decisions. The path from Risk Appetite (RA) to Investment Decision Making (IDM) is 0.018, which is a negligible and statistically weak, indicating that risk appetite does not significantly influence investment decision-making in this model.

#### Construct Reliability and Validity

Construct reliability measures how consistent a variable or a set of variables are regarding what they are intended to measure. This means how well the items selected for the construct measure up. The magnitude to which an instrument generates consistent effects over time is referred to as internal consistency and reliability. There are several methods for measuring reliability, and the most commonly used methods are Cronbach Alpha and composite reliability; the value of Cronbach's Alpha has to be ranged between 0.70 to 0.91, while the composite

reliability value should be at least 0.70, which is acceptable as a good indicator of internal consistency, as shown in Table 4.

Two tests were applied to measure the construct validity, namely, convergent and discriminant validity. Convergent validity has been measured through AVE values. The Average Variance Extracted (AVE) values must be higher than or close to 0.50 for all constructs in order to approve convergent validity. To utilize the factors, the values need to be more than 0.50, which indicates that the constructs have formed convergent validity [28].

#### Discriminant Validity

Discriminant validity is a measure that assesses the degree to which the different constructs of the study are unrelated. When evaluating the discriminant validity of results, it successfully shows that the results are not highly correlated.

Table 5 shows the Heterotrait-Monotrait (HTMT) ratio which is the most common approach to determining the discriminant validity. An acceptable



Table 4

**Cronbach's Alpha, Composite Reliability, and Average Variance Extracted**

| Indicator | Cronbach's alpha | Composite reliability (rho_c) | Average variance extracted (AVE) |
|-----------|------------------|-------------------------------|----------------------------------|
| IB        | 0.892            | 0.914                         | 0.570                            |
| IDM       | 0.803            | 0.863                         | 0.557                            |
| RA        | 0.775            | 0.846                         | 0.525                            |

Source: Smart-PLS Output.

Table 5

**HTMT**

| Indicator | IB    | IDM   | RA |
|-----------|-------|-------|----|
| IB        |       |       |    |
| IDM       | 0.786 |       |    |
| RA        | 0.380 | 0.296 |    |

Source: Smart-PLS Output.

Table 6

**Fornell-Larcker Criterion**

| Indicators | IB    | IDM   | RA    |
|------------|-------|-------|-------|
| IB         | 0.755 |       |       |
| IDM        | 0.680 | 0.747 |       |
| RA         | 0.326 | 0.238 | 0.725 |

Source: Smart-PLS Output.

Structural Model

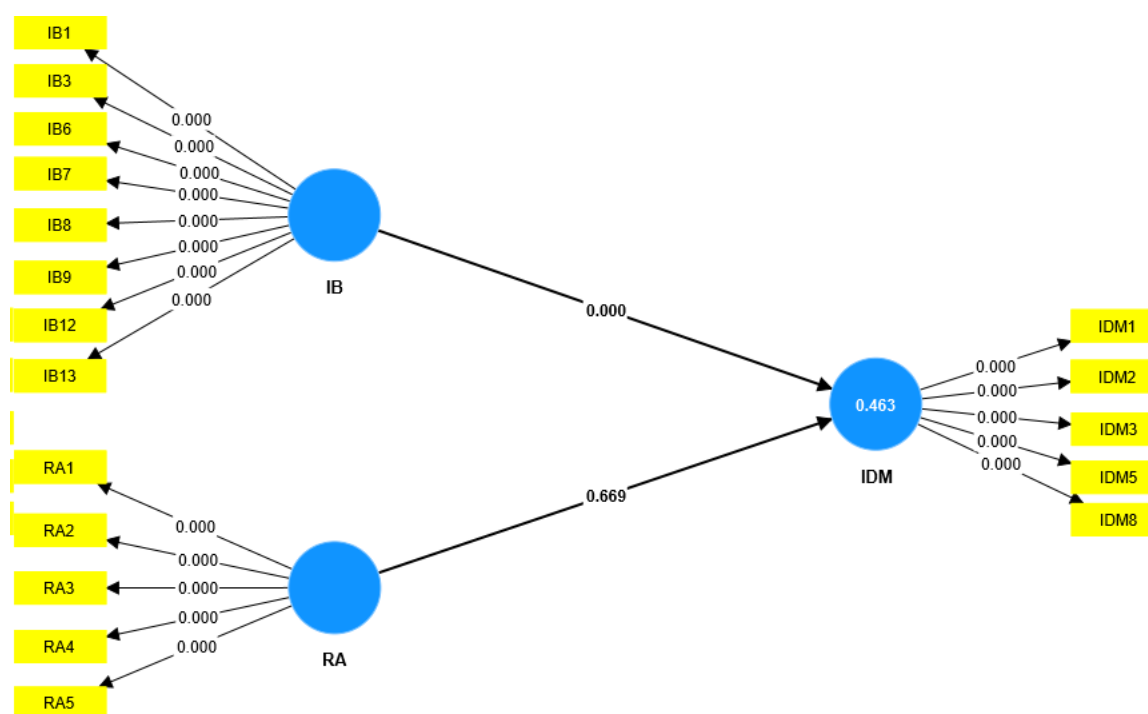


Fig. 3. Structural Model

Source: Smart-PLS Output.

level for this ratio needs to be less than 0.90, indicating the establishment of discriminant validity.

**Fornell-Larcker Criterion**

The Fornell-Larcker criterion is also a popular measure to check discriminant validity. As per this model which is shown in Table 6, the square root of the average variance extracted from the construct must exceed the correlation between the constructs.

The above Fig. 3 presents the structural model estimated using SmartPLS, along with the results of hypothesis testing. The model examines the direct effects of Investment Behaviour (IB) and Risk Appetite (RA) on Investment Decision Making (IDM).

Table 7 represents the relationship between investment behaviour and investment decision-making and the relationship between the risk appetite and investment decision-making.

Table 7

**Hypothesis Testing**

| Relationship | Beta  | SD    | T-Value | P-value | Result        |
|--------------|-------|-------|---------|---------|---------------|
| IB -> IDM    | 0.674 | 0.031 | 21.503  | 0.000   | Significant   |
| RA -> IDM    | 0.018 | 0.042 | 0.427   | 0.669   | Insignificant |

Source: Smart-PLS Output.

The bootstrapping techniques were used to measure the structural model using 5000 samples, with a significance level of 5%, two-tailed, and without significant changes. Researchers define bootstrapping as a re-sampling technique involving the routing model [29]. This is done by generating multiple samples with slight variations in the data configurations through random sampling with replacement from the dataset. Two objectives are satisfied by the bootstrapping which evaluates the statistical significance of coefficients without relying on the distribution assumptions. Another goal is to estimate the standard error of coefficient estimates.

Table 7 shows that investment behavior significantly impacts investment decision-making. The value of p-value = 0.000 and the t-value = 21.503. So, H1 has been accepted as Investment Behaviour (IB), which substantially impacts Investment decision-making (IDM). Another result we can see from the table is that the risk appetite (RA) does not have an impact on the Investment decision-making (IDM) for rural investors. The values p and t are 0.669 and 0.427 respectively, so the H2 will be rejected.

In Table 8, the value of R-square is reflected in the model. It tells us about the proportion of the variance in the dependent variable, which is explained by the independent variables of the model. The range of the R-squared must be between 0 and 1, or the study shows a value of 0.463. This reflects that the impact of investment behavior and risk appetite on investment decision-making is moderate. The adjusted R-square also tells us that the effects of the independent variables were moderate on investment decision-making.

As shown in Table 9, the value of f-square, which denotes the impact of the investment behavior and risk appetite on the investment decision-making, the value of IB -> IDM is  $f = 0.757$ . This implies that there is a high impact of investment behavior on the investment decision making and the value of RA -> IDM is  $f =$

Table 8

**R-square and Adjusted R-square**

| Dependent Variable | R-square | R-square adjusted |
|--------------------|----------|-------------------|
| IDM                | 0.463    | 0.461             |

Source: Smart-PLS Output.

Table 9

**F-square**

| Exogenous Construct | IB | IDM   | RA |
|---------------------|----|-------|----|
| IB                  |    | 0.757 |    |
| IDM                 |    |       |    |
| RA                  |    | 0.001 |    |

Source: Smart-PLS Output.

0.001 indicating a low impact of risk appetite on the investment decision-making.

**DISCUSSION**

The study seeks to investigate the influence of investment behavior and risk tolerance on the decision-making process of rural investors. Most of the investors' main occupation is farming, as mentioned in the demographic section, and their primary asset is land, which they cultivate and earn their livelihood. There are fewer females who have assets, another occupation which is preferred by many individuals apart from farming is self-employment and more than 2/3 number of people earn less than five lakhs annually. Almost half of the people have less than five years of investment experience. As mentioned in the factor loading section, the  $IB1 = 0.776$  tells us that rural people are very clear about their future financial needs.  $IB6 = 0.757$ , implies that they only invest in asset after reviewing the asset's risk, return, security and liquidity, and other historical information.  $IB7 = 0.801$  tells us that assets chosen by the investors were correctly understood. This study infers that investment behavior significantly impacts the decision-making of rural investors. The study's findings align with the literature [30, 31]. While the risk appetite of rural investors has no substantial association with investment decision-making, regardless of the level of risk appetite is it does not impact their investment decision-making, as the data tells us that rural investors feel it challenging to understand the investing world as mentioned in the

factor loading sections where  $RA1 = 0.69$ . Many of them prefer to park their investments in the bank deposits rather than in the stock market which was cited in  $RA2 = 0.725$ , and whenever they think of the term 'risk', the 'loss' comes into their mind directly which has a high factor loading  $RA3 = 0.817$ . When they were asked about making money from the stock market and bond market based on luck, most of them were unaware of both the markets as it is showing the lowest factor loading  $RA4 = 0.64$  and most investors prefer the safety of their capital rather than making returns while taking some risk in which  $RA5 = 0.739$ . This is the first time there has been a study on the impact of risk appetite on the investment decision making, and these results may be due to limited investment opportunities, low financial needs, a primary focus on the immediate needs and restricted access to the multiple investment options which could lead to insignificant relationship between risk appetite and investment decision-making.

### CONCLUSION AND FUTURE SCOPE

After analysing the data in which the results revealed that the rural investors decision making has been highly impacted by their investment behaviour. After analysing the data, the results revealed that rural investors' decision-making has been highly impacted by their investment behavior. If we dig deeper, we can see that various items have highly impacted their decision-making. These include: clarity about future

financial needs; thorough thinking before investing in any asset class; and keeping in mind factors such as risk, security, return, and liquidity before selecting an asset class. They also explore historical information about assets, ensuring that they only invest in assets they understand well. If their needs change, they may prefer other asset classes. Most investors take investment decisions on their own, indicating their independent decision-making rather than relying on financial advisors. And they definitely review the performance of their investments in various assets from time to time.

As the risk appetite does not have an impact on the investment decision-making of investors, we can conclude that rural investors have moderate to low risk appetites, which financial institutions and companies should take into account when targeting rural people with their financial products. They should base their approach on the investors' investment behavior, rather than relying solely on risk appetite.

This study is limited to the direct relationship between investment behavior, risk appetite and investment decision-making; the relationship can also be examined with the moderate influence of demographic factors such as age, gender and educational background. The top of the form, which can help government and financial institutions and companies to deeply delve into investment behavior of rural investors, is also geographically limited to two states in India, but it can be extended to other rural areas for research.

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**The Construct of the Investment Behaviour, Risk Appetite and Investment Decision Making Has Been Showing the Publication Support**

| Construct                  | Items                                                                                                                                                                                     | Publication Support         |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Investment Behaviour       | I am clear with my future financial needs/objectives                                                                                                                                      | Rastogi and Gupta [20]      |
|                            | I know all investment avenues, such as bank deposits, mutual funds, equity, bonds, real estate, gold, etc.] available for investments                                                     |                             |
|                            | I determine my investment objectives before investing                                                                                                                                     |                             |
|                            | I invest first and then use/will use the accumulated funds to meet my different investment objectives                                                                                     |                             |
|                            | I determine a time frame for each of my investment objectives in which those are to be achieved                                                                                           |                             |
|                            | Before selecting an investment, I critically evaluate all the investment avenues on the parameters (such as risk, return, safety, security, liquidity, etc., associated with that avenue) |                             |
|                            | While analysing an investment avenue, I explore/use historical information, such as past performance, risk, management information, etc.                                                  |                             |
|                            | I select investment avenues that match my investment objectives                                                                                                                           |                             |
|                            | I invest in different investment avenues for other investment objectives                                                                                                                  |                             |
|                            | I allocate my investible funds among different selected investment avenues based on my future fund's requirements                                                                         |                             |
|                            | My investment decisions (selection of investment avenues and allocation of funds) are influenced by my agent (s), friend (s), family member (s), and or relative (s)                      |                             |
|                            | I make investment decisions based on my analysis                                                                                                                                          |                             |
|                            | I periodically review the performance of my investments in connection with my investment objectives                                                                                       |                             |
|                            | After selecting and investing in a particular investment avenue, I remain invested until it matches my investment objective                                                               |                             |
|                            | I revised my investment portfolio (deleting and or adding new investment avenues) to match the changes in my investment objectives                                                        |                             |
| Risk appetite              | I increase or decrease investment amounts based on my changing/ increasing / decreasing financial needs                                                                                   | Kannadhasan, Manoharan [21] |
|                            | I find difficulty in managing many investment avenues in one point of time                                                                                                                |                             |
|                            | Investing is too difficult to understand                                                                                                                                                  |                             |
|                            | I am more comfortable putting my money in a bank account than in the stock market                                                                                                         |                             |
|                            | When I think of the word "risk", the term "loss" comes to mind Immediately                                                                                                                |                             |
| Investment Decision-Making | Making money in stocks and bonds is based on luck                                                                                                                                         | Sarwar and Afaf [22]        |
|                            | In terms of investing, safety is more important than returns                                                                                                                              |                             |
|                            | In general, I am satisfied with how I make investment decisions                                                                                                                           |                             |
|                            | My decision-making helps me to achieve my investment objectives                                                                                                                           |                             |
|                            | I am confident about the accuracy of my investment decisions                                                                                                                              |                             |
|                            | My investments decisions can mainly earn higher than average return in the market                                                                                                         |                             |
|                            | I make all my investment decisions on my own                                                                                                                                              |                             |
|                            | I believe that my skills and knowledge of the market help me to outperform the market                                                                                                     |                             |
|                            | I am usually able to anticipate the movements in market returns                                                                                                                           |                             |
|                            | I consider all possible factors while making investment decisions                                                                                                                         |                             |

Source: Author's presentation.

# Integration of AIDA and the TPB on Cashless Fintech Usage Interest

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## ABSTRACT

This study integrated two theories: the Theory of Planned Behavior (TPB) and the AIDA (Attention Interest Desire Action) model, to understand interest in using cashless fintech and to assess the impact of marketing communication on consumer behavior. The study included culture as a factor believed to influence the intention to use cashless fintech. For the AIDA model, only the variables attention, interest, and desire were used, excluding action, as the study focused on consumer interest rather than the decision-making to use cashless fintech. The conceptual model and hypotheses combine key constructs from both models to predict behavioral intentions. This quantitative study involves residents of Ambon City and used Partial Least Square (PLS) analysis, a structural equation modeling (SEM) technique, to estimate the simultaneous effects between variables. The results revealed that first, integrating the AIDA model and TPB does not show AIDA as a stimulus for increased interest in fintech usage, with attention, interest, and desire negatively impacting behavior intention. Second, TPB, through its three constructs: attitude towards behavior, subjective norm, and perceived behavioral control, successfully explained fintech interest, and culture was found to have a significant influence on behavioral intention.

**Keywords:** theory of planned behavior; the AIDA model; cashless fintech; consumer behavior; culture

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## INTRODUCTION

Technological growth has fundamentally transformed the consumer environment in society. Technological advancements are undeniable; technology and information have rapidly influenced the environment and have made information a critical necessity. This transition to the “on-demand” era ushers in economic activities facilitated by information technology and communication infrastructures that deliver products and services tailored to meet societal needs, thereby offering anticipated advantages for consumers themselves [1]. Fintech, short for Financial Technology, combines financial systems with technology to create innovations that simplify financial processes, offering ease in financial transactions [2]. Today, people can conduct various transactions for goods and services using new methods beyond traditional cash and checks. This phenomenon of cashless payments is known as e-payment.

The e-payment system allows individuals to make payments via the internet without using physical cash [3, 4]. It possesses characteristics such as convenience, security, transparency, and transaction cost savings [5]. Cashless mobile payment methods can enhance financial

inclusion by reducing barriers for people in accessing financial services, enabling easy micropayments without cash [6]. Mobile payments enable society to eliminate the need for cash usage, thus aiding government efforts in promoting the National Non-Cash Movement (Gerakan Nasional Non Tunai, GNNT) initiated in 2014. Mobile payments make the payment process faster, safer, and more practical [6]. People can utilize mobile payment services to settle small transactions anywhere, using smartphones, internet connectivity, and server-based electronic money payment tools.

Ambon City is a small city with a relatively dense population and high socio-economic activity, necessitating changes in people’s lifestyles regarding social interaction, including the payment models they use. One such change is increasing demand for using non-cash (cashless) payment instruments in transactions. Cashless technology, stemming from fintech, collaborates with various economic sectors to meet the public’s increasing technological needs. Although society is becoming more aware of digital payments, usage remains relatively low [7]. According to data from the Department of Cooperatives and UMKM in Ambon City, the number of SME (Small and Medium

Enterprises) actors in this area has reached 38,518, with 27.46% obtaining loans. This means that 72.54% secure are funded by their own capital or other sources of loans [8]. This reluctance arises because people perceive it as complicated and inconsistent with the prevailing culture, coupled with personal factors that shape individual behavior patterns, influencing responses and conduct which others can explain consistently [9].

Another observation is that residents of Ambon City already possess mobile banking and other non-cash payment applications but they prefer using cash because they consider face-to-face social interactions during transactions to be more meaningful [8]. Cash payments or other traditional methods are deemed more personal and trustworthy compared to digital transactions. Trust in digital payments is significantly influenced by digital literacy. Individuals with low digital skills or financial challenges tend to have less trust in digital payment systems. This trust deficit can act as a barrier to adopting digital transactions, making cash a more trusted option for these groups [10, 11].

A deep understanding of individual behavior is essential for assessing people's behavioral intentions in adopting new technologies. Communication serves as a means to deliver messages that introduce cashless fintech products and encourage the public, as recipients of the message, to develop interest in using the product [12, 13]. Marketing communication can be explained through the AIDA model (Attention, Interest, Desire, and Action), which has proven effective in explaining human behavior. These four stages assist marketers in understanding how target consumers evolve over time [14]. Economic transactions can occur anywhere, unhindered by time and distance constraints, with just one touch on a fintech application [15], thus forcing individuals to adapt to the existing conditions.

However, technology-based services like cashless fintech present challenges in predicting behavioral processes where consumer interest sparked by marketing communication leads to actual usage, due to technological complexities [16]. The belief that one may not necessarily use cashless fintech services but will gain greater practical benefits fosters a supportive attitude toward adopting the system, positively impacting the intention to use it [17]. Despite the widespread use of smartphones and frequent engagement with mobile applications, embracing technologies such as cashless finance brings in various influential factors, such as

cultural elements, which significantly impact the intention to adopt these technologies [17, 18].

In this context, the Theory of Planned Behavior (TPB) explains how influences on an individual determine their decision to perform a behavior [19, 20]. TPB is a theory related to the acceptance and usage behavior of fintech technology and it has been widely employed to understand individual behaviors in embracing such technologies [21, 22]. The model positions "attitude" as a primary determinant in predicting users' intentions to utilize cashless fintech services, with growing interest serving as a determinant of attitude [23]. Conversely, the AIDA model suggests "desire" as an important emotional determinant in behavioral intention [24].

Although the TPB and AIDA models have been validated across various disciplines, constructing and expanding TPB by integrating the AIDA model can offer valuable insights for fintech service providers. This integration helps in developing strategies that keep their businesses competitive amid the escalating use of mobile applications. Combining the core constructs of both models enhances the predictive power in studying behavioral intentions and provides a more comprehensive understanding of the intricate process of technology adoption. Therefore, the purpose of this research is to identify how the potential interest in using cashless fintech services, as analyzed through marketing communication, can be better understood through combining AIDA and TPB models.

The AIDA model, which stands for Attention, Interest, Desire, and Action, has been modified to focus on its influence on interest in using fintech by disregarding the action variable [14, 25]. This modification is driven by the desire to understand the extent to which interest in using fintech is influenced by the AIDA model, specifically attention, interest, and desire, without considering the action variable [14, 25]. Furthermore, researchers do not use the use behaviour variable which is part of the Theory of Planned Behaviour because the research needs only to see behavioural interest (behaviour intention) to accept new technology that influences them to use or not use the technology, not to how intensely users use the technology so that only the behaviour intention variable is used.

Furthermore, this study aims to bridge the gap between theoretical models and practical application by offering a consolidated framework that addresses both emotional and rational factors influencing consumer

behavior. By understanding these dynamics, fintech companies and policymakers can tailor their approaches to effectively encourage the adoption of cashless fintech solutions in culturally diverse settings like Ambon City.

## LITERARY REVIEW

### AIDA Model

The AIDA model outlines the stages of Attention, Interest, Desire, and Action in the communication process [14, 26]. It has been successfully applied in various contexts and product categories, explaining the process of communicating product features to customers [14]. The model reflects the hierarchy of effects of advertising, where customers progress from product unawareness to making a purchase [14]. However, the AIDA model, along with other hierarchy-of-effects models, has been criticized for reflecting “old world” thinking and underestimation the role of emotional responses in advertising [27]. Recent advances in neuroscience have challenged the traditional sequential and rational view of consumer behavior, raising questions about the model’s alignment with modern understanding of advertising and brand purchase [27].

The evolution of media and digital technologies has significantly impacted marketing and advertising strategies, leading to changes in distribution, marketing models, monetization, and competitive scenarios [28]. Digital marketing has evolved from a business-oriented approach to a consumer-oriented one, with theory and practice influencing each other closely over time [29]. The emergence of algorithmic (programmatic) advertising has revolutionized the advertising market, allowing for highly customized advertising communication with consumers [30]. In response to these developments, the AIDA model has been adapted to new contexts. For example, it has been applied to crowdfunding, demonstrating its utility in guiding project owners to take backers from unawareness to contributions [14]. By integrating digital channels and interactive elements, the model remains relevant in guiding marketing communication in the modern landscape.

The AIDA model outlines four key stages in the consumer decision-making process: Attention, Interest, Desire, and Action [14, 31]. It has been successfully applied in various contexts, including advertising products, crowdfunding, social media marketing,

and tourism advertisements [26, 32, 33]. The model emphasizes the importance of attracting customer attention as the initial step in marketing, followed by generating interest, creating desire, and ultimately leading to action, such as a purchase or engagement [14, 34, 35]. The AIDA model has been widely used globally by business owners and entrepreneurs, demonstrating its practical relevance in marketing and promoting products and services v[35–37]. Studies also indicate that integrating the AIDA model with other theories provides valuable insights into consumer decision-making and the acceptance of new technologies [31].

Based on this understanding, we propose the following hypotheses:

H1: Attention towards cashless fintech services significantly and positively affects the behavioral intention to use cashless fintech.

H2: Interest in cashless fintech services significantly and positively affects the behavioral intention to utilize cashless fintech.

H3: Desire for cashless fintech services significantly and positively affects the behavioral intention to use cashless fintech.

### Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) is based on the Theory of Reasoned Action (TRA), which enhances our understanding of the relationship between attitudes and behaviors in human action. The TRA, originally proposed by Fishbein and Ajzen, posits that an individual’s behavioral intentions are influenced by their attitude towards the behavior and the subjective norms [38, 39]. However, the TPB expands this model by incorporating the concept of perceived behavioral control, which accounts for factors that may facilitate or impede the performance of the behavior [38]. The TPB framework is robust and adaptable across different domains, effectively predicting behavioral intentions by considering attitudes, subjective norms, and perceived behavioral control [40, 41]. This makes it a useful tool for understanding and influencing behavior in diverse contexts.

The TPB has been utilized as a framework for behavioral change interventions, with Meta-analytic evidence confirming its effectiveness in predicting and explaining behavior in different domains [42]. For instance, in environmental activities, the TPB helps to explain individuals’ engagement in pro-environmental



behaviors by assessing their attitude towards the environment, perceived social pressures, and control over environmental actions. In technology adoption, the TPB has been instrumental in understanding and predicting behavior related to the acceptance and use of new technologies [42–44]. By analyzing psychological factors that influence technology use, such as perceived usefulness and ease of use, the TPB provides valuable insights for interventions and policy development aimed at increasing technology uptake.

In the context of the Theory of Planned Behavior (TPB), three key components play a crucial role in influencing an individual's intention to adopt fintech services. Attitude Towards Behavior (ATB) refers to the individual's positive or negative evaluation of using fintech services. When a person perceives fintech as beneficial and convenient, this increases their intention to use it, whereas a negative evaluation tends to reduce this intention [22, 45]. Furthermore, Subjective Norms (SN) are related to social influences, where individuals consider the opinions of important people in their lives, such as family, friends, or colleagues, regarding whether they should adopt fintech services. This social pressure can be a strong motivator, especially when individuals feel the need to conform to prevailing social views [22]. Lastly, Perceived Behavioral Control (PBC) is associated with the individual's perception of their ability or control over using fintech services. If individuals believe they have the necessary skills, knowledge, or resources, they are more confident and motivated to adopt fintech. Conversely, barriers such as a lack of technological understanding or access can lower their intention to engage with fintech services [22, 46].

Based on the TPB, the following hypotheses are proposed:

H4: Attitude toward using cashless fintech services significantly and positively influences the behavioral intention to use cashless fintech.

H5: Subjective norm significantly and positively influences the behavioral intention to use cashless fintech.

H6: Perceived behavioral control significantly and positively influences the behavioral intention to use cashless fintech.

### Culture

Culture, which encompasses values, beliefs, artifacts, and symbols passed down and shared among members

of a society, significantly impacts behavioral intention [47]. Key components of culture, such as values, beliefs and norms play a crucial role in shaping how individuals form their intentions [48]. Cultural norms, which prescribe acceptable behaviors within a society, guide individual actions by outlining what is considered appropriate and inappropriate, thus influencing behavioral intentions [49, 50]. These norms serve as widely accepted standards that reduce uncertainty and provide clarity on otherwise ambiguous issues, helping individuals make decisions aligned with their cultural context [50]. Additionally, shared values and beliefs within a society are fundamental in shaping behavioral intention, as they represent what is considered important and valuable within a culture. They influence how individuals prioritize their actions and align their behavior with societal expectations [51].

Culture encompasses the set of values, beliefs, artifacts, and symbols passed down and shared among members of a society, influencing behaviors and actions. Studies show that cultural alignment can significantly impact the intention to use new technologies, with different cultural dimensions affecting this process in various ways [52, 53]. For instance, social norms are stronger determinants of intended behavior in cultures with high uncertainty avoidance [53].

Therefore, we propose the following hypothesis:

H7: Culture significantly and positively influences the behavioral intention to use cashless fintech services.

### METHODOLOGY

The population for this study consisted of residents in Ambon City, spread across six districts, all of whom owned smartphones. The study utilized Partial Least Square (PLS) analysis, which is a structural equation modeling (SEM) method, to estimate the simultaneous effects between variables, with a focus on prediction and exploration. Cluster random sampling technique was used to select samples based on geographic clusters within the population. Questionnaires were distributed electronically to individuals who owned smartphones, and a total of 100 questionnaires were distributed, all of which were returned, resulting in a 100% response rate for further analysis.

The key variables in this study are defined as follows: Attention (AT) represents the level of focus and interest in a product, driven by media exposure and brand awareness; Interest (INT) reflects a consumer's



positive inclination towards a product, influenced by media effectiveness and user recommendations. Desire (DES) captures the motivation to use a product, driven by relevant product information. Attitude Toward Behavior (ATB) measures the individual's overall evaluation, whether positive or negative, toward using fintech; Perceived Behavioral Control (PBC) refers to the user's confidence and ability to engage with fintech; Behavior Intention (BI) reflects the individual's intention to use and recommend fintech in the future; Subjective Norm (SN) captures the influence of social pressure and the opinions of significant others, such as family, friends, or colleagues, on an individual's behavior; lastly, Culture (CU) represents societal habits, values, and social norms that may influence behavior. All variables are measured using a five-point Likert scale.

## RESULTS AND DISCUSSION

The initial measurement model assessment examined the relationships between variables and their measurement items. All 64 items were valid, with loading factors above 0.70, and reliable, as indicated by Cronbach's Alpha and Composite Reliability exceeding 0.70, and AVE above 0.50. Discriminant validity was confirmed using the Fornell-Larcker criterion and the HTMT approach, with all HTMT values below 0.90. Hair et al. 54 recommend HTMT for better discriminant validity detection. Sarstedt et al.[50] suggest removing highly correlated or low-loading items to improve HTMT results.

The analysis reveals that all measurement items demonstrate strong reliability and validity, with loading factors for all variables ranging from 0.761 to 0.950. These values exceed the acceptable threshold of 0.70, indicating that each item significantly contributes to its corresponding construct.

The analysis confirms that the measurement model demonstrates strong reliability and validity, supported by the Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) values, as shown in *Table 1*. All Cronbach's Alpha values exceed 0.70, ensuring strong internal consistency for each construct. Similarly, the Composite Reliability values are above 0.90 for all variables, indicating excellent reliability across the board. The AVE values for all constructs surpass 0.50, confirming adequate convergent validity for the model. These results, shown in *Table 1*, demonstrate that the measurement items effectively represent their respective

*Table 1*  
**Evaluasi Model Pengukuran Variabel Attention**

| Variable | Cronbach's Alpha | Composite Reliability | Average Variance Extracted |
|----------|------------------|-----------------------|----------------------------|
| AT       | 0.954            | 0.962                 | 0.783                      |
| INT      | 0.960            | 0.966                 | 0.805                      |
| DES      | 0.979            | 0.981                 | 0.813                      |
| ATB      | 0.929            | 0.946                 | 0.780                      |
| SN       | 0.956            | 0.964                 | 0.819                      |
| PBC      | 0.971            | 0.975                 | 0.832                      |
| CUL      | 0.953            | 0.959                 | 0.703                      |
| BI       | 0.971            | 0.975                 | 0.794                      |

Source: Compiled by the authors.

constructs, providing a reliable and valid foundation for further analysis.

The discriminant validity was confirmed using the Fornell-Larcker criterion, with the square root of the Average Variance Extracted (AVE) for each construct exceeding the correlations between constructs. Additionally, the HTMT values, as shown in *Table 2*, were all below the threshold of 0.90, indicating that each construct is distinct and the model has strong discriminant validity. These findings confirm that the constructs are adequately differentiated and the measurement model is valid.

## Structural Model Evaluation

The evaluation of the structural model involves testing the hypothesized effects between variables, where the evaluation consists of checking for collinearity between the variables by using the Inner VIF (Variance Inflated Factor), with VIF values below 5 indicating that there are no collinearity problems. The significance of the path coefficient is tested, along with the 95% confidence intervals of the path coefficient. The influence of variables at the structural level is evaluated using  $f$ -squared ( $f^2$ ), where an effect size is considered low ( $f^2 = 0.02$ ), medium ( $f^2 = 0.15$ ), and high ( $f^2 = 0.35$ ).

Based on *Table 4*, the structural model evaluation included the VIF,  $R^2$ , and  $Q^2$  values. The VIF values were all below 5, indicating no multicollinearity issues among the exogenous variables, ensuring that the parameter estimates are reliable and unbiased. The

Table 2

## Fornell Dan Lacker

| Variable | ATB   | AT    | BI    | CUL   | DES   | INT   | PBC   | SN    |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|
| ATB      | 0.883 |       |       |       |       |       |       |       |
| AT       | 0.479 | 0.885 |       |       |       |       |       |       |
| BI       | 0.749 | 0.504 | 0.891 |       |       |       |       |       |
| CUL      | 0.467 | 0.402 | 0.528 | 0.839 |       |       |       |       |
| DES      | 0.409 | 0.422 | 0.493 | 0.307 | 0.901 |       |       |       |
| INT      | 0.442 | 0.468 | 0.479 | 0.335 | 0.348 | 0.897 |       |       |
| PBC      | 0.422 | 0.240 | 0.487 | 0.248 | 0.145 | 0.190 | 0.912 |       |
| SN       | 0.717 | 0.472 | 0.773 | 0.486 | 0.377 | 0.432 | 0.479 | 0.905 |

Source: Compiled by the authors.

Note: Diagonal is correlation & the value above the diagonal is HTMT.

$R^2$  value of 0.730 suggests that the model explains 73% of the variance in Behavior Intention, reflecting a strong level of explanatory power. Additionally, the  $Q^2$  value of 0.573 indicates good predictive relevance, demonstrating that the model has a strong ability to predict Behavior Intention based on the exogenous variables. These results confirmed the robustness and predictive capabilities of the structural model.

Based on Table 3, the hypothesis testing revealed that the first hypothesis (H1) was rejected, indicating no significant effect of Attention on behavior intention, with a path coefficient of 0.028 and a p-value of 0.482 ( $>0.05$ ). The effect size, as seen in Table 4, was low with an  $f^2$  of 0.002, indicating a minimal influence at the structural level. This contradicts the AIDA model, which suggests that higher attention leads to greater interest, and it also differs from the findings of Arrasyid et al. [51], which showed that attention has a significant impact on behavior intention.

The second hypothesis (H2) was also rejected, indicating no significant effect of Interest on behavior intention, with a path coefficient of 0.074 and a p-value of 0.070 ( $>0.05$ ). The effect size was also low ( $f^2 = 0.014$ ), suggesting a minimal structural influence. This finding contradicts both the AIDA model and the results of Arrasyid et al. [51], which found that interest significantly impacts behavior intention.

The third hypothesis (H3) was also rejected, showing that desire did not have a significant effect on behavioral intention, with a path coefficient of 0.115 and a p-value

Table 3

## Hypotesis Test Results

| Hypotesis | Path Coefficient | P values |
|-----------|------------------|----------|
| AT → BI   | 0.028            | 0.482    |
| INT → BI  | 0.074            | 0.070    |
| DES → BI  | 0.155            | 0.071    |
| ATB → BI  | 0.279            | 0.005    |
| SN → BI   | 0.354            | 0.002    |
| PBC → BI  | 0.129            | 0.005    |
| CUL → BI  | 0.109            | 0.012    |

Source: Compiled by the authors.

of 0.070 ( $>0.05$ ). The effect size was low ( $f^2 = 0.067$ ), again indicating a minimal influence at the structural level. These results do not align with the AIDA theory, which suggests that increased desire leads to higher intention, nor with the findings of Arrasyid et al. [51], which demonstrated a significant relationship between desire and behavior intention.

In contrast, the fourth hypothesis (H4) was accepted, indicating a significant effect of Attitude Towards Behavior on behavior intention, with a path coefficient of 0.279 and a p-value of 0.005 ( $<0.05$ ). The effect size was moderate ( $f^2 = 0.123$ ), indicating a considerable influence at the structural level. This result supports the Theory of Planned Behavior, which posits that a positive attitude increases the intention to use technology, and is consistent with the findings of Khanifah et al. [48, 52] and of other scientists, who found that attitude towards behavior significantly affects behavior intention.

Table 4

**Model Test Results**

| Hypotesis | VIF   | F- Square | R- Square | Q- Square |
|-----------|-------|-----------|-----------|-----------|
| ATB → BI  | 1.600 | 0.123     | 0.730     | 0.573     |
| AT → BI   | 1.440 | 0.002     |           |           |
| CUL → BI  | 1.341 | 0.031     |           |           |
| DES → BI  | 2.351 | 0.067     |           |           |
| INT → BI  | 2.474 | 0.014     |           |           |
| PBC → BI  | 1.329 | 0.046     |           |           |
| SN → BI   | 1.424 | 0.187     |           |           |

Source: Compiled by the authors.

The fifth hypothesis (H5) was accepted, showing a significant effect of Subjective Norm on behavior intention, with a path coefficient of 0.354 and a p-value of 0.002 ( $<0.05$ ). The effect size was moderate ( $f^2 = 0.187$ ), indicating a substantial structural influence. This result is consistent with the Theory of Planned Behavior, which suggests that social support from family, friends, or colleagues enhances the intention to use the system. The findings are also consistent with studies by Ahn & Kahlor [53] and Aji et al. [19], which demonstrated that subjective norm positively influences behavior intention.

The sixth hypothesis (H6) was accepted, showing a significant effect of Perceived Behavioral Control on behavior intention, with a path coefficient of 0.128 and a p-value of 0.005 ( $<0.05$ ). The effect size was low ( $f^2 = 0.046$ ), indicating a minor structural impact. This result supports the Theory of Planned Behavior, which posits that individuals with higher perceived control over their actions are more likely to form intentions. The finding is also consistent with the ideas of many researchers who found that perceived behavioral control positively influences behavior intention.

Finally, the seventh hypothesis (H7) was accepted, showing a significant effect of Culture on behavior intention, with a path coefficient of 0.109 and a p-value of 0.012 ( $<0.05$ ). The effect size was low ( $f^2 = 0.031$ ), indicating a moderate influence at the structural level. This result demonstrates that culture, as a fundamental aspect of human behavior, influences decision-making processes. The impact of culture may vary across regions, making it an important factor in designing communication strategies tailored to specific societal contexts.

**CONCLUSION**

This study aimed to integrate the AIDA model and the Theory of Planned Behavior (TPB) in order to understand the intention to use cashless fintech in Ambon. The findings showed that the variables of attention, interest, and desire had a negative influence on the intention to use fintech, indicating that this model is not effective as a stimulus in promoting fintech adoption. In contrast, the TPB, with its key constructs, such as attitude towards behavior, subjective norm, and perceived behavioral control, successfully explained the intention to use fintech in Ambon. Additionally, cultural factors that positively influence the adoption of cashless fintech services.

The results suggest that fintech providers must focus on innovation and align their marketing strategies with local cultural contexts to enhance consumer interest in fintech. Marketing messages should be meaningful, trustworthy, and clearly differentiated from competitors, resonating with the target audience's values and customs. Companies must not overlook the importance of marketing efforts in promoting their services alongside developing user-friendly applications.

This study has several limitations, including its focus on the city of Ambon, the use of online surveys, and the limited representation of older age groups, which may affect the generalizability of the findings. Future research should expand the sample population and explore the impact of fintech adoption across different age groups to better understand the inppact. Additionally, future studies could further examine how the AIDA model works as a marketing tool to foster interest in fintech, particularly in diverse cultural settings.

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**A.R. Kadir** — Literature review, Interpretation of results, Writing — review & editing, and Conclusion formulation.

**M. Pono** — Data curation, Investigation, Software/statistical analysis, and Visualization.

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# Comparative Analysis of Macroeconomic Variables and Financial Performance Indicators Before and During the Russia-Ukraine Conflict: Evidence from Russia

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## ABSTRACT

This study examines the economic and geopolitical ramifications of the ongoing Russia-Ukraine conflict on Russia and the global economy. It conducts a comparative analysis of selected macroeconomic and financial indicators across the pre-conflict (2005–2013) and during-conflict (2014–2022) periods. **The objective** is to determine whether significant differences exist in the mean values of key variables across the two phases. The study employs ratio analysis, descriptive statistics, the Shapiro-Wilk test, Wilcoxon matched-pairs signed-rank test, and t-tests. **Methodologically**, the two-period framework enables comparison of means, medians, and ratios, representing a key analytical contribution. **The results** indicate significant differences in oil rents and foreign direct investment (FDI) between the two periods, with higher average levels in the pre-conflict phase. In contrast, unemployment rates are lower during the conflict period compared to the pre-conflict period. These findings suggest structural shifts in Russia's macroeconomic performance amid geopolitical tensions, sanctions, the 2014 conflict escalation, the COVID-19 pandemic, and the 2022 special military operation. The study concludes that while oil rents and FDI declined during the conflict period, the Russian economy exhibited relative labor market resilience despite Western sanctions. It recommends **future research** applying regression analysis to further examine the impact of oil rents, FDI, and unemployment on economic growth under conditions of conflict and instability. **Keywords:** Russia; oil rents; foreign direct investment; Russia-Ukraine conflict; economic growth; financial performance

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## INTRODUCTION

The Russia-Ukraine conflict, which began in February 2014, has persisted for over a decade. Its escalation in February 2022 has significantly affected global economic growth and disrupted supply chains, contributing to slower growth, rising inflation, and increased volatility in energy, food, and commodity prices [1, 2]. In response, the United States, the European Union, and their allies imposed extensive sanctions, including restrictions on Russia's access to foreign reserves, limitations on dollar-based transactions for major Russian banks, and bans on selected imports and exports.<sup>1</sup> These measures have created substantial challenges for Russian financial authorities, particularly the Bank of Russia, which has implemented policy interventions

such as capital controls, market support measures, and actions to maintain financial stability and banking sector resilience. Consequently, the Bank of Russia implemented measures to support the stock market, including the introduction of cross-border capital controls and efforts to strengthen financial stability amid restricted access to part of its international reserves. These interventions aim to uphold the resilience of banks and other financial entities, ensuring their uninterrupted operation, and providing support for the functioning of enterprises.<sup>2</sup>

Given these developments, it is important to assess the broader effects of the conflict and sanctions on Russia's macroeconomic and financial performance. However, there remains limited literature examining these impacts in detail. This study addresses this gap

<sup>1</sup> CRS. Russia's War on Ukraine: U.S. Policy and the Role of Congress, February, 2024. URL: <https://crsreports.congress.gov/product/pdf/if/if12277> (accessed on 19.04.2024).

<sup>2</sup> Bank of Russia. The Bank of Russia's Work in 2022: Results in Brief, 2023. URL: [https://www.cbr.ru/collection/collection/file/43917/rb\\_2022.pdf](https://www.cbr.ru/collection/collection/file/43917/rb_2022.pdf) (accessed on 19.04.2024).

by comparing macroeconomic and financial indicators before and during the conflict to evaluate their overall effects. Specifically, the study analyzes how the Russia-Ukraine conflict has influenced key economic and banking performance indicators by comparing average values across the pre-conflict (2005–2013) and conflict (2014–2022) periods. The paper is organized as follows: Section 2 presents the oil and natural gas sector, Section 3 reviews the literature, Section 4 outlines the data and methodology, Section 5 presents empirical results, and Section 6 concludes the study.

### RUSSIA: OIL AND NATURAL GAS SECTOR

Russia is richly endowed with natural resources, including oil, natural gas, coal, gold, timber, diamonds, and rare earth metals [3]. Oil and gas form the backbone of its economy and are key drivers of global energy supply [4]. Russia is among the world's top oil producers and exporters, accounting for about 14% of global crude oil production in 2021.<sup>3</sup> It is also the seventh-largest holder of proven oil reserves and has made major investments in production facilities, refining capacity, and pipeline infrastructure serving Europe and Asia. In natural gas, Russia is the second-largest producer globally and holds the world's largest reserves.<sup>4</sup> It is the leading exporter, with major pipelines such as Nord Stream, Blue Stream, and TurkStream supplying a significant share of Europe's gas demand prior to 2022.<sup>5</sup>

Hydrocarbons dominate the Russian economy, accounting for around two-thirds of exports and about 45% of federal budget revenues in 2021 [5], highlighting strong energy dependence [6]. *Figure 1* illustrates global oil production, where the United States leads output but consumes most domestically, while Russia remains a major exporter. The figure also indicates a slight increase in Russia's oil output in 2022, raising questions about the effectiveness of sanctions [7, 8].

<sup>3</sup> IEA. Energy Fact Sheet: Why does Russian oil and gas matter? March 2022. URL: <https://www.iea.org/articles/energy-fact-sheet-why-does-russian-oil-and-gas-matter> (accessed on 22.12.2023).

<sup>4</sup> OPEC. OPEC Annual Statistical Bulletin 58th edition. Organization of the Petroleum Exporting Countries. 2023. URL: [https://asb.opec.org/ASB\\_PDFDownload.php](https://asb.opec.org/ASB_PDFDownload.php) (accessed on 19.04.2024).

<sup>5</sup> IEA. Energy Fact Sheet: Why does Russian oil and gas matter? March 2022. URL: <https://www.iea.org/articles/energy-fact-sheet-why-does-russian-oil-and-gas-matter> (accessed on 22.12.2023).

Russia is the world's second-largest natural gas producer and the leading gas exporter globally. *Figure 2* presents Russian gas export trends from 2018 to 2022, mainly directed toward Europe and Asia. The data shows a sharp 31.67% decline in gas exports in 2022 compared to the previous year, largely due to sanctions imposed by the United States and the European Union.

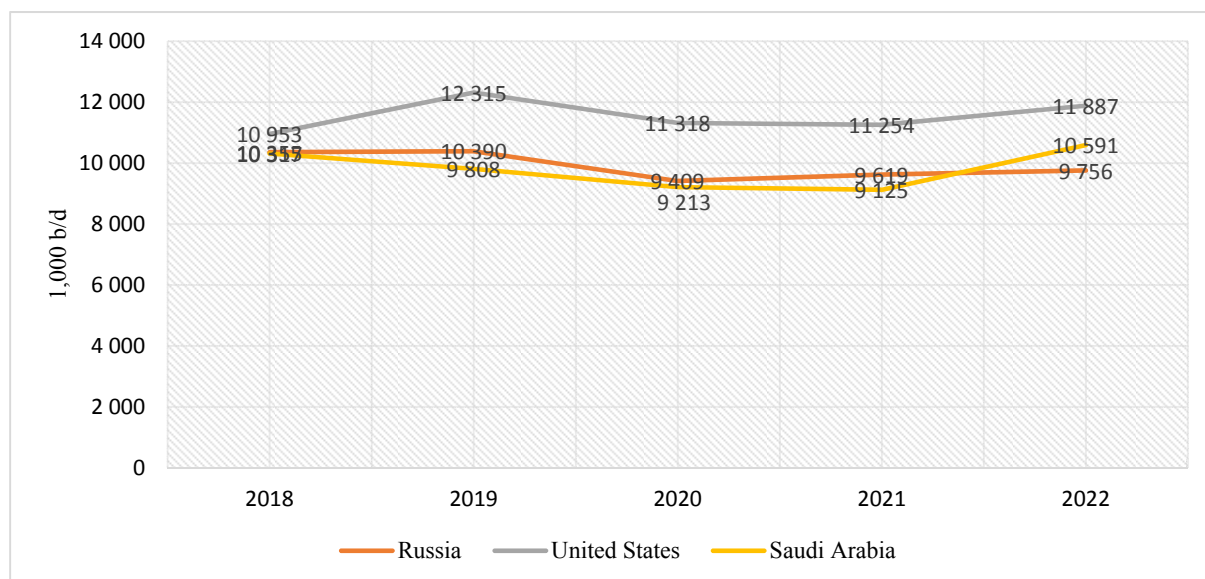
Against this background, the study examines the long-term effects of the Russia-Ukraine conflict on oil and gas revenues, FDI inflows, financial performance indicators, inflation, unemployment, and trade patterns, comparing the pre-conflict (2005–2013) and conflict (2014–2022) periods to assess statistically significant changes.

### LITERATURE REVIEW

This section reviews prior studies that applied ratio analysis, descriptive statistics, and t-test methods. Most of the existing literature focuses on the performance comparison between Islamic and conventional banks. These studies are used as a reference due to limited research applying similar techniques to macroeconomic indicators. Samad [9] examined Islamic and conventional banks in Bahrain (1991–2001), focusing on profitability, liquidity, and credit risk. Using financial ratios and t-tests across 21 banks, the study found no significant difference in profitability and liquidity, although Islamic banks performed better in credit risk. Similarly, Majeed and Zainab [10] analyzed Pakistani banks (2008–2019) and found that Islamic banks outperformed in capitalization, risk management, and liquidity, but underperformed in profitability, showing Islamic banks performing relatively weaker than conventional banks. Masruki et al. [11] used descriptive statistics, ratio analysis, and t-tests across profitability, liquidity, risk, and efficiency indicators, concluding that Islamic banks were less profitable but more liquid at the 5% significance level. Siraj and Pillai [12], studying GCC banks (2005–2010), found that Islamic banks performed better in several indicators, including operating income, assets, and deposits, partially supporting earlier findings on capitalization but contradicting results on profitability.

Building on these studies, this research applies ratio analysis, descriptive statistics, and t-tests to





**Fig. 1. The World's Largest Oil Producers**

Source: Authors' calculation based on data from 2023 OPEC Annual Statistical Bulletin 58th edition. URL: [https://asb.opec.org/ASB\\_PDFDownload.php](https://asb.opec.org/ASB_PDFDownload.php) (accessed on 10.12.2023).

compare macroeconomic and financial indicators between the pre-conflict and during-conflict periods. The aim is to determine whether there are statistically significant differences in the average values of the selected variables across the two periods.

## DATA AND RESEARCH METHODOLOGY

### Data and sample selection

This study conducts a comparative analysis of macroeconomic and financial performance indicators before and during the Russia-Ukraine conflict over the period 2005–2022. The sample is divided into two phases: the pre-conflict period (2005–2013) and the during-conflict period (2014–2022), enabling a clear comparison between the two eras. The study uses annual secondary data for Russia. The variables include GDP, inflation, gross domestic savings, unemployment, FDI, oil and gas rents, exports, bank nonperforming loans, deposit and lending interest rates, and total reserves. Most variables are expressed in ratio form, while total reserves are measured in real values. The analysis focuses on assessing the impact of the conflict on macroeconomic performance and financial stability across the two periods.

### Research Methodology

This study employs average ratio analysis to compare macroeconomic and financial performance indicators

before and during the Russia-Ukraine conflict (2005–2022). It evaluates key variables including GDP, inflation, gross domestic savings, unemployment, FDI, oil and gas rents, exports, and banking indicators such as NPLs, deposit and lending rates, and total reserves.

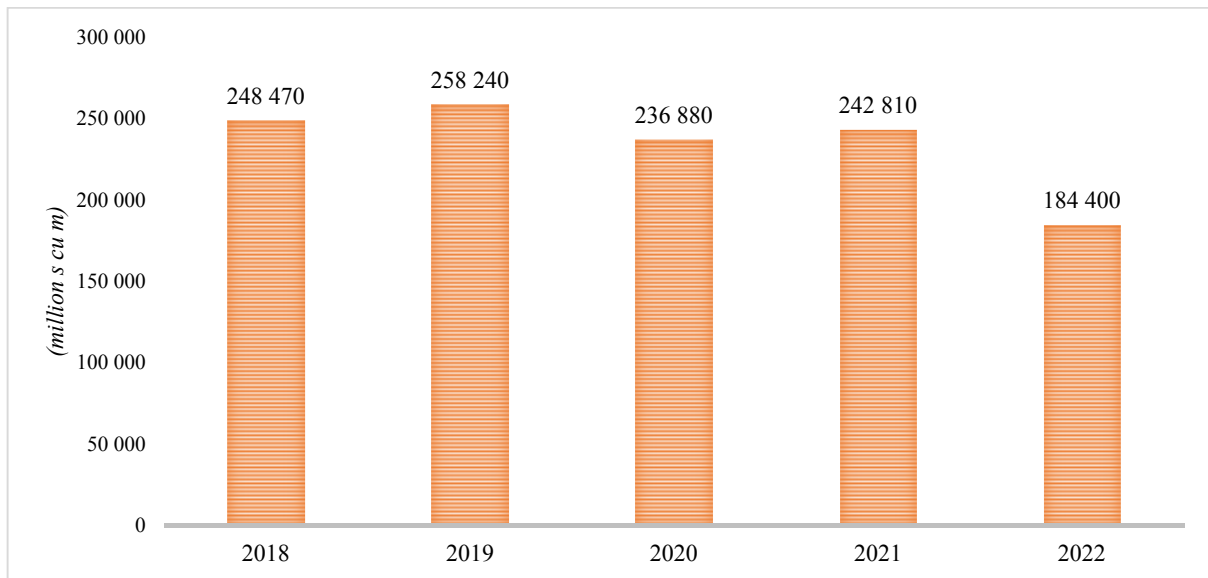
The analysis applies descriptive statistics alongside the Shapiro-Wilk test to assess data normality. Where data are normally distributed, t-tests are used to examine differences in mean values between the pre-conflict (2005–2013) and conflict (2014–2022) periods. For non-normally distributed data, the Wilcoxon matched-pairs signed-rank test is applied to compare medians. This combined approach helps determine whether statistically significant differences exist between the two periods.

### Gross Domestic Product (GDP)

GDP measures the total value of final goods and services produced within a country over a given period and is widely used to assess economic performance [13]. Real GDP growth reflects economic health, with increases indicating expansion and declines signaling downturns.<sup>6</sup> This study compares average GDP between the pre-conflict and during-

<sup>6</sup> IMF. Gross Domestic Product: An Economy's All. URL: <https://www.imf.org/en/Publications/fandd/issues/Series/Back-to-Basics/gross-domestic-product-GDP>





**Fig. 2. The Historical Data for Russian Gas Exports**

Source: Authors' calculation based on data from 2023 OPEC Annual Statistical Bulletin 58th edition. URL: [https://asb.opec.org/ASB\\_PDFDownload.php](https://asb.opec.org/ASB_PDFDownload.php) (accessed on 10.12.2023).

conflict periods to test for significant differences. The following hypothesis was developed.

There is a difference between the average two means of GDP.

#### **Inflation Rate**

Inflation refers to the rate at which general price levels increase over time, reducing purchasing power [14, 15]. It is commonly measured using the Consumer Price Index (CPI).<sup>7</sup> This study compares average inflation rates across the two periods to assess differences. The hypothesis is that there is a significant difference between the two period means of the inflation rate.

#### **Gross Domestic Savings**

GDS represents national income remaining after total consumption and reflects resources available for investment.<sup>8</sup> This study examines whether average GDS differs significantly between the pre-conflict and conflict periods. The following hypothesis was formulated:

There is a significant difference between the average two means of GDS.

<sup>7</sup> World Bank. Inflation, consumer prices for the United States [FPCPITOTLZGUSA], December 2023. URL: <https://fred.stlouisfed.org/series/FPCPITOTLZGUSA> (accessed on 06.02.2024).

<sup>8</sup> The World Bank. Gross domestic savings. URL: <https://databank.worldbank.org/metadataglossary/world-development-indicators/series/NY.GDS.TOTL.ZS> (accessed on 20.04.2024).

#### **Unemployment Rate**

The unemployment rate measures the share of the labor force actively seeking but unable to find work and is a key indicator of labor market performance.<sup>9</sup> This study compares average unemployment before and during the conflict to assess its impact. The following hypothesis was formulated.

There is a significant difference between the average two means of unemployment rate.

#### **Foreign Direct Investment Inflows**

FDI refers to cross-border investment involving ownership in foreign enterprises [16, 17]. It reflects long-term economic integration.<sup>10</sup> This study examines whether average FDI inflows differ significantly between the two periods. The following hypothesis was developed.

There is a significant difference between the average two means of FDI.

#### **Oil and Gas Rents**

Oil and gas rents represent the difference between resource value and production cost.<sup>11</sup> This study

<sup>9</sup> OECD. Unemployment rate (indicator). URL: <https://doi.org/10.1787/cbe71f42-en> (accessed on 07.02.2024).

<sup>10</sup> OECD. FDI flows, 2024. URL: <https://data.oecd.org/fdi/fdi-flows.htm> (accessed on 21.04.2024).

<sup>11</sup> World Bank. Oil rents (% of GDP). URL: <https://databank.worldbank.org/metadataglossary/adjusted-net-savings/series/NY.GDP.PETR.RT.ZS> (accessed on 06.02.2024).

examines whether the average oil and gas rents in Russia differ significantly between the pre-conflict and during-conflict periods.

The study is guided by the following hypothesis that there is a significant difference in the average means of oil rents and natural gas rents between the pre-conflict and conflict periods.

#### Export of Goods and Services

Exports measure the value of goods and services provided to non-residents and are key indicators of economic performance.<sup>12</sup> This study compares average exports across the two periods. The following hypothesis was developed.

There is a significant difference between the average two means of exports of goods and services.

#### Bank Nonperforming Loans Ratio

The NPL ratio measures the share of loans that are in default or near default and reflects banking sector health.<sup>13</sup> This study examines whether average NPL ratios differ across the two periods. The hypothesis is that there is a significant difference between the two period means of bank non-performing loans.

#### Deposit Interest Rate

The deposit interest rate is the rate paid by banks on demand, time, or savings deposits [18], which are often used by investors for capital preservation, modest returns, and insurance protection.<sup>14</sup> This study compares average deposit rates between the two periods. The hypothesis is that there is a significant difference between the two period means of the deposit interest rate.

#### Lending Interest Rate

The lending rate is the cost of borrowing for private sector loans and reflects credit conditions in the

economy.<sup>15</sup> This study examines whether the mean lending rate differs significantly between the pre-conflict and conflict periods in Russia's banking sector.<sup>16</sup> The hypothesis is that there is a significant difference between the two period means of the lending interest rate.

#### Total Reserves

Total reserves include monetary gold, SDRs, IMF positions, and foreign exchange assets held by monetary authorities.<sup>17</sup> This study examines whether the mean of total reserves differs between the pre-conflict and conflict periods and tests whether the difference is statistically significant. The hypothesis is that there is a significant difference between the two period means of total reserves.

### RESULTS AND DISCUSSIONS

#### Shapiro-Wilk for Testing Normality

The Shapiro-Wilk test is used to assess the normality of the macroeconomic variables and financial performance indicators. *Table 1* summarizes the results of the Shapiro-Wilk test for 12 variables. The data for three variables, namely GDP, GAS, and TR, failed to demonstrate normality, while the data for the remaining nine variables showed normality.

The Shapiro-Wilk test of normality was conducted to determine whether GDP, inflation rate, gross domestic savings, unemployment rate, foreign direct investment inflows, oil and natural gas rents, export of goods and services, bank nonperforming loans, deposit interest rate, lending interest rate, and total reserves are normally distributed. The results indicate that we must reject the null hypothesis for GDP with a p-value of 0.02699, GAS with a p-value of 0.03773, and total reserves (TR) with a p-value of 0.03956, concluding that these data are not normally distributed. Conversely, for the remaining nine variables, their p-values are greater than 0.05, indicating that we fail

<sup>12</sup> The World Bank. Exports of goods and services (% of GDP). URL: <https://databank.worldbank.org/metadataglossary/jobs/series/NE.EXP.GNFS.ZS> (accessed on 05.02.2024).

<sup>13</sup> The World Bank. Bank nonperforming loans to total gross loans (%). URL: <https://databank.worldbank.org/metadataglossary/world-development-indicators/series/FB.AST.NPER.ZS> (accessed on 20.04.2024).

<sup>14</sup> The World Bank. Deposit interest rate (%). URL: <https://databank.worldbank.org/metadataglossary/world-development-indicators/series/FR.INR.DPST> (accessed on 05.02.2024).

<sup>15</sup> The World Bank. Lending interest rate (%). URL: <https://databank.worldbank.org/metadataglossary/world-development-indicators/series/FR.INR.LEND> (accessed on 21.04.2024).

<sup>16</sup> The World Bank. Lending interest rate (%). URL: <https://databank.worldbank.org/metadataglossary/world-development-indicators/series/FR.INR.LEND> (accessed on 05.02.2024).

<sup>17</sup> World Bank. Total reserves in months of imports. URL: <https://databank.worldbank.org/metadataglossary/international-debt-statistics/series/FI.RES.TOTL.MO> (accessed on 06.02.2024).

Table 1

## Shapiro-Wilk for Testing Normality Results

| Variable         | Obs | W       | z      | Prob > z | Obs              | W       | z      | Prob > z |
|------------------|-----|---------|--------|----------|------------------|---------|--------|----------|
| 2005–2013 period |     |         |        |          | 2014–2022 period |         |        |          |
| GDP              | 9   | 0.81064 | 1.927  | 0.02699  | 9                | 0.90888 | 0.501  | 0.30813  |
| Inf              | 9   | 0.97421 | –1.462 | 0.92812  | 9                | 0.91699 | 0.337  | 0.3679   |
| GDS              | 9   | 0.8739  | 1.102  | 0.13534  | 9                | 0.8616  | 1.283  | 0.09979  |
| UnEmp            | 9   | 0.95301 | –0.592 | 0.72315  | 9                | 0.90692 | 0.539  | 0.29489  |
| FDI              | 9   | 0.92886 | 0.074  | 0.47061  | 9                | 0.88949 | 0.852  | 0.19714  |
| OIL              | 9   | 0.9196  | 0.282  | 0.38894  | 8                | 0.86336 | 1.128  | 0.12967  |
| GAS              | 9   | 0.98425 | –2.109 | 0.98254  | 8                | 0.81125 | 1.778  | 0.03773  |
| Exp              | 9   | 0.94708 | –0.407 | 0.65803  | 9                | 0.9446  | –0.335 | 0.63107  |
| BNLTGL           | 6   | 0.96428 | –1.045 | 0.85203  | 9                | 0.90734 | 0.531  | 0.29771  |
| DIR              | 9   | 0.85845 | 1.327  | 0.09224  | 9                | 0.94942 | –0.478 | 0.68366  |
| LIR              | 9   | 0.8703  | 1.156  | 0.12386  | 9                | 0.95402 | –0.625 | 0.73417  |
| TR               | 9   | 0.82532 | 1.756  | 0.03956  | 9                | 0.88895 | 0.861  | 0.19461  |

Source: Authors' calculation.

to reject the null hypothesis and conclude that their data are normally distributed.

#### Descriptive Statistics and T-test Values

This section presents descriptive statistics and t-test results for key economic indicators across the pre-conflict (2005–2013) and during-conflict (2014–2022) periods.

Table 2 indicates that inflation declines from an average of 13.46 (pre-conflict) to 7.99 (during-conflict), but the difference is not statistically significant ( $p = 0.0966$ ). Gross domestic savings remain relatively stable at 31.04 and 30.36, with no significant difference ( $p = 0.6042$ ). In contrast, unemployment decreases significantly from 6.61 to 5.00 ( $p = 0.0005$ ), indicating a meaningful improvement during the conflict period. FDI falls sharply from 3.16 to 1.04, with a statistically significant difference ( $p = 0.0009$ ),

while oil revenues also decline from 10.67 to 7.35 ( $p = 0.0033$ ), confirming a significant reduction during the conflict period. Export values slightly decrease (29.82 to 27.84), but the difference is not significant ( $p = 0.1214$ ). Bank nonperforming loans rise from 6.73 to 8.19, though the change is not statistically significant ( $p = 1.000$ ). Similarly, deposit and lending interest rates show small variations between periods, with no significant differences ( $p = 0.477$  and  $p = 1.000$ , respectively). Overall, the results indicate significant differences only in unemployment, FDI, and oil revenues, while other indicators remain statistically unchanged between the two periods.

#### Wilcoxon Matched-Pairs Signed-Rank Test and Descriptive Statistics

Table 3 reports the Wilcoxon test results for variables that are not normally distributed (GDP, gas, and total

Table 2

Descriptive Statistics

| Results             | Mean                           | Std. Dev. | Mean                                  | Std. Dev. | T-tests (mean-comparison tests)-two sample using variables |          |           |
|---------------------|--------------------------------|-----------|---------------------------------------|-----------|------------------------------------------------------------|----------|-----------|
| Variables / Periods | Pre-Conflict Period: 2005–2013 |           | During-The-Conflict Period: 2014–2022 |           | t-values                                                   | p-values | Inference |
| Inf                 | 13.45605                       | 7.053582  | 7.987603                              | 6.051826  | 1.7652                                                     | 0.0966   | REJ H0    |
| GDS                 | 31.03508                       | 3.131834  | 30.35545                              | 2.249261  | 0.5288                                                     | 0.6042   | REJ H0    |
| UnEmp               | 6.611111                       | 0.9437087 | 5.003333                              | 0.5792236 | 4.356                                                      | 0.0005   | AcceptH1  |
| FDI                 | 3.161632                       | 0.8598356 | 1.044808                              | 1.30636   | 4.0606                                                     | 0.0009   | AcceptH1  |
| OIL                 | 10.66609                       | 1.833608  | 7.34787                               | 2.096576  | 3.4828                                                     | 0.0033   | AcceptH1  |
| Exp                 | 29.81876                       | 3.120674  | 27.84361                              | 1.839456  | 1.6358                                                     | 0.1214   | REJ H0    |
| BNLTGL              | 6.733952                       | 2.004778  | 8.193731                              | 1.348569  | 0.000                                                      | 1.000    | REJ H0    |
| DIR                 | 5.458333                       | 1.386549  | 5.999444                              | 1.745224  | 0.7283                                                     | 0.477    | REJ H0    |
| LIR                 | 10.72407                       | 2.037072  | 10.33919                              | 2.813416  | 0.000                                                      | 1.000    | REJ H0    |

Source: Authors' calculation based on data from World Bank. URL: <https://data.worldbank.org/country/russian-federation?view=chart> (accessed on 10.12.2023).

Note: All the data are expressed as percentages.

reserves), as identified by the Shapiro-Wilk test. GDP shows a median decline from 4.45 (pre-conflict) to 0.01 (during-conflict), but the difference is not statistically significant ( $p = 0.1097$ ). Similarly, gas (GAS) decreases from 3.19 to 2.25, with no significant difference between periods ( $p = 0.2076$ ). Total reserves also show a decline across periods, but the change remains statistically insignificant ( $p = 0.0858$ ).

Overall, the results indicate that there are no statistically significant differences in GDP, gas, or total reserves between the pre-conflict and during-conflict periods, thereby failing to support the stated hypothesis.

## RATIO ANALYSIS

### Macroeconomic Ratio Analysis

This section examines eight macroeconomic indicators across three figures: (1) gross domestic savings, GDP, and inflation; (2) unemployment and FDI inflows; and (3) oil and gas rents and exports of goods and services.

### Gross Domestic Savings, GDP, and Inflation Analysis

Figure 3 illustrates the historical trends of gross domestic savings, GDP, and inflation rate during four major events: the 2008 financial crisis, the 2014

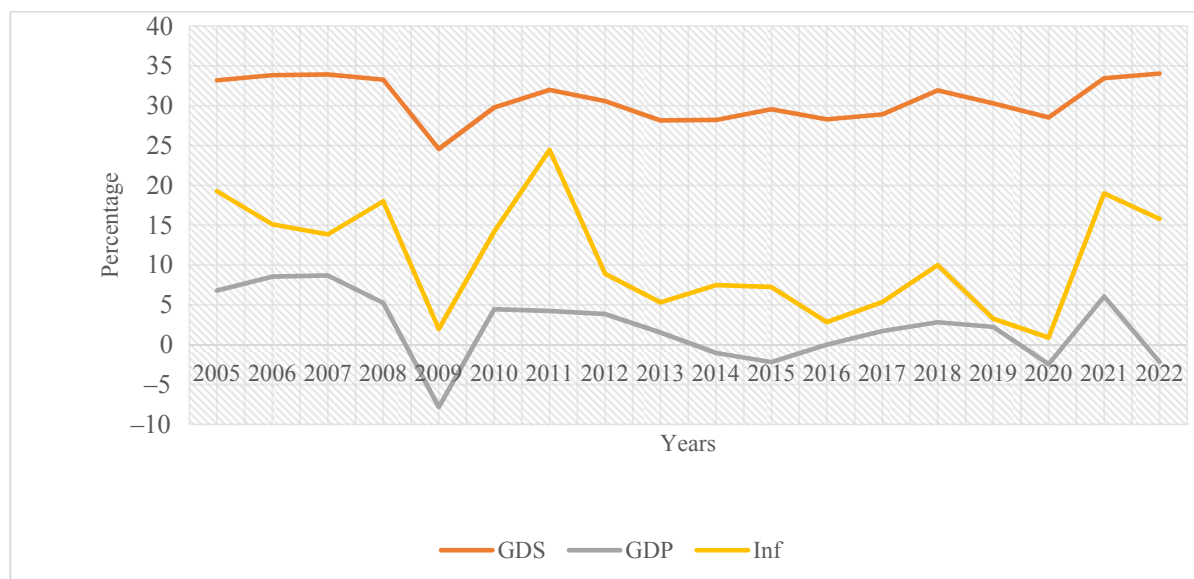
Table 3

**Wilcoxon Matched-Pairs Signed-Rank Test and Descriptive Statistics**

| Results             | Median                         | Std. Dev. | Median                                | Std. Dev. | Wilcoxon matched-pairs signed-rank test |           |
|---------------------|--------------------------------|-----------|---------------------------------------|-----------|-----------------------------------------|-----------|
| Variables / Periods | Pre-Conflict Period: 2005–2013 |           | During-The-Conflict Period: 2005–2013 |           | P. Value                                | Inference |
| GDP                 | 4.453096                       | 4.979172  | 0.010248                              | 2.877068  | 0.1097                                  | REJ H0    |
| GAS                 | 3.186084                       | 0.59412   | 2.253895                              | 1.451025  | 0.2076                                  | REJ H0    |
| TR                  | 4.79E+08                       | 1.14E+08  | 4.69E+08                              | 1.04E+08  | 0.0858                                  | REJ H0    |

Source: Authors' calculation based on data from world bank. <https://data.worldbank.org/country/russian-federation?view=chart> (accessed on 10.12.2023).

Note: All the data are expressed as percentages, except for total reserves (TR), which is represented in its real amount.



**Fig. 3. Gross Domestic Savings, GDP, and Inflation**

Source: Compiled by authors based on data from World Bank. URL: <https://data.worldbank.org/country/russian-federation?view=chart> (accessed on 10.12.2023).

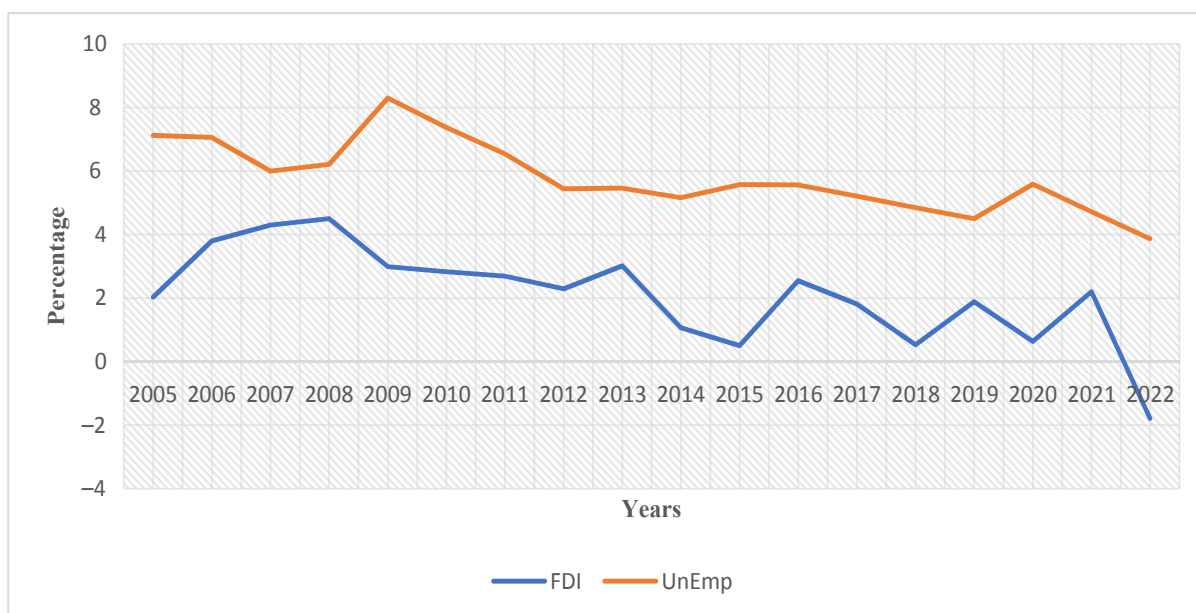
Russia-Ukraine conflict, the COVID-19 pandemic [19], and the renewed conflict in 2022. The three indicators display similar trends over the study period. Following the 2008 financial crisis, all indicators declined sharply to 24.60%, -7.82%, and 1.97%, respectively [20]. A gradual recovery followed, though growth slowed after the 2014 conflict, with values reaching 28.20%, -1.04%, and 7.49%. A similar pattern appeared during the COVID-19 pandemic in 2020, when the indicators fell to 28.53%, -2.45%, and 0.89%, respectively. Although slight improvements

were observed in 2021, all three variables declined again in 2022 following the renewed Russia-Ukraine conflict.

#### Foreign Direct Investment Inflows and the Unemployment Rate Analysis

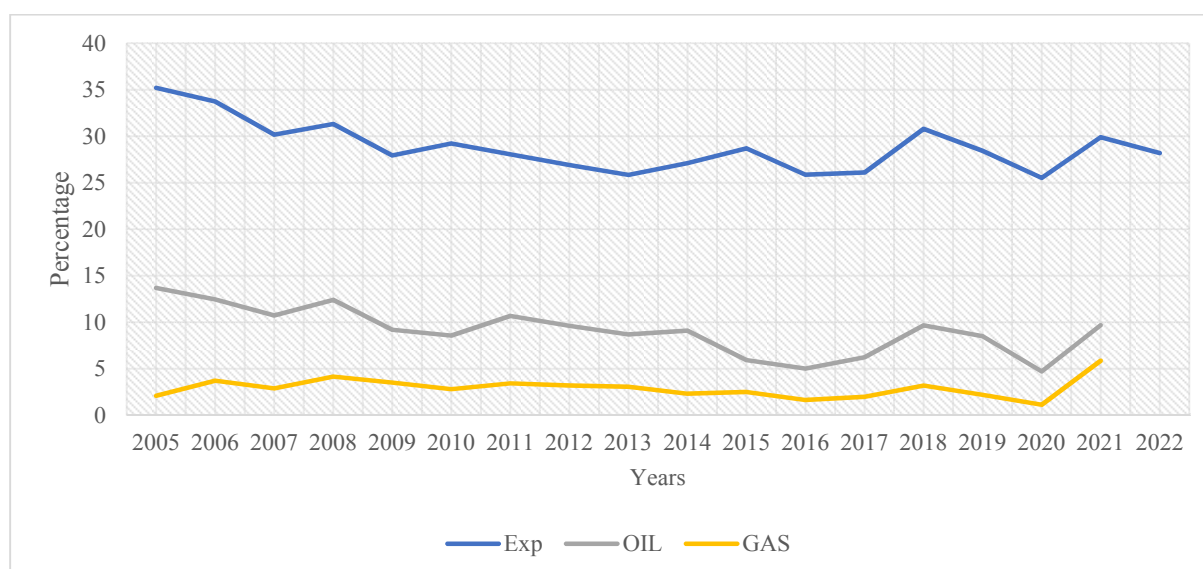
This section examines the historical trends of foreign direct investment (FDI) and unemployment rate from 2005 to 2022. *Figure 4* shows an inverse relationship between the two variables, where declines in FDI generally coincide with rising unemployment. FDI remained highly volatile throughout the period.





**Fig. 4. Foreign Direct Investment Inflows and the Unemployment Rate**

Source: Compiled by authors based on data from World Bank. URL: <https://data.worldbank.org/country/russian-federation?view=chart> (accessed on 10.12.2023).



**Fig. 5. Oil and Gas and Export of Goods and Services Analysis**

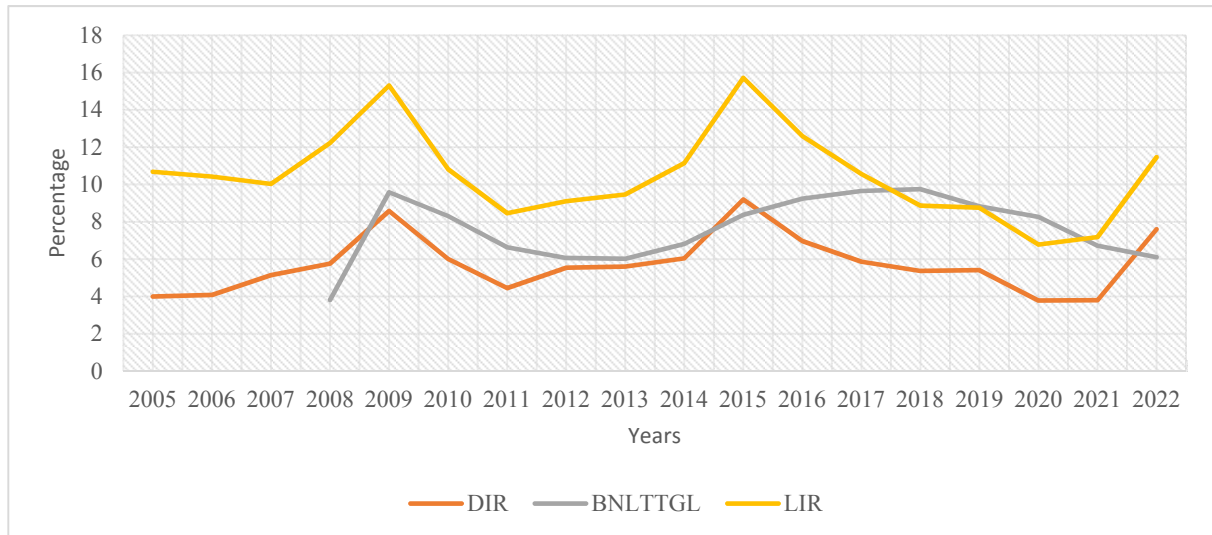
Source: Compiled by authors based on data from World Bank. URL: <https://data.worldbank.org/country/russian-federation?view=chart> (accessed on 10.12.2023).

Following the 2008 financial crisis, FDI fell sharply from 4.50 to 2.99 and recovered gradually until 2013. However, the 2014 Russia-Ukraine conflict and subsequent US sanctions triggered another decline, while the COVID-19 pandemic further reduced FDI in 2020. Although conditions improved in 2021, the renewed conflict and intensified Western sanctions in 2022 caused another sharp drop. In contrast, unemployment rose significantly after the 2008

financial crisis, then gradually declined, reaching 4.5 in 2019. A slight increase occurred during the COVID-19 slowdown in 2020, followed by recovery in 2021, when the unemployment rate reached its lowest level of 3.87%.

#### **Oil and Gas and Export of Goods and Services Analysis**

This final section presents the historical trends of key macroeconomic variables — oil and gas rents



**Fig. 6. Bank Nonperforming Loans Ratio, Deposit Interest Rate and Lending Interest Rate**

Source: Compiled by authors based on data from World Bank. URL: <https://data.worldbank.org/country/russian-federation?view=chart> (accessed on 10.12.2023).

and exports of goods and services — from 2005 to 2022. *Figure 5* shows that all three indicators generally move in similar patterns. A sharp decline began after 2007, linked to the global financial crisis, followed by a downturn in 2014 during the Russia-Ukraine conflict that lasted until 2017. Growth resumed in 2018–2019 before falling in 2020 due to the COVID-19 pandemic, recovering in 2021, and declining again in 2022 amid renewed conflict. Data for oil and gas rents in 2022 is unavailable, but based on export trends, a similar decline is expected given their closely aligned movements.

#### Financial Performance Analysis

This section examines four key variables: bank nonperforming loans (NPLs), deposit interest rate, lending interest rate, and total reserves. The analysis is divided into two parts: the first covers NPLs, deposit, and lending rates, while the second focuses on total reserves.

##### Bank Nonperforming Loans Ratio, Deposit Interest Rate and Lending Interest Rate Analysis

*Figure 6* indicates that the deposit and lending interest rates show similar movements over the study period. After the 2008 financial crisis, both increased, peaking at 8.6% and 15.3% respectively, before gradually stabilizing. In 2015, both rates rose again to 9.2% and 15.7%, reflecting the effects of the 2014 Russia-Ukraine conflict and related

sanctions. A sharp decline occurred in 2020 due to the COVID-19 pandemic, with rates falling to 3.76% and 6.77%, followed by recovery in 2021 and beyond.

NPLs increased significantly in 2009, reaching 9.6% during the financial crisis, then improved until 2013. However, they rose again after 2014, peaking at 9.75% in 2018, before declining in the following years as conditions improved.

#### Total Reserves Analysis

This section focuses on total reserves, including gold and US currency, which are important for monetary stability and supporting cross-border trade. *Figure 7* shows the trend from 2005 to 2022, which closely follows the patterns observed in *Fig. 6*.

Total reserves slightly declined during the 2008 financial crisis, followed by a recovery up to 2013. A sharp drop occurred in 2014 due to the Russia-Ukraine conflict, after which reserves gradually recovered and peaked in 2021. However, a downward trend emerged in 2020 due to COVID-19 and continued into 2022, driven by the renewed Russia-Ukraine conflict and its broader economic effects.

#### CONCLUSION

This study conducts a comparative analysis of key macroeconomic and financial indicators-GDP, oil and gas rents, FDI, domestic savings, trade patterns, inflation, unemployment, and banking performance-

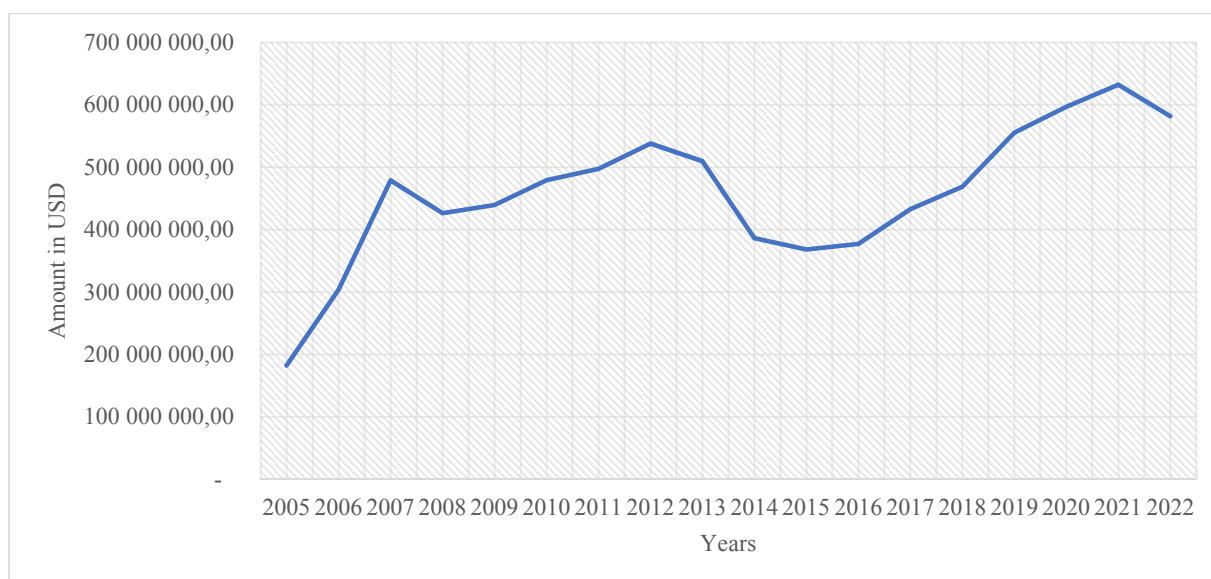


Fig. 7. Total Reserves Analysis

Source: Compiled by authors based on data from World Bank. URL: <https://data.worldbank.org/country/russian-federation?view=chart> (accessed on 10.12.2023).

across the pre-conflict period (2005–2013) and the conflict period (2014–2022) to test for differences in their means and medians. The analysis uses ratio analysis, descriptive statistics, the Shapiro-Wilk test, Wilcoxon signed-rank test, and t-tests.

The results show statistically significant differences in oil rents, FDI inflows, and unemployment rates. Pre-conflict averages for oil rents and FDI were higher, reflecting the impact of major shocks such as the 2014 Russia-Ukraine conflict, COVID-19, and the 2022 conflict. In contrast, unemployment was lower during the conflict period, suggesting some labor market resilience despite sanctions. No significant differences

were found in GDP, inflation, gross domestic savings, gas rents, exports, bank NPLs, interest rates, and total reserves, indicating relative stability in the broader economy and banking sector despite multiple external shocks.

Overall, the findings suggest that the economy demonstrated considerable resilience in absorbing major geopolitical and economic disturbances without severe systemic disruption. The study recommends future research using regression analysis to further examine the effects of oil rents, FDI, and unemployment on economic growth to strengthen these findings.

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