Vol. 27, No. 3 | DOI: 10.26794/2587-5671 | ISSN 2587-5671 (Print) ISSN 2587-7089 (Online)

FINANCE: THEORY AND PRACTICE

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

Registration certificate:
PI No. FS77-70021 of 31 May 2017

Founder: Financial University under the Government of the Russian Federation, Moscow, Russia

Publication frequency — 6 times a year

The Journal is focused on scientific discussion of topical problems in the sphere of financial economy.

Indexed in databases: Scopus, Russian Science Citation Index (RSCI), CrossRef, DOAJ, Ebsco, Dimensions, EconLit, EconBiz, RePec, eLibrary.ru, Russian Index of Science Citation (RINTs), etc.

A journal included in the first category of the List of VAC’s peer-reviewed scientific publications (K1) on specialties: 5.2.1. Economic theory, 5.2.4. Finance (Economic science).

Each article is assigned a digital object identifier (DOI).

The printed version of the journal is distributed by subscription.
Subscription to the Journal is carried out through the union catalogue “Pressa Rossii”, subscription index – 82140.

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Scientific and practical journal

Vol. 27, No. 3, 2023

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Signed for press on 06.07.2023
Format 60 x 84 1/8.
Size 29,75 printer sheets.
Order № 238.
Printed by Publishing House of the Financial University (Moscow, 51, Leningradsky prospekt)

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ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-6-16
UDC 338.22.021.2(045)
JEL E52, E62, E63

Distribution of the Impact of Monetary and Fiscal Policy Instruments by Technological Modes and Economic Sectors

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ABSTRACT

The subject of the study is the impact of monetary and fiscal policy instruments on the functioning of the structural elements of the economy, represented by sectors and technological structures. **The purpose** of the paper is to establish how the monetary and individual fiscal policy instruments influenced the structure of the Russian economy. **The methodology** consists of the "distributed control" doctrine, which modifies Tinbergen's principle of "goals-instruments" of macroeconomic policy, since it allows to reveal the unequal power of the instrument by objects of economy, structural and empirical analysis, correlation-regression analysis, with which it is possible to show a picture of the distributed influence of monetary and fiscal policy instruments. A general algorithm of research and application of the doctrine of "distributed management" at the macroeconomic level are developed — by technological structures and economic sectors, which made it possible to obtain a picture of the distribution of the influence of monetary policy on economic objects, to identify the significance of individual fiscal policy instruments. **The general result** of the research is that the doctrine of "distributed management" used not only modifies the classical theory of economic policy, but also confirms that, in addition to the economic structure, the impact structure of standard monetary and fiscal policy instruments arises. The distribution of the most significant instruments of monetary and fiscal policy by technology and three sectors of the Russian economy to ensure its growth in the period 2011–2021 are obtained. It was found that the development of high-level processing and technological modes were more influenced by monetary than budgetary instruments, and the transfer of resources to the national welfare fund hindered their development. Fiscal policy measures — revenues, expenditures, budget deficit/surplus — did not have an equal impact on the development of the considered sectors of the economy. **The prospect** of further research is to develop a software module that includes ongoing analysis and automates calculations based on available statistics to change of monetary and fiscal policy measures in Russia aimed at developing the manufacturing sector and high-tech.

Keywords: monetary policy; economic sectors; technological paradigms; fiscal policy; economic growth; distributed control; Tinbergen principle; efficient market classification

For citation: **Sukharev O.S., Afanasyeva O.N. Distribution of the impact of monetary and fiscal policy instruments by technological modes and sectors of the economy. *Finance: Theory and Practice*. 2023;27(3):6-16. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-6-16**

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INTRODUCTION

Modern economic policy theory [1] has two basic tools — monetary and fiscal, reducing analysis and models to determine the overall impact of each on goals such as economic growth, employment, inflation or technological and innovation development [2, 3].

In some cases, the combined influence of tools is taken into account, but there are multiple studies that do not take such influence into account [4, 5] by considering a separate tool or a type of policy in general — monetary or fiscal, affecting technology, productivity, labour, etc. [6, 7].

The classic option is the principle of "goal-tools" by Jan Tinbergen, as well as extending its "principle of effective market classification" by Robert Mundell, arguing that not only the number of tools should be no less than the number of objectives, but each economic policy objective must be matched by the most appropriate tools [8, p. 162]. However, how to determine the degree of adaptation, and especially the conditions under which it changes when tools operate together — it still remains unanswered in economic policy theory. In addition, the effect that fewer tools manage to achieve more goals is also known in practice, which is some exception to the Tinbergen principle [9], that have a mathematical description that is used in a number of studies, but it does not seem to be widely applied in macroeconomic analysis [10–15].

That could be because each type of policy (monetary, fiscal) is equipped with some set of independent and partly interconnected tools with different application force, and over time has a cumulative effect, when the objects of influence become weakly sensitive to a given tool or type of policy, for example, monetary [16]. This increases the difficulty of implementing development policies — to stimulate specific activities. As a result, there is very slow progress on national development goals, in particular in Russia, and a reasonable change of policy is facing various restrictions [17].

Technological innovation, industrial development 4.0, structural changes and economic growth depend on credit capacity and financial policies [18–20], and this dependence is visible for various economies, including China. However, researches provide an important but one-factor description of the impact of the tool on the target, and are limited to a single tool, such as money supply (M2 aggregate) for economic growth [21]. It is important to consider how the impact of each tool and policy is distributed across the economic structure presented by sectoral and, for example, technological paradigms [17]. The task of distribution the monetary policy tools by economic development goals was first performed by the authors in the paper [22]. The **purpose** of the paper is to identify the influence structure of monetary policy tools and individual tools of fiscal policy in order to reasonably change the content of tools of influence and to stimulate specific elements of the economic system, for the development of this research and the doctrine of "distributed management" [9]. First of all, the authors explore the influence on the structure of technological paradigms (according to S. Yu. Glaziev) and on the basic sectors of the Russian economy (processing, raw materials and transactional). Such research, as far as we know from the analysis of the literature, is conducted in Russia for the first time. Structural and empirical methods, correlation and regression analysis are used in this paper. This assumption is the foundation of a number of other works [16, 22] that the tool power is not distributed evenly on the economic structure. To achieve this goal, we will define the methodology of further research, taking as the basis the doctrine of "distributed management" [9]. Then make an analysis of the impact of tools on technological paradigms and sectors of the Russian economy.

RESEARCH METHODOLOGY "DISTRIBUTED MACROMANAGEMENT": EVALUATION OF POLICY TOOLS

The methodology of this study is based on the concept of "distributed management" [9], according to which policy-making and the selection of its tools are important:

- state of the object;
- purposes of changing this state;
- methods of influence (management function);
- object state change time (according to L. Pontryagin [23]).

In addition, the sensitivity of the objectives to the tools and the power of the tools applied [9] related to the factors of the functioning of economic objects are changing.

It is not only the change of purpose, but also of the tool itself, together with the factors and conditions of the change of the object in question. Thus, emerge structural modifications on various structures allocated in the economy, in particular technological paradigms [17, 24] and sectors.

Consider the impact of monetary tools and individual fiscal policy tools on these economic structures. For this we use correlation and regression analysis and build algorithm for further research.

The task was to consider the impact of monetary and fiscal tools on the structure of technological paradigms and sectors of the Russian economy.

Provision of technological paradigms is carried out according to the Russian Classification of Types of Economic Activity (further — RCTEA), which is implemented in the paper [26, p. 15–17]. The measurement of paradigms is based on gross value added of the activities to be included in the aggregated first, second and third, then fourth and fifth paradigms. The sixth mode was allocated according to the research and development costs of the priority activities, for which the aggregated fifth paradigm was adjusted (deducted this cost, attributed to the sixth paradigm).[1] The accounting of the statistical parameters used is such that gross value added data are available since 2011, on research and development costs — since 2015. In this regard, the intervals 2011–2021 and 2015–2021 are taken and considered, respectively. Data used are adjusted to prices 2000 using GDP deflator.[2]

According to the goal of this paper and research objectives it is necessary to allocate monetary and fiscal policy tools.

Monetary policy tools:

- volume of the National Wealth Fund, bln rubles ($xi1$)[3];
- money supply M2, bln rubles[4] ($xi2$);
- volume of the public internal debt of Russia, bln rubles ($xi5$)[5];
- the volume of the public external debt of Russia, bln rubles ($xi6$)[6];
- required reserves (balances of funds in accounts required reserves deposited by credit organizations in the Bank of Russia, on borrowed funds, bln rubles ($xi7$)[7];
- key rate, % ($xi8$)[8];
- liquidity absorption (deposits of credit organizations with the Bank of Russia plus bonds of the Bank of Russia with credit institutions, bln rubles ($xi9$).[9]

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[1] Official website of Rosstat. URL: https://rosstat.gov.ru/storage/mediabank/nauka-5.xlsx (accessed on 05.05.2023).

[2] Official website of Rosstat. URL: https://rosstat.gov.ru/storage/mediabank/VDS_god_ OKVED 2_s2011.xls (accessed on 05.05.2023).

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[7] Bank of Russia. URL: https://cbr.ru/vfs/statistics/ms/mb_bd.xlsx (accessed on 05.05.2023).

[8] Bank of Russia. URL: https://cbr.ru/hd_base/KeyRate/ (accessed on 05.05.2023).

[9] Bank of Russia. URL: https://cbr.ru/vfs/statistics/ms/mb_bd.xlsx (accessed on 05.05.2023).

Fiscal (budget and tax) policy tools[10]:

- state budget revenues, bln rubles ($xi10$);
- state budget expenditures, bln rubles ($xi3$);
- deficit/surplus of the state budget, bln rubles ($xi4$).

Therefore, seven tools refer to monetary policy, and three interrelated tools refer to fiscal policy.[11]

Based on variable data, the general regression equation takes the form:

$$U_i = a_{0i} + a_{1i}xi1 + a_{2i}xi1 + a_{3i}xi3 + a_{4i}xi4 + a_{5i}xi5 + \\ + a_{6i}xi6 + a_{7i}xi7 + a_{8i}xi8 + a_{9i}xi9 + a_{10i}xi10 + \tau,$$

where U — gross value added of i-element the structure, paradigm or sector; τ — random error.

The target of the paradigms structure is the gross value added and growth rate, for sectors — gross value added in a given regression with the assessment of the impact of the same tools on the elements of economic structure.

Summarizing, we denote the general algorithm of research.

Step 1. Separation of technological paradigms and sectors by RCTEA.

Step 2. Identification of the list of monetary and fiscal policy tools, as well as the objectives characterizing the development of the elements of the allocated economic structure (for example, gross value added, its growth rate[12]).

Step 3. Preliminary correlation analysis with the designation of the link objectives and tools in pairs.

Step 4. Regression and selection of a relevant model for linking tools and objectives.

Step 5. Analysis of the tools impact on the structure of economic elements — assessment of the distributed impact of policy tools. Preparation of possible proposals for policy adjustments.

In further actions we use an algorithm that can be extended and detailed with subordination to the task of improvement of the "distributed management" doctrine.

Quantification of the impact of policy tools on gross value added and growth in technological paradigms and sectors implies multiple regression analysis. The final model was selected by the rejection method, taking into account the results of the evaluation of the pair correlations. Fisher, Student, Akaike and Schwarz criterions are applied. To eliminate autocorrelation and heteroskedasticity of model residues, standard errors were evaluated using the Newey-West criterion. Multicollinearity was eliminated by removing collinear factors from the model and the effects were estimated in pairs. All the final models were statistically significant according to the Fisher criterion (F- criterion).

The study of the influence of monetary and fiscal policy tools on the sectoral structure of the Russian economy was carried out by constructing regressions using the least squares method, which is a standard procedure in regression analysis. Autocorrelation and multicollinearity were found in model selection. Standard errors were also evaluated in the Newey-West form. Final rejection of the model — the choice of the best was based on t and F-criterions, coefficient of determination. Models were tested for heteroscedasticity residues, according to the White test, for autocorrelation of residues, according to the Darbin-Watson criterion.

Initially, tools were included if correlation was found. However, this approach created multicollinearity, so the accuracy of the analysis of the impact of tools on targets was sharply reduced. Therefore, collinear variables were consistently eliminated and

[10] Ministry of Finance of the Russian Federation. URL: https://minfin.gov.ru/common/upload/ library/2022/10/main/fedbud.xlsx (accessed on 05.05.2023).

[11] It does not take into account the structure of taxes, as it is an independent and complex tool in the influence on the structure of the economy, requiring additional and sufficient research.

[12] The objectives may be multiple, such as the flow of labour, investment in the sector or paradigm, etc.

the best model was selected. The regression equation was selected for each of the selected paradigms and, accordingly, for each sector of the economy.[13]

Using this method, it is possible to analyze the distribution of the influence of monetary and fiscal policy tools on the elements of the economic structure, highlighting the most significant results by paradigms and sectors.

IMPACT OF POLICY TOOLS TO TECHNOLOGICAL PARADIGMS

Based on the methodology presented above, we will give the general result of its application, which is summarized in the *Table* of the *Appendix*.

The following results are from these assessments, which concern the study of the impact of policy tools on the goals in each technological paradigm.

First, the change in the size of the money supply of M2 worked to increase the value added of the first, third and fifth paradigms, without affecting the growth rate of all paradigms.

Second, the National Welfare Fund had a positive impact on the value added of the fourth and fifth paradigms, which can be explained by the achievement of the goal of stimulating the development of high-tech sectors. Probably for the same reason, budget expenditures have had a positive impact on the value added of the fifth paradigm, no longer affecting other paradigms and the pace of their development (*Table* of the *Appendix*). At the same time, the same positive impact was on the growth rate of value added of the fourth paradigm and inhibitory effect on the growth rate of value added of the fifth paradigm.

Third, the key rate did not affect the value added and the rate of growth. This result requires, of course, additional research, which was not the task of this paper. However, given that the change in the key rate does not show a good correlation even with capital inflows and outflows and a very weak negative association with investment, we can assume that such a result is possible.

Fourth, required reserves and liquidity absorption, as their volumes increase, operate to increase the value added of the fifth and the first to third paradigms (*Table* of the *Appendix*).

Fifth, it is noteworthy that the national wealth fund, the money supply, budget expenditures, domestic debt are operating to stimulate the fifth technological order. This immediately shows policy' orientations with the right tools to develop high-tech economic sectors.

Thus, a fairly laborious analysis revealed the following features of policy at the instrumental level:

1) the greater impact of the number of tools occurred in the fifth technological paradigm, and its weak development is due to the fact that the strength of these tools was low, it was constrained by the content of policies;

2) the first and third paradigms were also influenced by almost the same tools as the fifth paradigm, but this influence was probably much more significant, as the first and third paradigms of GDP share;

3) the added value of the fifth paradigm increased with expansion of the Welfare Fund, money supply M2, state budget expenditure, domestic debt, required reserves and liquidity absorption, but with a reduction of external debt (*Table* of the *Appendix*);

4) the added value of the first and third paradigms will increase with expansion of money supply M2, domestic debt, required reserves, but with a reduction of external debt. According to quantitative estimates, which take up to 35 pages with tables, it can be specified that the impact of the Fund, required reserves, liquidity absorption have not as significant an impact as, let's say, money supply and budget expenditure or domestic debt;

[13] In total, three allocated sectors by gross value added give the GDP of the Russian Federation as well as the paradigms of consideration.

5) the small number of tools influences the value added of the fourth paradigm and the sixth paradigm, and the growth rate of all paradigms is not affected by the number of tools, except for the Fund, whose growth positively affects the growth rate of the fourth paradigm and slows the fifth paradigm, domestic debt, which is a constraint on the fifth paradigm, and budget revenues that have a positive impact on the fourth paradigm.

The result of the analysis of the distribution of the influence of tools by the structure of technological paradigms confirms the validity of the formulation of the "distributed management" doctrine for modification in the sense of expanding the Tinbergen principle and clarifying the effective classification of the market, because the power of the tool and the direction of influence are essential.

Thus, monetary and fiscal policy tools (with the exception of taxes that were not considered, and this structure a priori adopted unchanged as another equal condition) have different effects on the gross value added of each of the paradigms, but have little influence on its growth rate. This, along with other factors, ensures the dynamics of the general structure and development of paradigms in their system.

Further, describe the results obtained for the sectors under consideration in the Russian economy.

IMPACT OF POLICY TOOLS TO ECONOMIC SECTORS

This research confirms the very interesting fact that the structural economic system, i.e. its presentation, for example, in the form of technological paradigms or economic sectors, determines the degree of influence of monetary and fiscal policy tools. It differs in structure and sector.

Consider the impact of monetary and fiscal policy tools on gross value added generated in three sectors of the Russian economy (processing, raw materials, transactional). The *Table* summarizes the results of the construction and selection of regressions, including supporting correlation analysis. Plus noted that the accumulation of the tool leads to an increase in the goal (value added or its rate). Minus in the *Table* indicates the reverse change when increasing the tool reduces the target and decreasing the tool increases.

The *Table* thus shows that the increase in money supply, domestic debt and required reserves contributed to the development of the proccesing sector, as well as the raw materials and transactional sectors. Lower key rate also stimulated processing and other sectors. External debt reduction operated to develop three sectors of the Russian economy, as well as the National Welfare Fund. Thus, withdrawals into the fund, i.e. the accumulation of the fund's resources, led to a constraint on the development of the Russian economy. In other words, this research concludes that there is an interaction. Taking into account that the growth of the money supply ensures growth of gross value added of all sectors of the economy, it is necessary to use stock resources for economic development.

The correlation analysis confirms that the most significant impact of monetary and fiscal policy tools is provided on the manufacturing sector at the time period under consideration. In particular, the variation of these tools explains the change in value added in processing between 75 and 88.4%. Value added of processing increased as the National Welfare Fund, interest rate, external debt, and when reserves, domestic debt and money supply grew. Liquidity absorption did not affect processing value added.

In the raw material sector, tool variations cause changes in value added in the range of 65.2–84%, i.e. less significant but still significant impact. Value added increases with increased absorption of liquidity, domestic debt, and money supply, with declining the National Welfare Fund and external debt. No impact of key rate and required reserves.

In the transaction sector, tool variations caused changes in value added in the range of

Table

Impact of Monetary and Fiscal Policy Instruments on Gross Value Added in Sectors of The Russian Economy in 2011–2022

Value added of the economic sectors	Tools						
	National wealth fund *xi*1	Money supply M2.*xi*2	Domestic debt *xi*5	External debt *xi*6	Required reserves *xi*7	Key rate *xi*8	Liquidity absorption *xi*9
Processing	–	+	+	–	+	–	ni
Raw materials	–	+	+	–	ni	ni	+
Transactional	–	+	+	–	ni	–	ni

Source: Compiled by the authors.

Note: ni — no impact, that is, the impact of the tool is absent. The lack of impact of the tool on the gross value added of the sector was noted in the case, if in any of the obtained specifications of the regression model the tool coefficient was not statistically significant and thus the tool was excluded from the regression models for the GVA of the economy.

57.9–79.8%. In other words, the impact of tools on the value added generated in the "service economy" is even less evident than in the raw material sector. The reduction of the National Welfare Fund, the key rate and external debt, as well as the increase in money supply and domestic debt worked to increase the added value of the sector (*Table*). However, required reserves and liquidity absorption did not affect value added.

It has also been found that the strongest influence on sectoral dynamics was the increase in the money supply, which led to an increase in the share of processing, the transaction sector, excluding raw materials, and the value added of the three sectors. Key rate as tool showed selective effects. As the share and value added of the processing and transactional sector increased, but with the growth — the share of the raw materials sector increased.

Domestic debt growth is positively associated with growth in all three sectors, while the reduction of external debt has increased value added in all sectors and processing.

Reduced liquidity absorption, i.e. saturation of the economy with the most liquid assets, led to an increase in the share of the transaction sector and a reduction in the share of the raw materials sector.

Thus, this analysis supports the assumption that the economic structure of tools is uneven. This is the root cause of the model of economic growth, in the way in which tools operate within the established economic structure. Impact depends on whether the structure is considered — by paradigms or sectors. However, the general assessment remains that the money supply, liquidity absorption and key rate significantly affected the structure of the Russian economy (by sectors[14]).

CONCLUSION

Summarizing the analysis conducted and the presented implementation of the "distributed management" doctrine on the example

[14] There is no study of the effect on paradigms shares. This conclusion is therefore derived from sectoral analysis of the dynamics and impact of tools on sectoral structure.

of monetary and fiscal policy tools for the selected types of economic structures, we will formulate the most important conclusions.

First, it is shown that standard approaches in the theory of economic policy need to be expanded due to the "distributed management" doctrine, the application of which allows to assess the distribution of influence of policy tools by the structure of the economy.

Second, the presented algorithm of assessment of the impact of tools of monetary and fiscal policy allows to see the force and direction of influence on the considered interval of time selected tools of macroeconomic policy. It is also established that the development of processing and high-level technological paradigms depended more on monetary than budgetary tools, and the transfer of resources to the national welfare fund hampered their development. The main influence was the M2 money supply, key rate, value of external debt and domestic debt, size of the National Welfare Fund, but multidirectional on individual tools. Fiscal policy measures — income, expenditure, deficit/surplus did not have an equal impact on the development of the sectors considered.

Third, the research could not, due to objective circumstances, answer questions about the reasons for the impact of tools. Moreover, modern statistics measure relevant parameters in such a way that they reflect a particular impact, including accumulated over time. The idea of cumulative effect is only introduced into the theory of economic policy, but the fact that over time the influence of the tool may weaken, and the sensitivity of the object of the economic structure decreases, makes it necessary to expand the subject area of research and in this direction.

The scientific novelty of the conducted study is not limited to the development of a practical algorithm and methods for assessing the impact of tools on the goals of economic development, depending on the state of the structure of the economy and its receptivity to the impact of these tools, but also to confirmation of theoretical significance of the "distributed management" doctrine.

A further step of the approved algorithm, which is applied for the first time in technological systems and sectors, is to coordination the results for different structures, i.e. to specify the content of the tools aimed at stimulating the development of certain sectors and/or selected high-technology industries. The perspective of the research is also the need to develop a software module that allows such calculations and assessments to be carried out not manually but automatically, defining the zones of influence of tools and their correction depending on the situation in the economy. This approach allows instrumentalizing monetary and fiscal policy, and for Russia shows the importance of activating it is budget policy, which, in fact, has been deduced from the necessary determinations of the new model of economic growth.

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

The article was submitted on 07.01.2023; revised on 07.02.2023 and accepted for publication on 27.02.2023.
The authors read and approved the final version of the manuscript.

Appendix

Table

Influence of Monetary and Fiscal Policy Instruments on Gross Value Added and Its Growth Rate of Technological Modes, 2011–2021

GVA and growth rate of technological modes	Instruments									
	National wealth fund (*xi*1)	Money supply M2, (*xi*2)	Budget expenditures (*xi*3)	Budget deficit/surplus (*xi*4)	Domestic debt (*xi*5)	External debt (*xi*6)	Required reserves (*xi*7)	Key rate (*xi*8)	Liquidity absorption (*xi*9)	Budget revenues (*xi*10)
GVA 1–3	NI	+	NI	NI	+	–	+	NI	NI	NI
GVA 4	+	NI	NI	NI	NI	NI	NI	NI	NI	+
GVA 5	+	+	+	NI	+	–	+	NI	+	NI
GVA 6	NI	NI	NI	NI	–	NI	NI	NI	NI	–
Growth rate of GVA 1–3	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Growth rate of GVA4	+	NI	NI	NI	NI	NI	NI	NI	NI	+
Growth rate of GVA 5	–	NI	NI	NI	–	NI	NI	NI	NI	NI
Growth rate of GVA 6	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI

Source: Compiled by the authors.

Note: NI — no impact; + directly impact; — reverse impact (target reduction).

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-17-32
UDC 334.012(045)
JEL F23, F63, G34, O32, O43

Innovation Ecosystem as a New Form of Organizational Integrity and a Mechanism for Financing and Reproducing Innovations

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ABSTRACT

The subject of the study is the factors, models and processes of the emergence and development of modern innovation ecosystems (IES) that ensure the flow of assets, their transformation into innovations, and distribution across the territories of economic growth. **The purpose** of the paper is to identify the factors and trends in the development of the IES, based on the practices of individual States and driving forces of the world. **The methods** of sampling, grouping, comparison, analogy, analysis, generalization, system-structural approach to assessing the development of the subject of research are used. The result of the study was the definition of IES as an open institutional mechanism for the reproduction of innovations, transforming the competitive market environment in the direction of the dominance of stable intersectoral network structures. The decisive role of IES in the chain "national innovation strategy → (start-ups + companies + state institutions) → IES → [new start-ups + deep-tech companies unicorns (hectocorns) + new level of quality of the competitive environment] → global competitive advantage of the State" is established. On the example of China, the prospects of formation a model of the national IES, focused on long-term development, technological self-sufficiency of the State and, at the same time, providing the possibility of expansion to new markets, are proved. The authors see the prospects for further research of the IES in Russia in a shift of emphasis from the "banking" nature of the IES towards the formation of large territorial centers of the location of the IES while maintaining strong institutional support of the State.

Keywords: ecosystem; innovation; innovation ecosystem; institute; competitive advantages; inter-firm strategic alliance; cluster; complementary asset; start-up; unicorn company

For citation: **Ezangina I.A., Malovichko A.E., Khryseva A.A. Innovation ecosystem as a new form of organizational integrity and a mechanism for financing and reproducing innovations. *Finance: Theory and Practice*. 2023;27(3):17-32. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-17-32**

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INTRODUCTION

Currently, there is a need for fundamentally new managerial and organizational approaches, tools, models to tap digital transformation of business subjects, to stimulate their innovative activity, to promote the initiation and implementation of technology creation, business process reengineering projects. Development of innovation and investment process from a linear model to modern self-organizing forms led to the formation of the concept of innovative ecosystem (further — IES). The collaboration, focused on simultaneous formation of horizontal and vertical network environment of communications between IES elements, ensures creation and multiplication of asset flows, their transformation into innovations, subsequent distribution across the territories of economic space, updating permanent scientific and applied research.

Problems of creation and development of IES were reflected in the paper of domestic and foreign researchers in agglomeration theory, network interaction, cluster concept. At the same time, setting a goal to identify the factors and tendencies of development of IES, following the practice of individual states and the driving forces of the world, the authors consider the application of research results as promising in reproduction of the advantages of the national innovation system, in developing the entrepreneurial potential of regions of the Russian Federation.

The methodology uses a three-stage approach. First, the views and concepts in the IES are analyzed. Second, the place of IES in the system of cluster-network structures was investigated, based on the synergistic principle of studying the ecosystem based on official statistics. Third, a detailed analysis of the institutional segments initiating and participating in IES in the context of domestic and foreign practice was conducted.

"INNOVATION ECOSYSTEM": TRANSFORMATION OF OPINIONS REGARDING CONTENT

The development of social networks and innovative business environment is accompanied by the formation of common perceptions and systems for the joint creation of economic values [1]. IES is considered by modern economic researchers as a new way of producing goods and services, taking different scales and configurations [2].

Among the first researchers, who applied the term "ecosystem" to the economic environment, was M. Rothschild in 1990, who determined the competitiveness of the organization in the network of customers, competitors, partners, suppliers, level of technology and innovation [3]. The IES concept presented for the first time by W. Wessner considers innovation as "the process of transforming an idea into a market product or service that requires synergy, and therefore — a lot of collective efforts of participants" [4].

In our view, the simplest definition of IES is declared by the National Science Foundation (NSF) under the US Government as "people, institutions, policies and resources that contribute to the transformation of new ideas into products, processes and services" [5].

"Innovation Ecosystem — network of private and public sector institutions, whose activities and relationships are aimed at initiating, importing, modifying and diffusing new technologies" (C. Freeman [6]). A similar position is presented in the papers of C. Edquist, which by IES means "all the significant factors that influence the formation, use and diffusion of innovation, singling out organizations that perform actions aimed at others and those who create rules of behavior" [7].

In the network innovation model of P. Gloor, community members form a specific ecosystem by entering into a relationship of collaboration [8, 9]. Thus, IES is based on

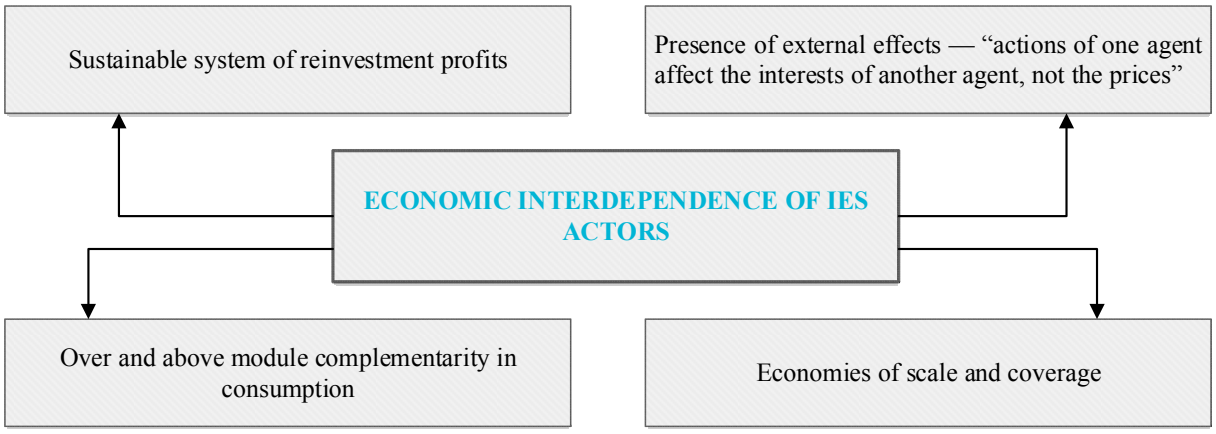

Fig. 1. **Manifestations of the Economic Interdependence of the Actors of the Innovation Ecosystem**

Source: Compiled by the authors.

certain institutions and a mechanism of joint institutionalization [10, 11].

A special client-centered context has a definition of IES by R. Adner as a cooperation mechanism by which firms combine their individual proposals into a coherent, customer-oriented whole [12]. According to Russian Venture Company terminology, "innovative ecosystem — is a set of subjects interacting in the process of commercialization of innovations and their interconnections, accumulating human, financial and other resources for intensification, optimization and efficiency of commercialization of innovations" [13].

Objectively, IES is a set of research and commercial systems [14, 15]. The development of IES should be accompanied by the creation of a sustainable system of reinvestment of profits and economic interdependence of system actors (*Fig. 1*).

The influence on the IES, the consolidation of its members is a developed regulatory and interested external institutional environment. Thus, IES in perspective "objectifies to the national IES and its regional segments, which form a unified metasystem" [16, 17].

The ecosystem on the localization of innovation processes is an open system, which is a permanent search for competencies. Organization can be an actor of a number of ecosystems; actors transform technological solutions, structure, behavior. As a result, an ecosystem property is formed the ability to self-development (*Fig. 2*).

The evolving environment formed on the basis of complementarity and network equality of actors is recognized as a key element in IES [5, 18]. The positions where the development of IES is linked to the effective management of the evolution of incoming platforms and communication technologies are known; the focus is on public and corporate strategies that stimulate the introduction of innovation at the national level [19].

In support of the J. Moore theory, there is the end of the era of competition between companies and its development between the business ecosystem and the IES [20]. At the same time, if the business ecosystem aims to obtain value, IES aims to create a new value.

The structure of the economy, in the form of a rigid separation of sectors, is being transformed into an interwoven structure, and a significant proportion of value chains will be integrated into several ecosystems [14].

Finally, IES is positioned as the next step after an inter-firm strategic alliance (further — ISA) in the business system evolution chain [10, 17, 21], succeeding both features of traditional forms of economic relations (market, inter-firm contract agreement, intra-firm hierarchy) and network structures (*Fig. 3*).

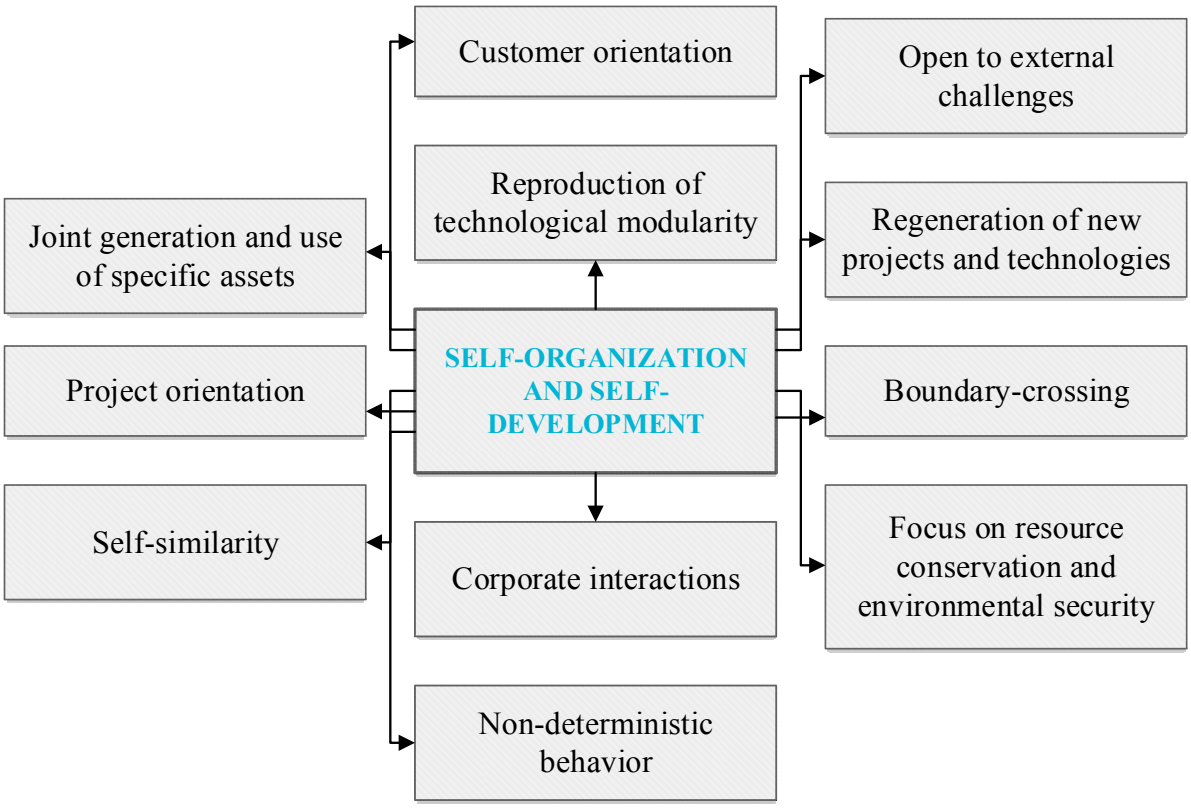

Fig. 2. **Key Properties of the IES**

Источник / Source: составлено авторами / Compiled by the authors.

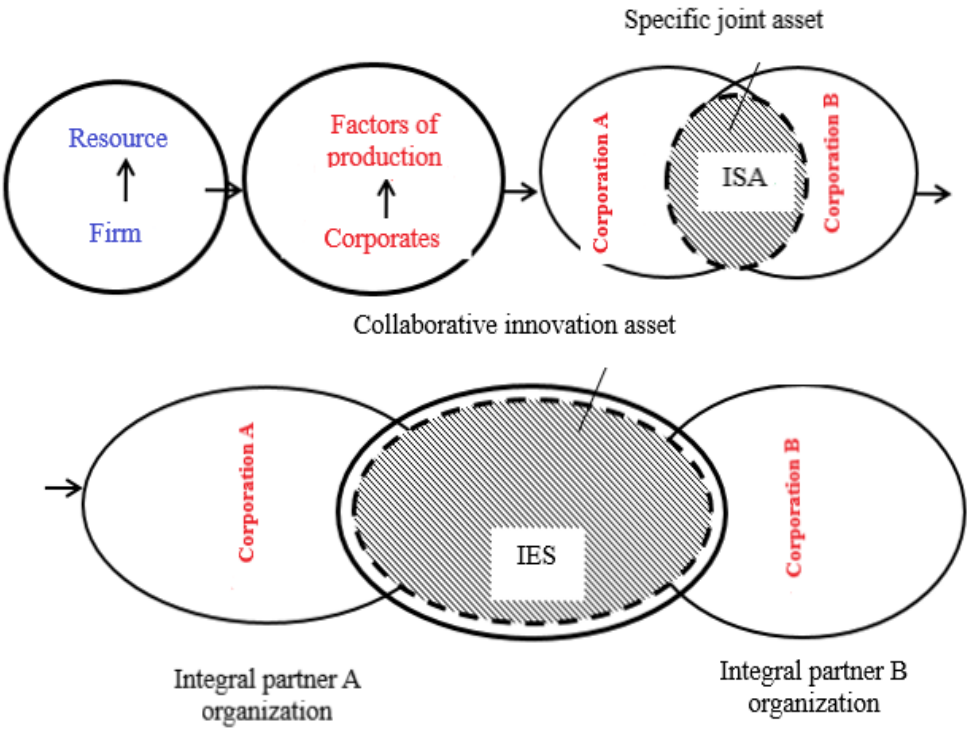

Fig. 3. **The Place of the IES in the Chain of Evolution of Business Systems**

Source: [22].

Table 1

Ranking of Countries by the Level of the Global Innovation Index

Position on the level of the GII	The economy of the State	The value of the GII	Rating by income level
1	Switzerland	65.5	1
2	Sweden	63.1	2
3	USA	61.3	2
4	UK	59.8	4
5	Republic of South Korea	59.3	5
6	Netherlands	58.6	6
7	Finland	58.4	7
8	Singapore	57.8	8
9	Denmark	57.3	9
10	Germany	57.3	10
11	France	55	11
12	China	54.8	1
13	Japan	54.5	12
14	Hong Kong	53.7	13
15	Israel	53.4	14

Source: Global Innovation Index 2021. URL: https://www.wipo.int/global_innovation_index/en/2021/ (accessed on 25.04.2022).

IES AND TECHNOLOGICAL CLUSTERS: COMPARE AND CONTRAST

Recognizing IES as a new organizational integrity and a way to produce innovation, some authors focus on the property of segmentation by cluster-network structures [23]. It should be noted that there is no single IES typology. An example is the classification proposed by the authors S. Zahra and S. Nambisan with four models [24]. This emphasizes the positional difference between IES and clusters. It is proposed to consider only ecosystems, where there is an integrating cluster project in the format of the triple spiral by Etzkowitz-Leydesdorff, which brings aggregated innovative effects [25]. Participation of the state in the network interaction do not have to IES.

In addition, unlike a cluster, the central subject of IES can be a digital platform that removes the transaction cost barrier [14]. O. Valdez-de-Leon considers that digital progress will ultimately transform any ecosystem of stakeholder interactions into a digital ecosystem [26].

The presence of developed IES determines the vector of development of economies, many IES occupy a monopolistic position in the national or world markets. High parameters of innovative development of the state are the basis for the value of the global innovation index (GII), contributing to the creation of new and development of the already established IES. The values of GII-2021 according to WIPO (World Intellectual Property Organization) are presented in *Table 1*.

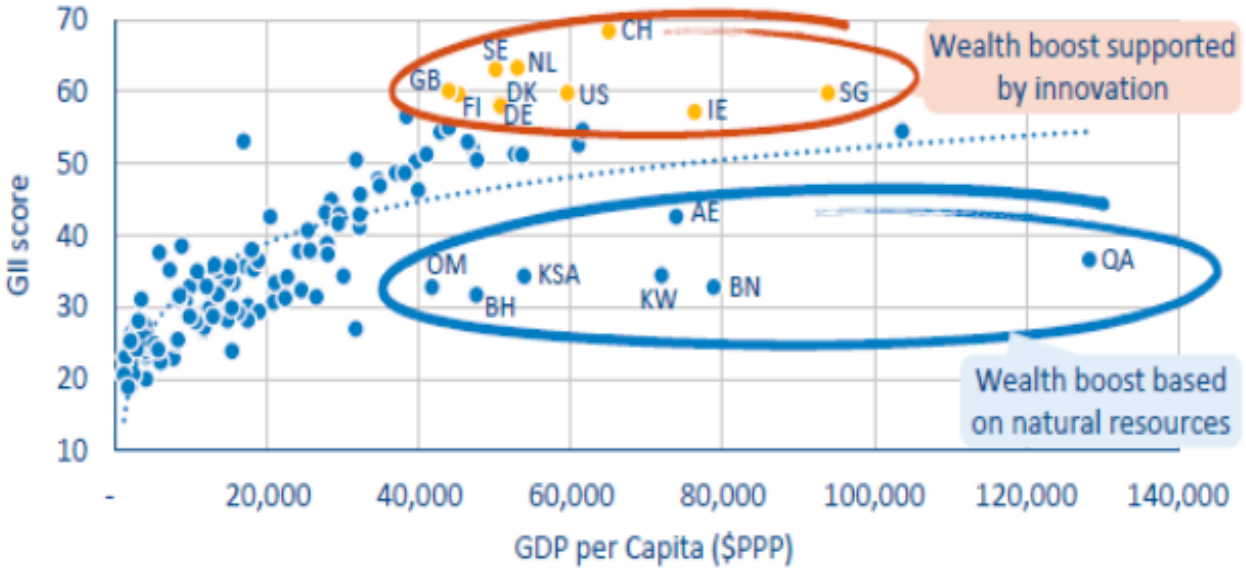

Fig. 4. **The Relationship Between Innovation and Economic Performance**

Source: National innovation ecosystem. URL: https://www.adlittle.com/en/insights/viewpoints/national-innovation-ecosystem (accessed on 20.04.2022).

According to *Table 1*, the world's most innovative economy in 2021 is Switzerland. Determinants of leadership — territorial ownership; dual basis of IES construction, significant wealth of the state; concentration of assets and financial capital of leading TNCs.

Fig. 4 shows the correlation between innovation (according to the GII index) and the country's wealth (according to GDP).

According to *Fig. 4*, countries achieve financial results and competitive advantage by owning natural resources and strengthening innovation leadership. At the same time, it should be stressed that IES models are lead role in the development of the national innovation strategy.

Thus, a technology cluster should be considered as a type of IES, provided that the focus is on reproduction of an innovative asset within a region with government involvement in networking. The digitalization of business space, the emergence of new digital ecosystems with the advantage of minimizing transaction costs, do not mean a reduction in the role of technology clusters. In contrast, national innovation strategies should focus on supporting technology cluster initiatives, especially in startups.

IES AS AN EFFECTIVE MECHANISM FOR DEVELOPMENT OF STARTUPS

The basis of successful IES was the development of a venture capital project startup. The rating of startup ecosystems on the basis of territorial ownership is presented in *Table 2*.

The number of ecosystems (*Fig. 5*) is growing significantly in the period 2013–2020, and the cost of startups of the 100 largest developing ecosystems in 2020 amounted to more than 540 billion dollars, which is 55% more than in 2019.

In the context of statistics (*Fig. 5*), it should be emphasized that in the 100 largest ecosystems in 2011–2020, startups with a total cost of 124 billion dollars, called unicorns, were created. IES are paying increasing attention to deeptech solution.

According to *Fig. 6*, Europe (37%), North America (30%) and Asia (19%) are the leaders of IES.

Using data from *Fig. 6*, it should be noted that in the EU and the USA, the most successful start-ups are based on universities or large companies. The uniqueness of IES Silicon Valley is that many of the unicorn companies that have since become

Table 2

Startup Genome Rating of Operating Startup Ecosystems Based on Territorial Affiliation in 2021

	Rating	Efficiency	Financing	Relationship of elements	Market coverage	Concentration of science and knowledge	Uniqueness of human resources
Silicon Valley	1	10	10	10	10	10	10
London	2	10	10	10	10	7	9
New York	2	10	10	10	10	5	10
Beijing	4	10	9	5	9	10	10
Boston	5	9	10	3	9	5	10
Los Angeles	6	9	10	3	9	7	9
Tel Aviv	7	8	9	8	10	4	8
Shanghai	8	10	7	1	9	10	9
Tokyo	9	8	9	1	8	9	9
Seattle	10	9	7	7	8	7	8

Source: Report on the global ecosystem of startups by the end of 2021. URL: https://about.crunchbase.com/blog/startup-genome-2021-global-startup-ecosystem-report/ (accessed on 20.04.2022).

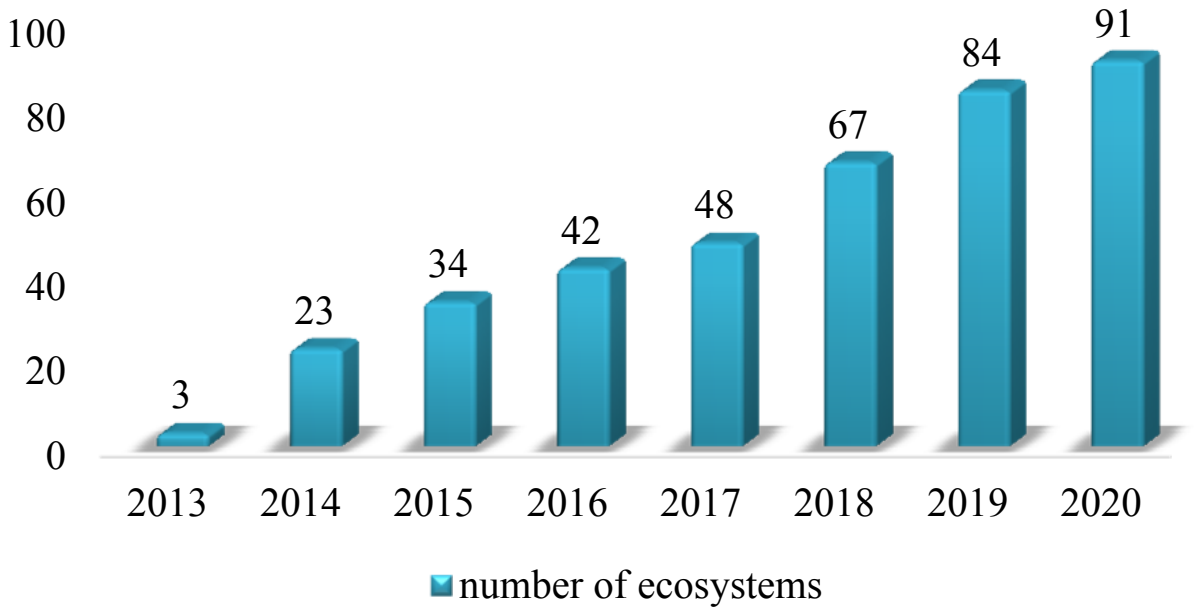

Fig. 5. **The Number of Ecosystems with Billion-Dollar Startups**

Source: Startup Genome. URL: https://startupgenome.com/reports/gser2021 (accessed on 15.04.2022).

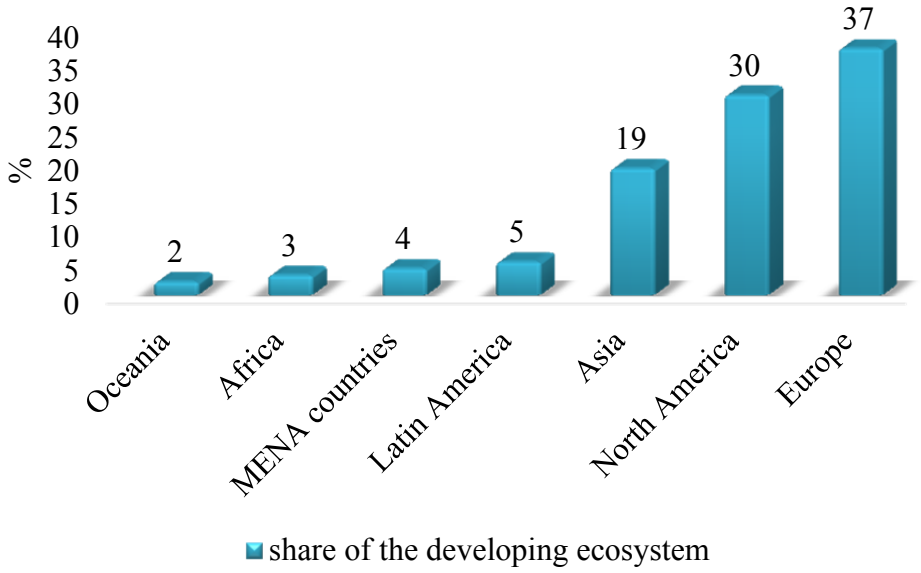

Fig. 6. **Share of Developing Ecosystems by Geographical Affiliation, %**

Source: Startup Genome. URL: https://startupgenome.com/reports/gser2021 (accessed on 15.04.2022).

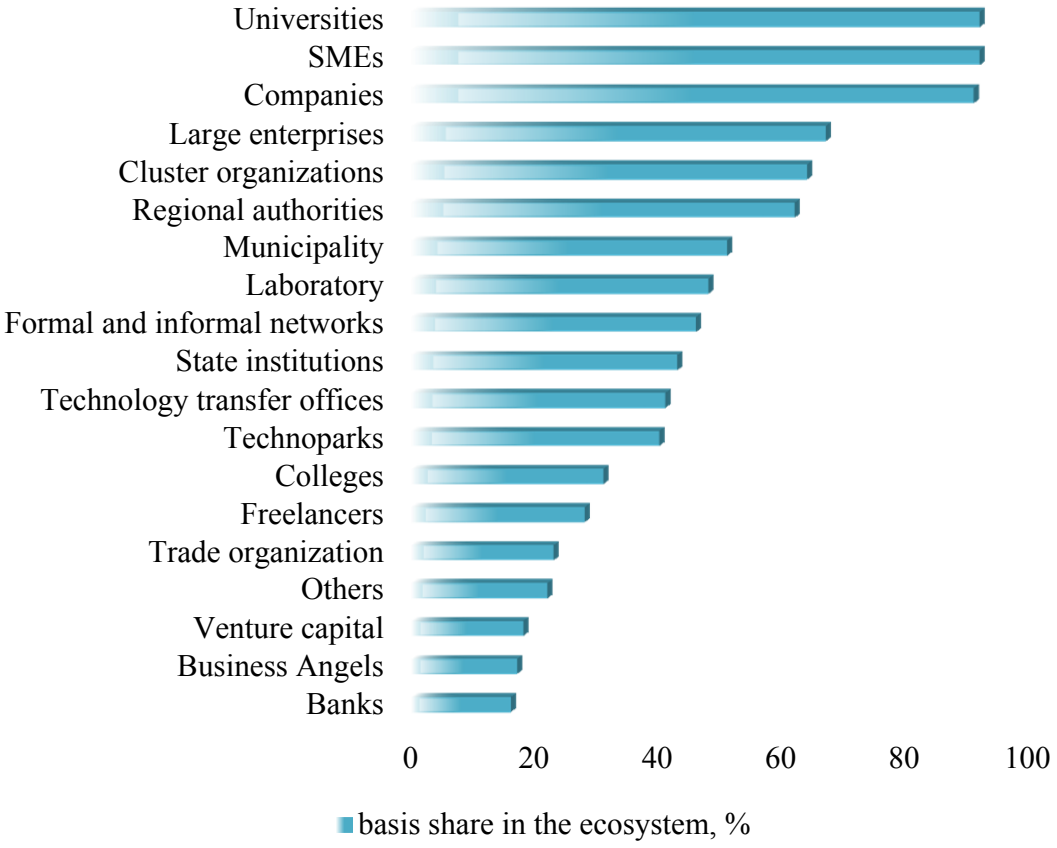

Fig. 7. **Identification of Ecosystems by a Fraction of the Basis**

Source: Innovation Ecosystems in Europe. URL: https://ec.europa.eu/futurium/en/system/files/ged/final_study_on_innovation_ecosystems_ in_europe_imec_smit_komorowski.pdf (accessed on 10.04.2022).

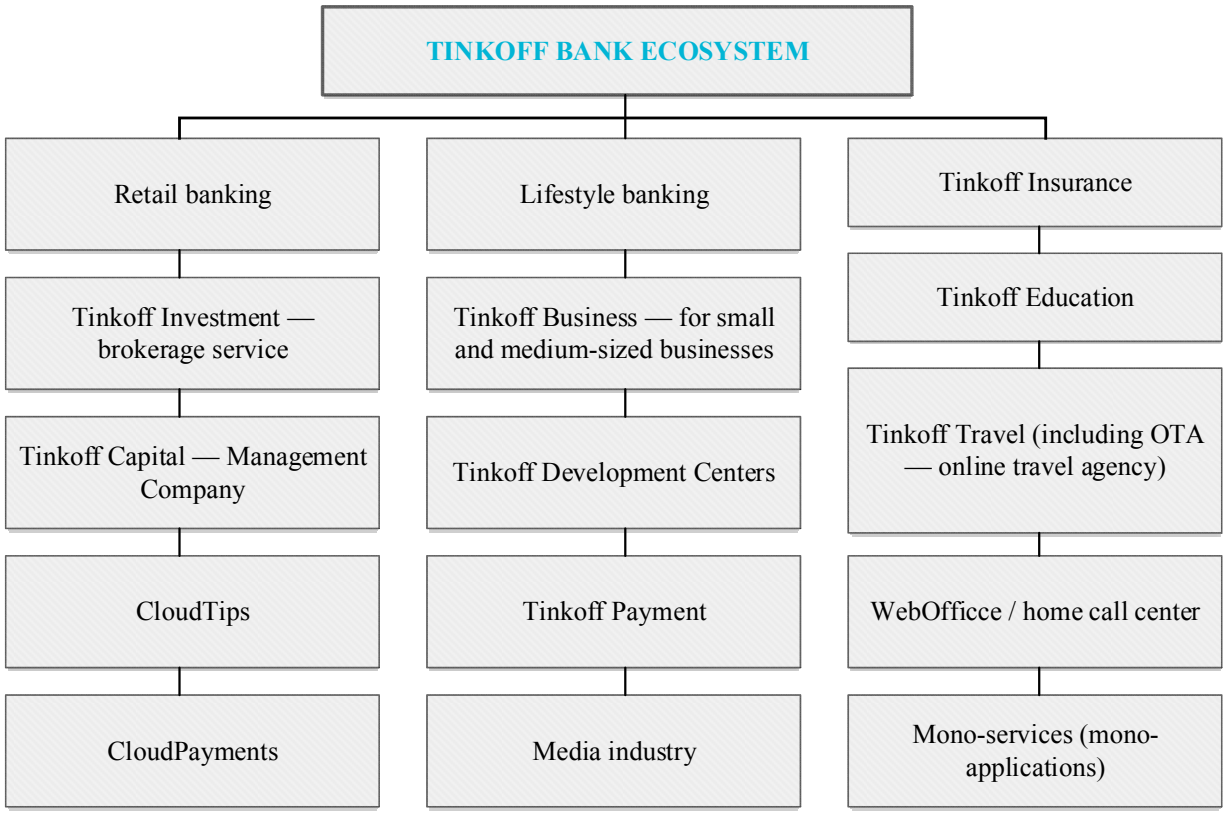

Fig. 8. **Elements of the Tinkoff Bank Ecosystem**

Source: [27].

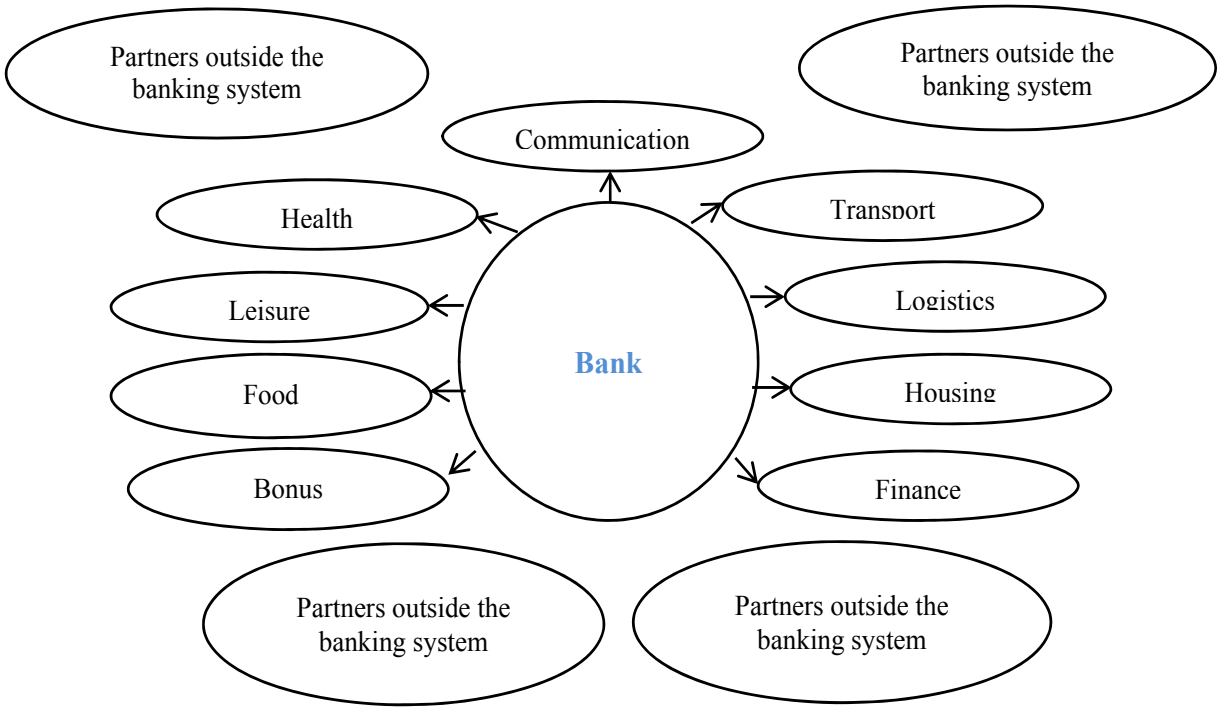

Fig. 9. **Scheme of the Russian Banking Ecosystem Model**

Source: [27].

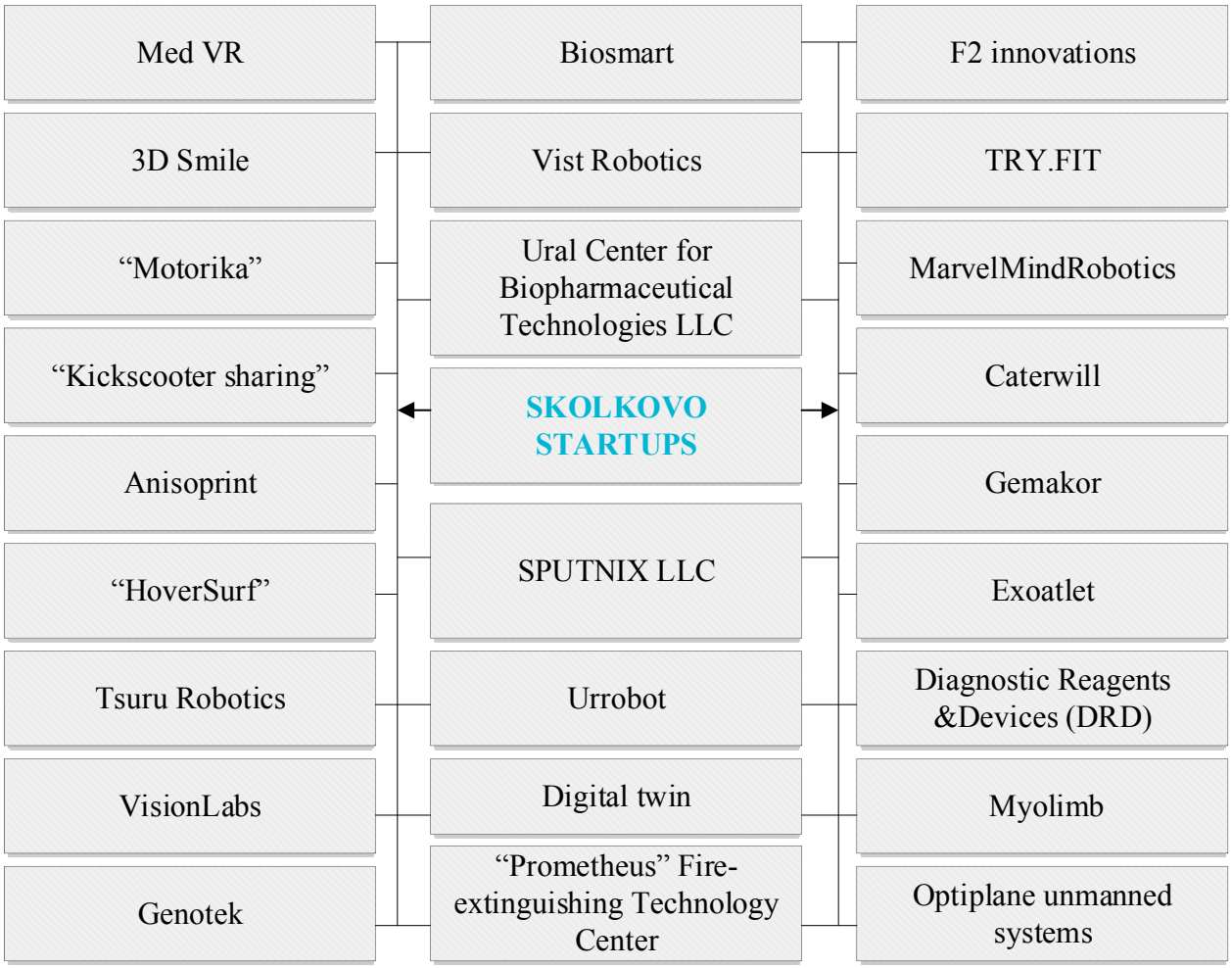

Fig. 10. **Startups of the Skolkovo Innovation Center**

Source: The best projects in Skolkovo. URL: https://skolkovo-resident.ru/proekty-skolkovo/ (accessed on 15.04.2022).

independent and the largest IES in the world have been its startups. In Startup Genome Rating the second place is given to London, where the startup Revolut was created. It is a fintech company that provides a service for converting currencies without bank commissions through exchange at the average exchange rate.

On *Fig. 7* reflects the contribution of various institutional segments (universities, representatives of ISA, companies, municipalities, laboratories) in the formation and development of IES in European countries.

In Russia, the approach to the IES basis is special: most IES are initiated and developed around major banks. Tinkoff is trying to build own ecosystem based on a super-application (Super App), which focuses on financial and non-financial directions (*Fig. 8*).

Sberbank develops some proposals independently, but a number of solutions completely buys out the development teams, thereby transferring prospective for the bank external initiatives into its own IES (*Fig. 9*).

So, according to the *Fig. 8* and *9*, it can be concluded that the banks are moving towards the implementation of the ecosystem lifestyle banking model with maximum satisfaction of formed and prospective customer needs in one application [27].

However, technology companies have experience in creating IES. In Russia, the analogue of the Silicon Valley functions in the form of the center of Skolkovo, created on the direct initiative of the State. The most famous startups of Skolkovo are reflected on *Fig. 10*.

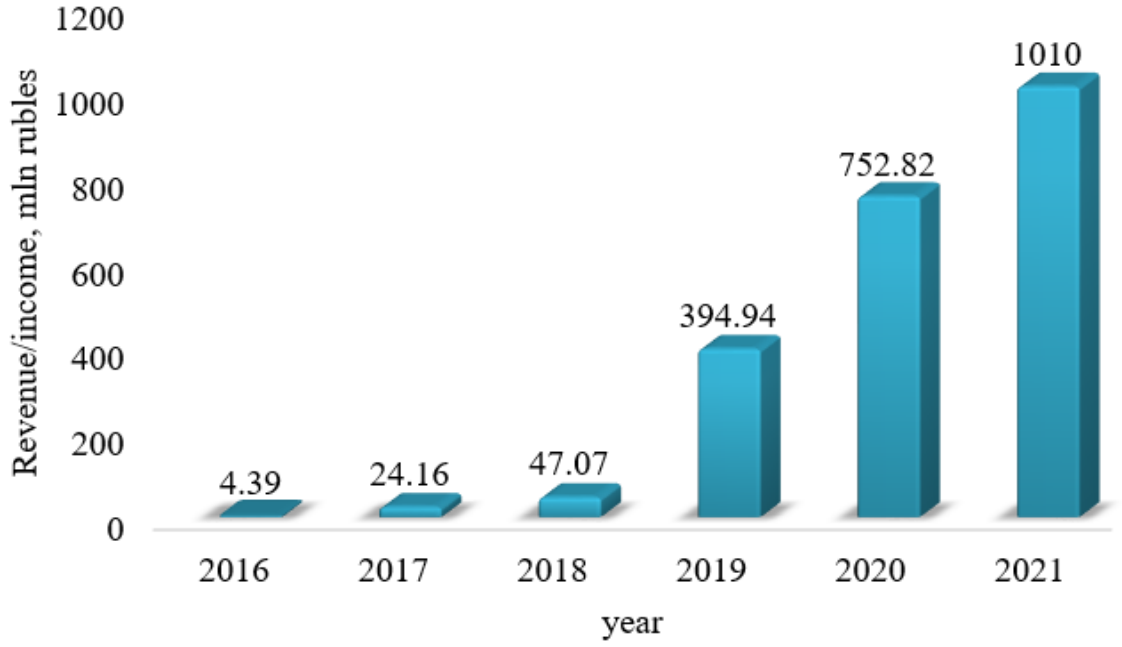

Fig. 11. **Revenue (Including "Other Income") of Ntechlab, a Resident of Skolkovo, in the Dynamics of 2016–2020, Million Rubles**

Source: About NTECH LAB. URL: https://companies.rbc.ru/id/1157746622109-ooo-nteh-lab/?ysclid=lheleu4ksj397494476 (accessed on 15.04.2022).

According to *Fig. 10* startups of Skolkovo have various functional affiliations. It is important that, according to 2021, the resident Skolkovo Ntechlab entered the list of "unicorns" [category Minicorns ("mini-unicorns")]. The revenue of Ntechlab in the dynamics of 2016–2020 is reflected on *Fig. 11*.[1]

According to *Fig. 11* total company income for the analyzed period increased by 22 906.83% with one-time support of the fund "Skolkovo" in the amount of 415 735 rubles within the microgrant. Ntechlab implements 11 key projects in which State institutions perform the role of the customer.

Thus, despite the differences of startup-IES models in different countries and regions, their development and the building of support tools mediate the reproduction of a new generation of "unicorns" — deeptech-startups and companies, opening new areas for development at the interface of disciplines, characterized by versatility, application in a wide range of industries.

CHINA'S SPECIAL DIGITAL IES MODEL: REALITY AND TARGET

In China, three main territorial centers of IES were identified, the key characteristics of which are presented in *Table 3*.

According to *Table 3*, there is: division by activity, clear functional diversification, active appearance of unicorn companies.

One of the first IES formed on the basis of the largest digital giants, which contributed to the build-up of influence through both financial success and the mass audience. The significant impact of ecosystems on a particular market is illustrated by the example of the duopoly in the retail payment market (Alipay and Tenpay).

China has 9 Internet giants with 100 small but fast-growing unicorn companies. One of them — Bytedance is the only hectocorn in the world, and the other eight are among the world's top 20 largest companies in terms of capitalization. As a result, China is a world leader on key parameters of the digital economy (*Fig. 12*).

[1] About Ntechlab. URL: https://sk.ru/news/rossiyskiy-ntechlab-poluchil-status-miniedinoroga/?ysclid=lhelhupkgz93858754 (accessed on 15.04.2022).

Table 3

Three Key Centers of China's IE

Specifications	Beijing	Shanghai	Shenzhen
Ecosystem value, billion dollars	445	157	71
Significant specification	Outstanding educational resources	Global Financial Centre, largest port	Location place of the testing for economic transformation; special economic zone
The largest unicorn companies	Alibaba, ByteDance	Lufax, Zhangmen	Tencent, Huawei, Vanke
Characteristics	93 unicorn companies, 13 public fintech-companies with capitalization of 16.35 billion dollars; Silicon Valley analogue — Zhongguancun (10 artificial intelligence laboratories, 9000 technology companies)	Base for 42 unicorn companies for the location of foreign companies	Shenzhen — enlarged analogue of Silicon Valley; zone of political and economic experiments at the city level; about 300 foreign companies from the Fortune-500 list operate on the territory
Significant investment deals	Yuanfudao (EdTech) raised 1 billion dollars; Xiaomawang (coding training) raised 21.2 million dollars; Shumei Technology (business risk management) raised 208 million dollars	Series B investment of 735.85 million dollars for Enovate Motors; Series E investment of 315 million dollars for Zhenkunhang; 310 billion dollars for startup LianBio at an early stage	ArchForce Financial Technology raised 18.3 million dollars in series B investments; Intellifusion raised 141 million dollars; SmartMore Technology raised 131 million dollars
Profile instruments	FinTech, AI, BigData/ Analytics	EdTech, Gaming	FinTech, AI, BigData/Analytics

Source: Startup Genome Report. URL: https://startupgenome.com/ (accessed on 08.03.2022).

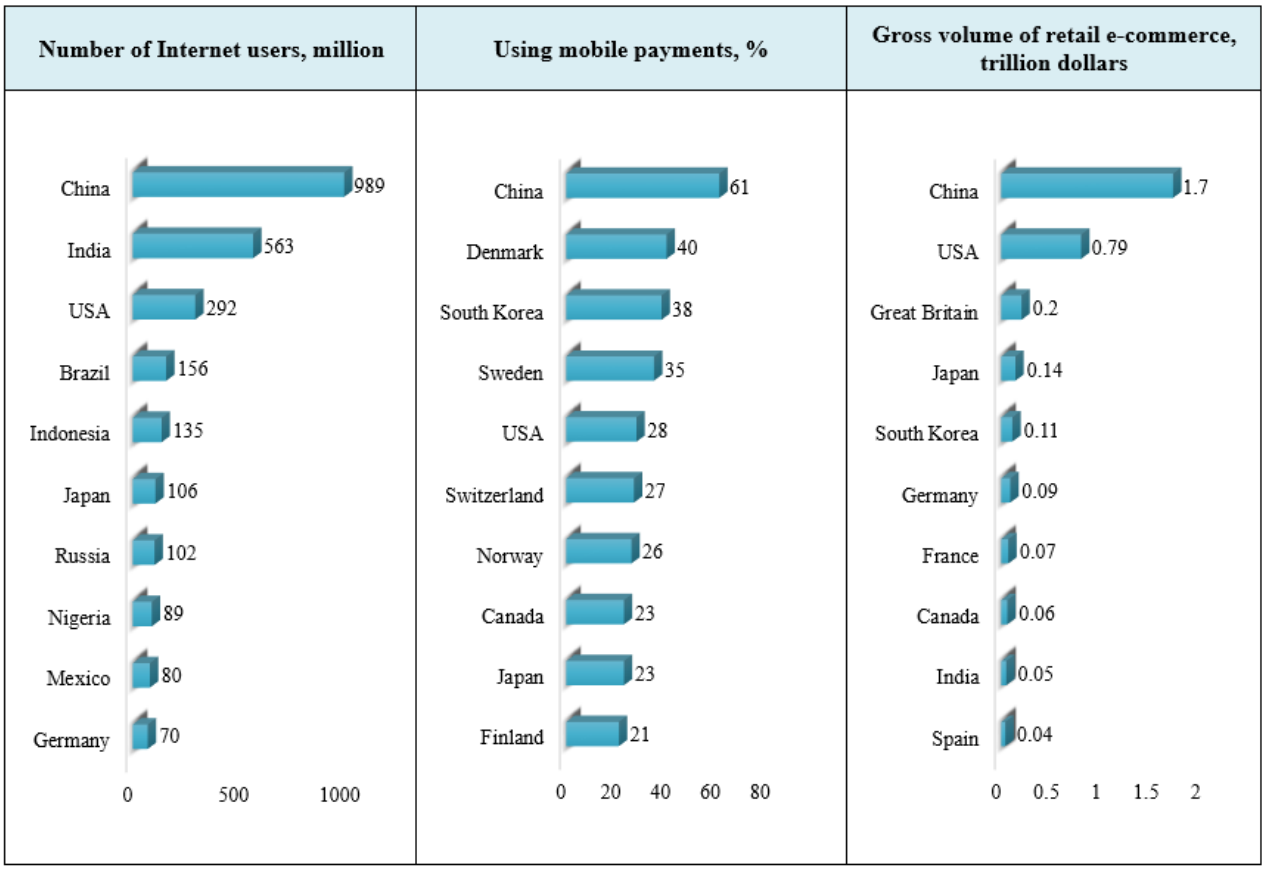

Fig. 12. **Key Parameters of China's Digital Economy as the Basis for the Development of the National Model of the IES**

Source: Future digital innovation in China. URL: https://www.mckinsey.com/~/media/mckinsey/featured%20insights/china/the%20future%20of%20digital%20innovation%20in%20china%20megatrends%20shaping%20one%20of%20the%20worlds%20fastest%20evolving%20digital%20ecosystems/future-of-digital-innovation-in-china.pdf (accessed on 12.04.2022).

The Chinese model should be recognized as the largest national IES. Due to the impressive size of the population, IES interests are objectively focused on the national market, and international expansion is less expressed in the priorities of strategy and action.

Digital IES is the result of the growth of e-commerce in China. At the same time, the Chinese model in a special format implements the principle of system. Companies diversify innovative products closely linked by presence on the same platform, that related to polarly different spheres of presence. State support for the development of IES consists not in the provision of grants tranches, but in "non-interference to demand".

Thus, the analysis of the Chinese IES model showed its competitive advantage:

- presence of a prepared and responsive market for new technologies;
- creation of the "testing ground", that did not have the world analogues with the ability to implement all innovations up to the main mass launch;
- reproduction of a special competitive environment that allows exogenously and endogenously compete with startups, companies;
- decisive position of big companies — giants of digital economy, which means exponential reproduction of startup-innovations and consumer loyalty;
- promotion of startups leads to the creation of companies that build their IES;
- special public policy of adaptive intervention;

• focus on digital networking by giving up a number of traditional corporate values and tools.

CONCLUSION

The research made it possible to conclude that IES is an open institutional mechanism for research and commercial reproduction of innovation, transforming the competitive market environment towards the dominance of sustainable intersectoral networks. IES can be an important tool in the transition to a new technology-based economy, and the externalities created by the technologies themselves will be neutralized through innovation.

Among the characteristic of IES' properties identified: openness, interactivity, dynamism, stability, hierarchy. In the context of reproduction — advantages of IES — the prospect of the model of the Chinese national IES, which should be recognized as a benchmark of the strategic innovation development of Russia with a shift of emphasis from the construction of ecosystems by leading financial organizations in the direction of the formation of territorial centers of location of technological IES.

Further scientific and practical research can go in one of two ways. First, we should examine what quantitative and qualitative factors, as well as management strategy and technology, can influence the innovation dynamics of companies and their further transformation into ecosystems. And secondly, we should consider what specific economic policies can help the development and adjustment of inefficient IES, in the context of modern innovation processes.

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A.E. Malovichko — analysis of the literature, collection of statistical data, tabular and graphical representation of the results.
A.A. Khryseva — analysis of the literature, established approaches to the study of the subject of research.

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

The article was submitted on 14.05.2022; revised on 30.05.2022 and accepted for publication on 27.01.2023.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-33-42
UDC 336.74(045)
JEL E40, G21, G28, H81, Q14

Possibilities of Using the Digital Currency of the Central Bank in Concessional Lending to the Agro-Industrial Complex

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ABSTRACT

The article is devoted to the study of niche opportunities for using the digital currency of the central bank (CECB or digital ruble) in the mechanism of concessional lending to agriculture. The purpose of the study is to identify possible effects from the use of the digital ruble for industry borrowers, the budget and banking system through the digitalization of transactions between participants in multilateral interaction and strengthening the control function. The relevance of the study is associated with a prospective assessment of the possibilities of digital modernization of existing areas of state financial support for agriculture, opened by the circulation of the digital form of the Russian ruble. The scientific novelty consists in clarifying the consumer properties of the digital ruble in relation to its possible use in agricultural lending with state support, which are practically not considered in modern scientific research, especially in an industry context. The author used the methods of abstraction, generalization, formalization, analogy, scenario forecasting. It is shown that digital financial instruments can improve the manufacturability and practical availability of concessional lending, as well as eliminate bureaucratic barriers. A promising model for the modernization of existing mechanisms for preferential lending to the agro-industrial complex using the Central Bank of Central Banks in the channels of loan capital and budget financing has been developed. Conclusions are drawn about the prospects of using digital labels that accept the permissible properties of spending funds (loans and subsidies) in the Central Bank of Central Banks, an algorithm for the automatic execution, control and documentation of all transactions regulated by the mechanism of concessional lending to the agro-industrial complex in the form of a smart contract on the projected digital ruble platform is described. The main positive effects from the use of the Central Bank of Central Banks are associated with an increase in the transparency of payments and the possibility of automating the control of target, cost and procedural parameters of transactions, accelerating the procedures for passing loan applications, and increasing the diffusion of modern digital innovations into the agricultural sector of the economy. Prospects for further research are related to the empirical verification of the proposed provisions in the process of approbation and issuance of the digital ruble by the Bank of Russia.

Keywords: digital currencies of central banks; digital ruble; credit; concessional lending to the agro-industrial complex; smart contract; state support for the agro-industrial complex; digitalization; digital economy

For citation: **Korobeynikov D.A. Possibilities of using the digital currency of the central bank in concessional lending to the agro-industrial complex.** ***Finance: Theory and Practice.*** **2023;27(3):33-42. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-33-42**

INTRODUCTION

Currently, Central Banks digital currencies (further — CBDC) as a new form of fiat money has not yet acquired clear and practical significance. Central banks are actively exploring the prospects and possible architecture of national CBDCs, opposing them to private cryptocurrencies and stablecoins in order to maintain the competitiveness of the centralized monetary system in the context of digital transformation of financial relations and increasing trends towards the decentralization of monetary and payment systems. A survey by the Bank for International Settlements showed that most Central Banks are conducting their own research and are at different stages of assessing the prospects of CBDC for issuance [1]. In particular, 86% of Central Banks are exploring CBDC issuance, 60% are experimenting with technologies, 14% are still under development or pilot phase [2]. The

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European Central Bank, the Bank of Sweden, the Bank of Canada, the Bank of Russia, the Bank of England, the Reserve Bank of Australia, the People's Bank of China are active in this issue, considering CBDC as "a new form of fiat money released in digital form by the central bank which are legal means of payment" [3].

As motivation for CBDC issuance are considered: the need for increasing competition in the payment market, reducing transaction and emission costs [4]; the opposition to the development of private cryptocurrencies [5] and global stablecoins with potentially large consumer coverage and lack control from the regulator [6]; the fight against the shadow payment turnover and economic crimes [7]; the increase the availability of financial services as a result of the diffusion of digital financial innovation and the creation of an inclusive system of digital payments [8], support financial stability and improvement of monetary policy instruments [9], and increase the attractiveness of national currencies and weakening dollar positions in cross-border settlements [10]. Additional incentives for CBDC implementation were associated with the development of online transactions and contactless payments under the restrictions imposed by COVID-19 [11]. Problems — risks associated with digital fiat money (besides cybersecurity threats) are identified as: increasing competition between Central and commercial banks for deposits as CBDC allows customers to directly accumulate funds in a more secure Central Bank [12]; increasing competition among countries for international CBDC emission standards and payment technology compatibility based on them, as control over industry standards will ensure a monopoly position in the international payment markets of CBDC [10]; achieving a socially agreed balance of control (tax, financing of illegal business and money laundering, anti-terrorism, etc.) and confidentiality (loss of anonymity of CBDC compared to cash) [13, 14].

The most relevant research areas today are the development of the optimal design of CBDC and the assessment of the impact of network effects on it [15], selection of the best CBDC model for individual countries [16], identification of possible effects on the monetary and payment system [17], study of legal, managerial and regulatory prospects of digital currency emission and turnover, issues of cybersecurity, the role of CBDC in corporate and public governance [18], identification of possible risks for consumers, financial system and monetary authorities [19] etc.

In contrast to the existing research, the article is niche, and its subject is limited to the assessment of the possibilities of introduction of CBDC in the existing mechanisms of concessional lending of agro-industrial complex (further — AIC) within the framework of technological solutions and consumer design of digital ruble, indicated by the regulator. However, CBDC itself is not the subject of research and will only be seen as a tool for digitalizing and innovating loan and budget flows through the industry's concessional lending facility. Today there are no such studies, methods are not developed, possible effects are not evaluated, which determines the scientific novelty and practical significance of this research.

MATERIALS AND METHODS

In the study of the stated problems, private sectoral approaches to regulation of conditions of functioning of the financial and credit system in agriculture and methodological approaches of the Bank of Russia to emission and circulation of digital form of the national currency are used by the author. Sectoral methodology is regulated by legislative and regulatory acts of various levels, departmental methodological and administrative materials, internal regulations of financial intermediaries and development institutions. This determines the procedure and conditions for the provision of budgetary subsidies to agricultural producers, the

functioning of the mechanism for concessional lending, the provision of credit guarantees to small and medium-sized enterprises in agriculture, etc. The aim of the study is a search for possible points of convergence between the approaches to the development of financial and credit system and the reversal of the digital currency of the central bank for the development of practice-oriented approaches and applied methods of implementing digital ruble in existing channels concessional lending to AIC. From the point of view of the overall scientific methodology of the study, the solution of the identified problems is assumed using abstraction, generalization, formalization, analogies and other theoretical and general logical methods.

MODEL OF CONCESSIONAL LENDING TO AGRO-INDUSTRIAL COMPLEX WITH CBDC

Persistent problems in the implementation of mechanism for concessional lending to AIC [20] require the use of innovative financial instruments, such as the digital ruble, allowing to increase the processability, transparency and movement of funds, simplify and improve its monitoring. The proposed model of concessional lending to AIC using the digital ruble includes two directions of modernization: 1) digitalization of payment turnover; 2) automation of control and fulfill legal and financial transactions (*Fig. 1*).

Complete substitution in non-cash money payment channels with digital in all transactions is offered in the first direction:

- loan capital in the form of concessional credit from financial intermediaries to industry borrowers and further to suppliers of funds and items of work, as well as a return flow from borrowers to banks on loan repayment;
- budget funds in the form of subsidies to authorized banks — participants of concessional lending to AIC system, compensating for the difference between the preferential and market rate of loan interest.

The second direction follows from the first and is connected with the use of technical possibilities created by the technological platform of digital ruble, and the features of its consumer design for the development of control tools and automation of routine procedures:

1. Use of digital labels to mark funds in digital money with a special feature indicating allowable spending purposes. This applies both to the budget funds brought to the Ministry of Agriculture within the limits of the budget obligations for the purpose of subsidizing authorized banks, and loan capital within the limits of the concessional short-term and investment loans to AIC subjects.
2. Digitization of the "analog" register of potential borrowers, claiming to receive a concessional loan, by including it as a structural element in a special application in a protected environment in the form of a smart-contract containing all the basic conditions for the granting and use of concessional loan, as well as settlements between the budget and authorized banks.
3. Implementation of a credit flow scheme in the form of a smart-contract for concessional loans and budget funds in the form of subsidies to authorized banks.

The proposed model does not change the general approaches and algorithm for implementing mechanism for concessional lending to AIC, but functional changes associated with the use of CBDC, can lead to positive effects for industry credit system and industry borrowers in terms of meaningful improvements in payment, control and interaction tools.

DIFFERENCES OF THE PROPOSED MODEL OF CONCESSIONAL LENDING TO AGRO-INDUSTRIAL COMPLEX WITH CBDC FROM THE EXISTING MECHANISM

In order to specify the method of using the digital ruble in mechanism for concessional lending to AIC, it is advisable to structure

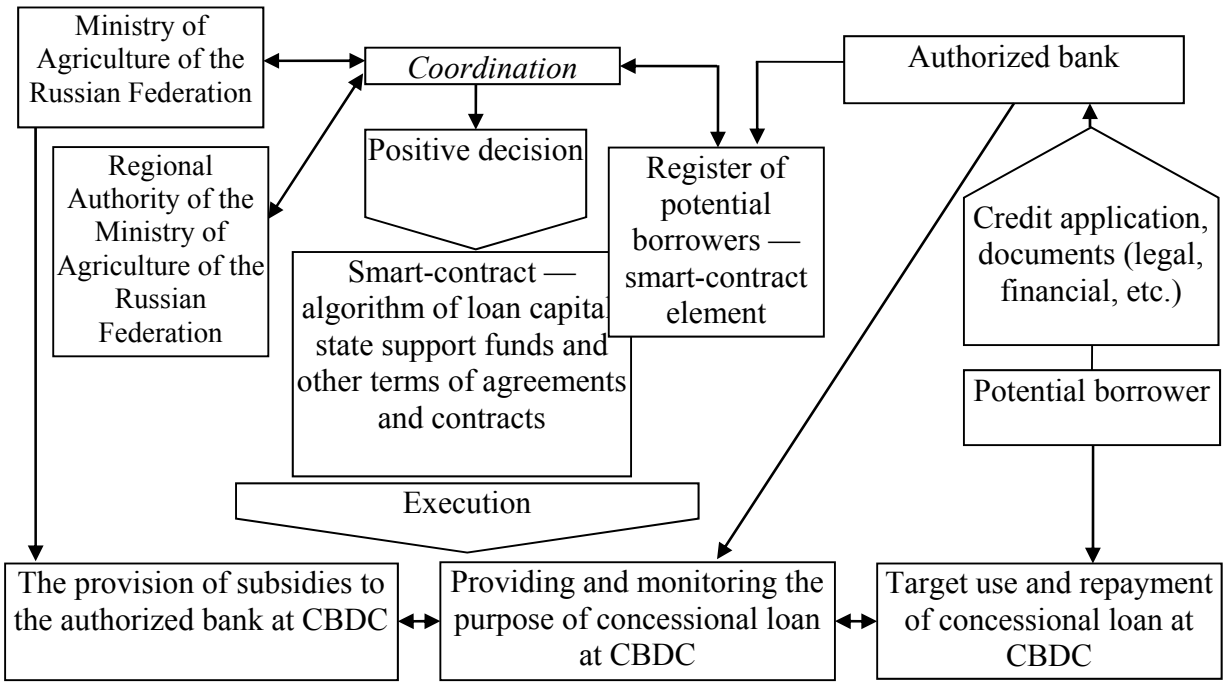

Fig. 1. **The Proposed Model of Concessional Lending to Agro-Industrial Complex Using CBDC**

Source: Compiled by the authors.

the algorithm of its implementation (*Fig. 2*) by identifying promising areas for using the technological capabilities of the digital ruble platform and digital money transactions for each stage.

In the first stage, the potential borrower determines the authorized bank, the type of concessional loan, specific objectives and loan terms. The result will be the submission to the authorized bank of a loan application and a set of accompanying documents.

In the second stage, the authorized bank, in accordance with internal rules and procedures, evaluates the creditworthiness of the borrower, its compliance with the established requirements and the target directions for the use of concessional loan. The result will be the formation of a register of potential borrowers, and the proposed algorithm will differ from the existing mechanism of concessional lending to AIC using the technological capabilities of the projected platform digital ruble. Its hybrid architecture, combining the components of a centralized system and distributed registries, will provide the necessary software environment for the launch and execution of smart-contracts (firstly, while blockchain smart-contracts are not functional, secondly, despite the fact that no CBDC blockchain-based projects have yet been implemented, permitted blockchain-based schemes are being investigated by 46 Central Banks around the world) [21].

Approbation of the digital ruble platform is planned for 2023, when the Bank of Russia, along with piloting calculations in digital money (C 2C, C 2B, B 2C), will allow a limited number of participants to conclude smart-contracts.[1] In this case, the regulator allows the use of smart-contracts in both lending and non-financial sectors of the economy.[2] As a result, it will be possible to gradually

[1] Official Website of Bank of Russia. The main directions of the Single State Monetary Policy for 2023 and the period 2024 and 2025. Project dated 11 August 2022. URL: https://cbr.ru/Content/Document/File/139691/on_project_2023(2024–2025).pdf (accessed on 14.09.2022).

[2] Official Website of Bank of Russia. Analytical review on the "Smart contracts". October 2018. URL: https://cbr.ru/Content/Document/File/47862/SmartKontrakt_18–10.pdf (accessed on 06.09.2022).

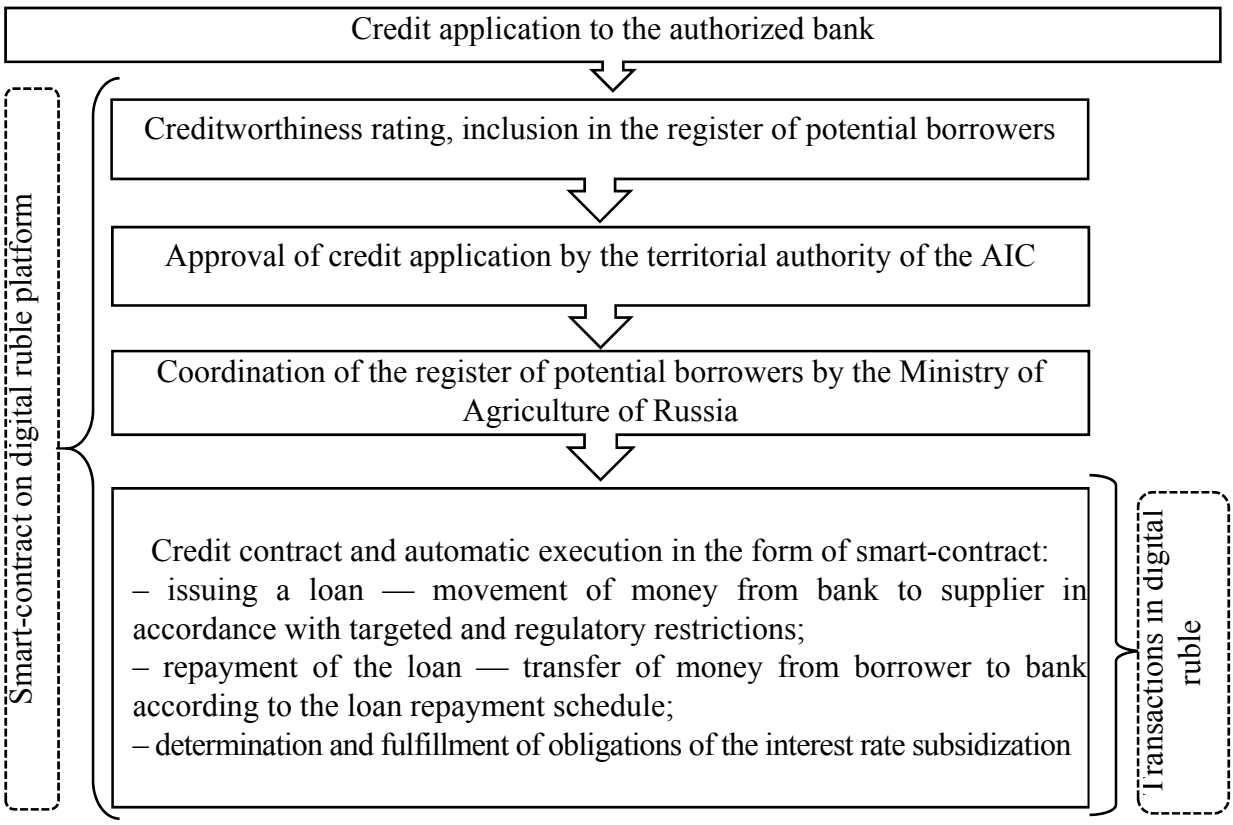

Fig. 2. **Algorithm for the Implementation of the Mechanism for Concessional Lending to Agro-Industrial Complex Using CBDC**

Source: Compiled by the authors.

implement the mechanism of concessional lending to AIC in the form of standardized smart contracts. At the initial stage, it is possible to perform individual elements of a smart-contract, i.e. transactions between banks, borrowers and the State. In the future, with the practice and wide-scale technology distributed registries, the development of legislative regulation and the digital ruble platform, smart-contracts will allow full algorithmic of the logic of occurrence, change or termination of legal and property rights between members of the mechanism for concessional lending.

The essence of the proposals for this stage of the algorithm implementation mechanism for concessional lending to AIC is the integration of data of the register of potential borrowers into a special application — smart-contract containing the terms and conditions for all subsequent payments and payments on approved loan applications in digital software code. Positive decision of the bank on the loan application and its inclusion in the register is "entry point", launching automatic execution of legally significant actions and financial transactions that comprise the content of the smart-contract.

In the third stage, the bank sends a credit application for approval to the territorial authority to AIC and after its approval sends the register of potential borrowers to the Ministry of Agriculture of Russia. At the same time, the procedure is prolonged (according to the regulation, the bank should send the extract from the register at least once a quarter, the Ministry of Agriculture of Russia reviews the data of the registers within 7 working days), which determines its duration and, as a consequence, probability of a complete devaluation of the idea of a concessionary short-term credit designed

to meet seasonal needs. The result of the third stage is the decision of the Ministry of Agriculture of Russia on the possibility of providing a concessional loan.

Using smart-contract on digital ruble platform and digital register of potential borrowers as its structural element will allow software: a) to organize the application process in real time; b) to automate the process of formal review of applications for compliance with legislative requirements for recipients of concessional loans. As a result, there are preconditions to reduce the time of coordination, simplify document management and its organization in electronic form. This will not only improve the efficiency of decision-making, but will also contribute to accelerate the loan application, to the length of which today large claims are made.

The fourth stage involves the implementation of the concessional lending mechanism. The change of forms of value and the exchange of property rights between participants during the emerging transactions allows to structure the content of this stage in the context of the relationship:

1) between the bank and the borrower to issue and repay a concessional loan, reflecting the processes of transformation of the loan capital into financial resources of enterprises when issuing credit and financial resources of enterprises into loan capital at repayment;

2) between the borrower and the supplier of purchase and sale of means and objects of labour, which are the subject of a loan agreement reflecting the movement of financial resources of business entities;

3) between the Bank and the Ministry of Agriculture on the fulfillment of budget obligations to subsidize the bank's windfall revenues, reflecting the transformation of budget funds into financial resources of financial intermediaries.

Unlike the current practices proposed algorithm for implementing the final phase of mechanism for concessional lending to AIC includes:

- entry into the software code of the smart-contract of the terms of the contracts between the parties (borrowers, banks and the Ministry of Agriculture of Russia), in which there will be automatic changes or termination of legal rights and obligations of participants in the distributed registry on the digital ruble platform, as well as the resulting payment transactions;
- automatic money transfers carried out by computer algorithm smart-contract in digital rubles using technology "coloring" (in terms of the Bank of Russia[3]), providing programming of permissible target parameters of use of concessional loans and budget funds.

PREDICTED EFFECTS OF CBDC IN MECHANISM FOR CONCESSIONAL LENDING TO AGRO-INDUSTRIAL COMPLEX

The most visible positive effects of using digital ruble in the mechanism of concessional lending will be associated with the reduction of transaction costs by automating the procedures of preparation, conclusion and execution of market agreements (loan agreement, contract of pledge, grant agreements), as well as automation and duplication of control tools in their implementation. In particular, the following possible effects are predicted:

1. Use of CBDC digital labels will eliminate the possibility of fraud and misuse of budget and credit funds at any stage of their movement. That is, the technology of "coloring" digital money will create an additional tool to control the target directions of spending, supplementing the computer algorithm of smart-contracts and automatically implemented in parallel with it in the network of distributed registries on the digital ruble platform.

[3] Official Website of Bank of Russia. The main directions of the Single State Monetary Policy for 2023 and the period 2024 and 2025. Project dated 11 August 2022. URL: https://cbr.ru/Content/Document/File/139691/on_project_2023(2024–2025).pdf (accessed on 14.09.2022).

2. The transparency of transactions with CBDC for the Central Bank will provide additional control tools that go beyond the boundaries of the distributed registry of the smart-contract, automatically implemented in the payment system of the platform digital ruble, allowing for budgetary control:

a) principles and amount for granting subsidies to authorized bank;

b) achieve results for granting subsidies;

c) verification and settlement of mutual obligations, including non-receipt of subsidies in cases of misuse of concessional credit, violations of conditions and procedure for granting subsidies or not achieving the threshold of the volume of concessional loans issued per ruble of subsidies.

3. The transparency of transactions with digital ruble (charge on the e-wallet of the borrower and crediting to the e-wallet of the provider of funds in CBDC for payment of the property that is the subject of the concessional loan) for financial intermediaries duplicates the tools for controlling the target nature of the borrower's use of concessional loan, given by the computer algorithm smart-contract and the technology of "coloring" digital money.

4. Automation of payments between the parties to a smart-contract will: reduce credit risks, risk of fraudulent activity, costs of banks (by automating document management and reducing labor cost on conclusion and monitoring of execution of banking contracts).

5. Automation of control of transaction target, cost and procedural parameters. A smart-contract containing in the form of digital codes all permissions and restrictions imposed by existing legal regulations, as well as agreements and contracts between the parties, provides for automatic suspension of its performance at any unacceptable deviation from the requirements. The result will be a triple (in addition to the digital footprint of CBDC and "coloring" technology) control over the movement, target nature and efficiency of budget and credit funds.

6. Acceleration of payment turnover as a result of automatic execution of smart contract by stages and procedures, which determine the procedure of granting and use of concessional loan, will significantly reduce time costs. Acceleration of payment turnover is especially important in short-term lending due to stringent technological requirements in the timing of the agricultural work.

7. Active penetration of the digital ruble into the payment turnover through mechanism of concessional lending to AIC will naturally contribute to strengthening the diffusion of modern digital innovations in the agricultural sector of the economy through the formation of digital habits of industry users when using this high-tech payment tool.

The use of digital ruble in mechanism of concessional lending to AIC will contribute to the overall development of information function of money and credit. However, its content in the activities of different actors will manifest itself in the goals and role in the system of emerging relationships, which allows to decompose the overall effects on more particular manifestations.

The main positive effects of using CBDC in mechanism of concessional lending to AIC can be reasonably expected for the State through:

- monetary policy — taking pressure off the money market rates that the regulator expects, especially at the stage of introduction of the digital ruble. Fixing the upper limit of concessional interest and setting limits on budgetary obligations for subsidizing authorized banks limit the ability of banks to influence both the formation of credit rates and the dynamics of lending, at least in terms of authorized bank operations by concessional lending to AIC. These funds, in fact, are not subject to the predicted negative effects associated with possible processes of transfer of funds between non-cash accounts and digital wallets of clients (reduction of bank deposits on demand, liquidity deficit, increase in the value of deposits and credits [22]). Further, as CBDC is scaled up, this private

effect will be exhausted and the influence of the CBDC model under consideration may manifest itself in the regulator's overall expectations, i.e. by strengthening the transmission of decisions on monetary policy through the system of authorized banks and the mechanism of concessional lending to the agricultural sector of the economy;

- fiscal policy — full transparency of transactions with CBDC for the regulator, the use of digital labels limiting software to the direction of use of a particular currency and the formation of a protected environment, creating conditions for the implementation mechanism of concessional lending in the form of a smart-contract, will have the greatest impact in improving the implementation of the budget policy by strengthening the control of the movement, target nature and efficiency of budget use. Additional effects for the budget system are associated with a decrease in the cost of control due to the possibilities of its automation and unloading by the Ministry of Agriculture in terms of routine control procedures, as well as a more objective and rapid assessment of the effectiveness of the use of subsidies as measured by the ratio of subsidies to banks and their concessional loans;
- agricultural policy — the use of CBDC will allow automatic monitoring of compliance of the objectives of concessional lending with the targets of the State agricultural policy, and will expand the possibilities for assessing the impact of concessional credit on the dynamics of the main macroeconomic indicators of industry development. The experience of the digital yuan pilot project in China shows that CBDC allows real-time intelligent big data monitoring to evaluate user behavior and market [23]. As a result, the additional information capabilities associated with CBDC technology can enhance the information and incentive functions of concessional agricultural loan. In terms of strengthening the information function, it is expected to increase the objectivity of the assessment of the economic impact of mechanism of concessional lending to AIC, manifested in the acceleration of economic dynamics of the industry. In terms of development, the stimulating function of CBDC will facilitate communication and reduce transaction costs for industry borrowers, which will have a positive impact on their access to concessional loans.

CONCLUSION

Without changing the essence and established approaches, the developed model of concessional lending to AIC using digital ruble includes two directions of modernization of the current mechanism. In the first direction — digitalization of the payment turnover — full replacement in payment channels of cashless money with digital money and use of technology "coloring" for programming the permissible purposes of their use. In the second direction — digitalization of control tools and automation of execution — proposed to use the technological capabilities of the digital ruble platform and features of its consumer design in part: use of digital labels indicating allowable spending purposes in CBDC; digitalization of the register of potential borrowers by including it as a structural element in the smart-contract (on the digital ruble platform); implementation of a credit flow scheme in the form of a smart-contract for concessional loans and budget funds in the form of subsidies to authorized banks.

To specify the methodology of using digital ruble in the mechanism of concessional lending to AIC developed an algorithm of its phased implementation. Starting from the stage of formation of the register of potential borrowers, mechanism of concessional lending to AIC can be automatically implemented in the form of a smart-contract on the platform of digital ruble. With the development of distributed registry technology, legislative regulation and digital ruble platform, smart-

contracts will allow to move from partial automation of individual transactions, to fully algorithmized and automatically realizable logic of multilateral interactions between banks, government and industry borrowers.

The use of CBDC in mechanism of concessional lending will reduce transaction costs in the preparation and conclusion of market agreements, as well as the automation of control tools in their implementation.

The possible impact of the use of CBDC in mechanism of concessional lending to AIC on the monetary, budgetary and agricultural policy of the state is described further. This research contributes to the theory of money (in terms of complementing the characteristics of the consumer properties of the new form of fiat money — digital ruble), public finance (complementing the control tools for the movement and efficiency of the use of budget funds) and credit (substantiation of possibilities of digitalization of procedures of the mechanism of concessional lending to the agro-industrial complex).

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

The article was submitted on 17.03.2022; revised on 30.04.2022 and accepted for publication on 27.01.2023.
The author read and approved the final version of the manuscript

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-43-55
UDC 336.745(045)
JEL E50, F31, F47

Security of the Money Supply with Gold and Foreign Exchange Reserves as a Leading Indicator of the Ruble Exchange Rate

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ABSTRACT

The purpose of the study is to determine of the influence of the Russian money supply provision with gold and foreign exchange reserves (GFR) on the exchange rate of the Russian ruble in dynamics and to form of approaches to the practical application of the results. **The objectives** of the study are: theoretical substantiation of the form of connection between the money supply of GFR and the national currency exchange rate; analysis of the relationship of these indicators according to the data of the Russian economy for 27 years at the 1994–2022; reinforcement of theoretical claims with data from empirical analysis; formation of methodological foundations and determination of directions for the practical application of the results obtained. **The research methodology** is based on graphical data analysis. The **results** of this analysis identified the presence of time lags in the reaction of the ruble exchange rate to the dynamics of the provision the Russian money supply with GFR; determine the specific value of the ratio of the volume of GFR and the money supply as a boundary, at which the national currency trend will be observed. Based on the results obtained, **it was concluded** that it is possible and necessary to use the relationship of the analyzed indicators not only as a leading indicator of the dynamics of the ruble exchange rate, but also as an active tool to manage the exchange rate of the national currency in a way that normalizes economic activity.

Keywords: ruble exchange rate; gold and foreign exchange reserves; dollar exchange rate; devaluation; monetary policy; money supply; exchange rate; monetary aggregates; monetary policy

For citation: **Eremin V.V. Security of the money supply with gold and foreign exchange reserves as a leading indicator of the ruble exchange rate. *Finance: Theory and Practice*. 2023;27(3):43-55. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-43-55**

INTRODUCTION

Foreign sanctions have created an unusual situation in the world, Russian economy and Russian currency market, which is the result of political conditions, artificial restrictions, severing trade links, and rising inflation in a relatively short period of time. Historical experience shows that such world economic anomalies are temporary. The guarantee of this — is their scale. Regardless of the duration of their effect, the situation normalizes when it returns to its pre-anomaly state.

The Russian economy and its foreign exchange market are no exception. The importance of the Russian economy for the world community shows that future normalization of economic relations is inevitable. This means that the Russian currency will be increasingly influenced by market factors. This will require the use of indicators that will allow economic agents to plan their activities, including those related to the dynamics of the ruble.

Passive acceptance that things are back to normal is insufficient. Active acceptance of the situation implies preparation for successful activity of economic agents in the realities of the future — "play ahead of the curve". One of the components of this game — is the search and application of leading indicators of the ruble exchange rate, as the dynamics of the exchange rate is one of the most important factors affecting the economic and, consequently, social situation in the country.

Dynamics of ruble exchange rate to major world currencies is important for Russian exporters, consumers of both imported products and domestic ones containing imported components. In normalized economic relations, it is important for investors to plan their investments. The predictability of the ruble reduces investors' risks, adding stability —

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one of the incentives to increase investments that create new jobs generating tax payments.

For a wide group of economic actors, if not the most accurate forecast of fluctuations of the ruble exchange rate (which, as practice shows, is extremely difficult to implement), the forecast of the trend of this rate for the near future is necessary. This raises the issue of the selection and application of an exchange rate indicator that has not only the property of leading change in relation to the change in the exchange rate of the ruble, but also the properties of comprehensibility of the logic of its formation to a broad mass of users, simplicity, and speed of calculation.

There is no requirement to accurately determine the short-term exchange rate of this indicator. It is not about its use in speculative exchange trading. Here it refers to the indicator that determines the turning points of the exchange rate.

The issue arises as to the practical application of such an indicator, since in the modern economy there is a wide range of indicators used to predict the change in the exchange rate. To this end, consider the features of the existing approaches to the study.

REVIEW OF STUDIES

First of all, exclude from the review mathematical models and algorithms for forecasting the exchange rate applied exchange trading robots. The reason — is that these algorithms focus on determining the short-term dynamics of the exchange rate [1]. And also — most economic subjects are unfamiliar with forex-trade programming and intricacies, which leads to a lack of comprehension of their work.

Similar situation with Elliott wave models [2]. Even the great experience of their use in the Forex market does not always allow us to understand: whether the current depreciation is the beginning of the second wave or it is a decline within the continuing first wave. As a result, a significant proportion of analysts interpret these waves after the fact or use neural networks [3], which makes such models for the most part a stock trading tool, understandable to narrow professionals.

Analysis of the dynamics of the ruble exchange rate based on the balance of payments data of the Russian Federation [4] was distributed, which is extremely relevant in the current economic conditions of Russia. But, as indicated above, the global scale of the problems is indicative of their abnormality. Consequently, and the ratio of export and import volumes as the main indicator of the dynamics of the ruble exchange rate has application within this abnormality. When normalizing the situation in the currency market, the dynamics of international financial flows is probably not an indicator of changes in the exchange rate, but one of the components of such a broader indicator.

Forming an indicator, actively use factor and structural analysis methodologies to identify the influence of the country's economic policies on the national currency [5]. Regression analysis is widely used, for example, to assess the impact of changes in monetary policy on the value of the ruble [6]. However, describing the technique of obtaining a result in such models to their prospective ordinary user will be difficult and will not be suitable to a large variety of individuals. In addition, each study considers the dependence of the exchange rate on a narrow factor.

Foreign authors also pay special attention to variables that influence exchange rate movements. Determine the positive link of the real exchange rate to the level of net foreign assets [7], the influence of government expenditures on the national currency exchange rate through their impact on the dynamics of consumer spending [8]. Dependence of the exchange rate on the monetary model [9], impact on the exchange rate structure of the economy through Balassa-Samuelson effect is modeled [10]. Note also a number of classical papers, which examine the correlation between the exchange rate and the terms of trade [11], justify the overvaluation

of the role of the current account in the formation of the exchange rate, determine the impact of capital mobility on the dynamics of the currency [13] and — the exchange rate's relationship to the country's monetary and fiscal policy [14]. Portfolio analysis techniques are actively used in the paper [15]. The authors investigate the crisis exposure of nations with various currency systems in the paper [16].

But most of these and similar papers consider not indicators, but factors that influence the exchange rate. Similar approach and in the papers of foreign researchers researching the dynamics of the ruble exchange rate [17]. Little is known regarding the influence of the budget rule on world exchange rates. The paper provides a thorough understanding of this impact [18]. It is not comprehensive, but it does suggest the disadvantages inherent in an indicator from the point of view of its wide application by persons far from currency pricing. For its implementation in normalizing economic situations, a simple, and to some extent understandable, leading indicator of exchange rate trend dynamics is required. Such as the money supply of the country gold and foreign exchange reserves. The idea of calculating it is based on the hypothesis of the dependence of the exchange rate on the resources available to the national banking system [19].

THEORETICAL ANALYSIS

Dependence of ruble exchange rate on gold and foreign exchange reserves is obvious and does not need proof. Since it is the volume of reserves that allows the Central Bank in the absence of abnormal conditions to conduct foreign exchange interventions to support the ruble exchange rate. However, rather than condemning the preceding set of indicators for their lack of openness for the general public, explain the basic logic of the chosen indication.

Let just two currencies to be used in the national economy — Russian ruble (*RUB*) and world reserve — (*WR*). For the analyzed period, the value of the national currency in the national economy is 200 rubles. National currency to world reserve exchange rate is 1 *RUB:* 1 *WR*. The Bank of Russia's task — is to keep this rate on par.

Let in the vaults of the Bank of Russia is 160 *WR*. Thus, the national currency has a world reserve of less than 100%:

$$\frac{160WR}{200RUB}\times 100\% = 80\%.$$

Suppose the situation in the national economy deteriorated and its natural and legal entities increased demand for the world reserve currency. To stabilize the exchange rate, the Bank of Russia is forced to use the world reserve currency from its reserves in exchange for Russian rubles. Let at the original rate of 1: 1 Bank of Russia sold 20 *WR* to legal entities in exchange for 20 Russian rubles. In such a new environment, money supply in the national economy:

$$200\ RUB - 20\ RUB = 180\ RUB.$$

Bank of Russia reserves to be:

$$160\ WR - 20\ WR = 140\ WR.$$

Availability of national currency in reserve currency will decline from the original 80% to:

$$\frac{140WR}{180RUB}\times 100\% = 77,78\%.$$

Continued expansion in reserve currency demand will need more actions by the Bank of Russia, worsening the proportion of global reserve currency provisioning. If this pattern continues, the Bank of Russia will exhaust its total reserve currency intervention, at which point it will lose its power over the exchange rate.

Consequently, under conditions of incomplete provision of the country's money supply with foreign currency reserves, it is possible to support the stable exchange rate of the ruble through the implementation of

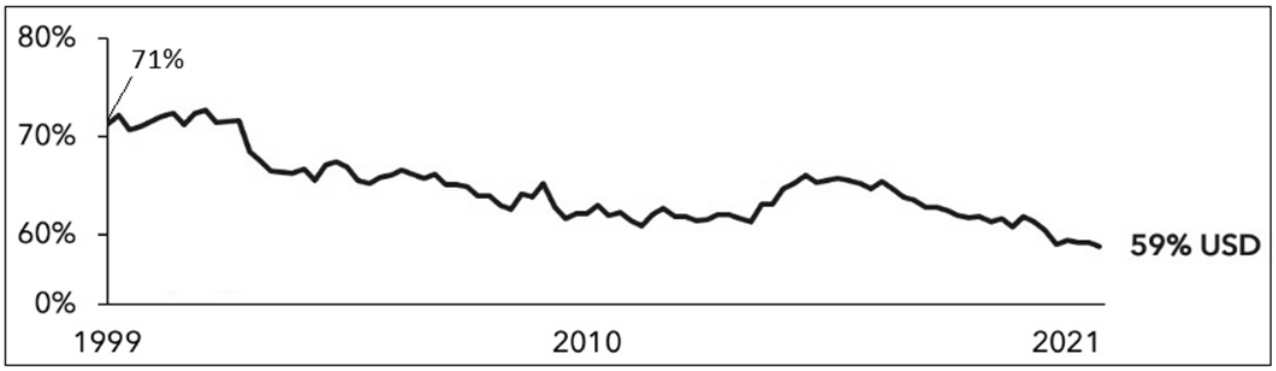

Fig. 1. **The Share of the US Dollar in the Reserves of the Central Banks of the World**
Source: Compiled by the author according to [20].

currency interventions by the Bank of Russia, but in the short or medium term, when the economic situation in the country has deteriorated temporarily, and the dynamics of its improvement is ahead of the dynamics of exhaustion of foreign currency reserves of the Bank of Russia. If the situation deteriorates in the long term and the demand for reserve currency remains high, devaluation of the national currency as a result of such support seems inevitable.

Despite the obvious correlation of the analyzed indicators, the question arises: what percentage of the Russian Federation's gold and foreign exchange reserves in terms of convertible ruble, at which the dynamics of the ruble exchange rate change the upward trend by a decrease and vice versa? It is possible to answer by analyzing the dynamics of both the ruble and the supply of Russian money supply with gold and foreign exchange reserves in the long term.

At the same time, the volume of national money in the Russian economy will be understood "the amount of cash in circulation and fund balances of non-financial and financial (except credit) organization — residents of the Russian Federation and individuals — residents of the Russian Federation on settlement, current and other accounts on demand"[1] — monetary aggregate M2.

The division of the country's money into cash and non-cash parts is accompanied by the analysis of banks' assets and liabilities. In order to keep the convertible ruble's exchange rate steady, the Bank of Russia, which offers a world reserve currency, buys the money supply it previously produced, reducing the level of ruble assets held by banks. But the volume of ruble monetary liabilities of these banks will remain unchanged. As a result, the stability of not only the ruble but also the national banking system becomes a factor in the overall stability equation for the Bank of Russia. Stability on one of these fronts will diminish stability on the other. As a result, in an attempt to ensure the stability of the banking system of the country, saturating it with ruble liquidity, the Bank of Russia will be forced to increase the money base in the context of a reduced volume of gold and foreign exchange reserves, which is also the current situation in the direction of ruble devaluation.

The above conclusions suggest the following hypothesis: the decline in the supply of the country's money supply with its gold and foreign exchange reserves precedes the devaluation of the convertible national currency. And vice versa — the rise in this security will result in the ruble strengthening.

For practical purposes, we shall substitute the US dollar for the neutral "world reserve currency". The author recognizes and supports dedollarization tendencies, but in the global

[1] Monetary aggregates. Bank of Russia. URL: https://www.cbr.ru/statistics/macro_itm/dkfs/monetary_agg/ (accessed on 25.10.2022).

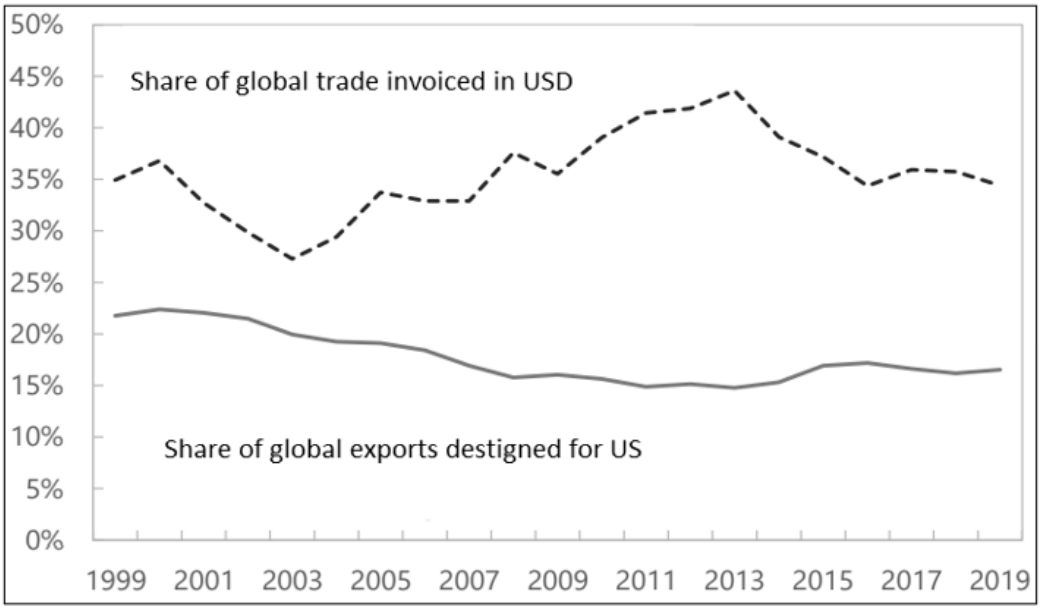

Fig. 2. **Share of the US Dollar in World Trade**

Source: Compiled by the author according to [20].

economy, two distinct patterns are forming. The US dollar is slowly but steadily losing its positions in the reserves of world central banks (*Fig. 1*). But its share in world trade has recently grown from 36.4% in 2013 to 41.1% currently (*Fig. 2*).

ANALYSIS OF THE IMPACT OF THE BANK OF RUSSIA'S GOLD AND FOREIGN EXCHANGE RATE ON THE RUBLE RATE

Based on the data of the Ministry of Finance and the Central Bank of the Russian Federation, we made calculations that allow us to determine the impact of the dynamics of the country's money supply by gold and currency reserves on the dynamics of the exchange rate of the ruble against the dollar. The calculation is as follows.

1. Compilation of statistics for the first of January of each year (1994–2022):

- gold and foreign exchange reserves of the Central Bank of the Russian Federation, mln US dollars;
- foreign currency assets of the National Welfare Fund and the Reserve Fund of the Russian Federation, mln US dollars;
- volume of monetary aggregate M2 in the economy of the Russian Federation, bln rubles;
- value of the exchange rate of the Central Bank of the Russian Federation, ruble/ US dollar.

2. Calculation of the supply of money in the economy of the Russian Federation with gold and foreign exchange reserves according to the formulas:

$$GFR' = GFR - RF, \quad (1)$$

where GFR' — adjusted gold and foreign exchange reserves of the Russian Federation, mln US dollars;

GFR — gold and foreign exchange reserves of the Russian Federation, mln US dollars;

RF — total amount of reserve fund and National Welfare Fund of the Russian Federation (NWF), mln US dollars.

Deduction of NWF and reserve fund (from 2018 — NWF volume) is necessary due to the certain non-transparency composition of these funds, resulting from their placement in low-liquid assets, as well as — insufficiency of current NWF reporting to assess the fund's performance [21].[2].

[2] Savatugin A.L. The Accounting Chamber requests that the Government rethink the terms of the NWF fund placement. Russian Federation Accounting Chamber. URL: https://ach.

$$ER = \frac{M2}{GFR'} \times 1000, \quad (2)$$

where ER — estimated exchange rate of the national currency, ruble/US dollars;

M2 — volume of monetary aggregate M2, bln rubles

$$AR = \frac{R}{ER} \times 100\%, \quad (3)$$

where AR — availability of the country's money supply with gold and foreign exchange reserves, %;

R — exchange rate, ruble/US dollars.

By means of formulas (1) — (3) we derive the calculation formula used to determine the availability of the money supply of the country by gold and foreign exchange reserves:

$$AR = \frac{GFR' \times R}{M2} \times 100\%. \quad (4)$$

3. Analysis of the dependence of the ruble exchange rate on the dynamics of the AR indicator values.

Since the value of the ruble is used to calculate the AR indicator according to formulas (3) or (4), the question arises: will AR as the leading indicator of the exchange rate dynamics be distorted by the influence of the correlation?

To address this issue, when should the exchange rate begin to respond to a change in the value of the indicator AR? No delay or a time lag? In the last case, the AR indicator will include the exchange rate for the period t, while the AR will compare the exchange rate for the period $t + i$, where i — is the value of the time lag. Will there be a correlation between these indicators? In order to obtain the answers, it is necessary to calculate the values of the indicator AR and graphical analysis of its dynamics in connection with the exchange rate dynamics, supplemented by calculation of correlation coefficients.

Original information and calculation results are shown in *Table 1*.

To determine the dependence (including its parameters) of the ruble's exchange rate against the US dollar on the supply of the Russian money supply with gold and foreign exchange reserves, we will perform a graphical analysis of the data presented in line 1 and line 2 in *Table 1*. To reduce visual load, the time period of analysis is divided into overlapping sub-periods.

Analysis of data for 1994–2000 presented at *Fig. 3*.

The analysis of the graph leads to the conclusion that the extremely low (below 37%) endowment of the money supply with international reserves led to a stable, with a significant rate of devaluation of the ruble in 1994–1998. A significant decline in money supply in 1997 and 1998 preceded the devaluation of the ruble exchange rate in 4 times in 1999 (note the similar situation 1994–1995)

Data analysis for 1999–2010 presented at *Fig. 4*.

The decline in GFR's money supply below 50% in 2000 and 2009 led to a devaluation of the ruble. In the first case, the devaluation started in 2000 and continued until 2002, while in the second case the devaluation began in 2010. The opposite situation was observed in 2006, when the growth of the money supply of GFR to 86.95% led to the strengthening of the ruble in 2007–2008.

GFR stable high money supply in 2001–2006 stabilized ruble exchange rate. Its value at the beginning of 2006 is almost equal to its value at the beginning of 2001.

Data analysis for 2010–2015 presented at *Fig. 5*.

The decline in Russia's currency reserves in 2000 below 50% led to a decrease of the ruble, which began in 2000. It continued until 2002. The situation is similar in 2009–2010.

In 2010–2012 a high percentage of Russia's money supply with gold and foreign

gov.ru/checks/schetnaya-palata-predlagaet-pravitelstvu-peresmotret-usloviya-razmeshcheniya-sredstv-fnb (accessed on 25.10.2022).

Table 1

Calculation of the Security of the Russian Money Supply with Gold and Foreign Exchange Reserves

No.	Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	Security of money supply with gold and foreign exchange reserves (line 2 / line 3), %	33.69	23.57	36.14	29.59	28.34	55.6	47.04	68.43	68.59	71.27
2	Exchange rate of the Central Bank RUB/USD	1.25	3.55	4.64	5.56	5.96	20.65	27	28.16	30.14	31.78
3	RUB/USD calculated rate (line 4 / line 5)	3.71	15.06	12.84	18.79	21.03	37.14	57.4	41.15	43.94	44.59
4	Monetary aggregate M2, bln rubles	33	98	221	288	374	454	715	1151	1609	2131
5	The volume of gold and foreign exchange reserves excluding the funds of the NWF and the reserve fund, mln USD (line 6 / line 7)	8894	6506	17207	15324	17784	12223	12456	27972	36622	47793
6	The volume of reserves of the Central Bank, mln USD	8894	6506	17207	15324	17784	12223	12456	27972	36622	47793
7	The volume of the NWF and the reserve fund, mln USD	0	0	0	0	0	0	0	0	0	0
No.	Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Security of money supply with gold and foreign exchange reserves (line 2 / line 3),%	70.69	79.38	86.95	62.99	61.42	48.69	59.97	59.25	54.23	45.7
2	Exchange rate of the Central Bank RUB/USD	29.45	27.75	28.78	26.33	24.55	29.39	30.19	30.35	32.2	30.37
3	RUB/USD calculated rate (line 4 / line 5)	41.66	34.96	33.1	41.8	39.97	60.36	50.34	51.22	59.38	66.45
4	Monetary aggregate M2, bln rubles	3205	4354	6032	8971	12869	12976	15268	20012	24205	27165
5	The volume of gold and foreign exchange reserves excluding the funds of the NWF and the reserve fund, mln USD (line 6 / line 7)	76938	124541	182240	214601	321951	214978	303286	390677	407608	408809

Table 1 (continued)

No.	Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
6	The volume of reserves of the Central Bank, million USD	76 938	124 541	182 240	303 732	478 762	426 281	439 450	479 379	498 649	537 618
7	The volume of the NWF and the reserve fund, mln USD	0	0	0	89 131	156 811	211 303	136 164	88 702	91 041	128 809
No.	Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	
1	Security of money supply with gold and foreign exchange reserves (line 2 / line 3), %	34.97	39.06	51.15	45.76	49.89	60.52	51.38	51.95	50.24	
2	Exchange rate of the Central Bank RUB/USD	32.66	56.24	72.93	60.66	57.6	69.47	61.9	73.88	74.29	
3	RUB/USD calculated rate (line 4 / line 5)	93.4	144	142.59	132.55	115.46	114.79	120.48	142.22	147.87	
4	Monetary aggregate M2, billion rubles	31 156	31 616	35 180	38 418	42 442	47 109	51 660	58 652	66 252	
5	The volume of gold and foreign exchange reserves excluding the funds of the NWF and the reserve fund, mln USD (line 6 / line 7)	333 585	219 550	246 729	289 841	367 592	410 395	428 799	412 414	448 037	
6	The volume of reserves of the Central Bank, million USD	509 595	385 460	368 399	377 741	432 742	468 495	554 359	595 774	630 627	
7	The volume of the NWF and the reserve fund, mln USD	176 010	165 910	121 670	87 900	65 150	58 100	125 560	183 360	182 590	

Source: Bank of Russia. URL: https://www.cbr.ru/statistics/macro_itm/dkfs/; Ministry of Finance of the Russian Federation. URL: https://www.minfin.ru/ru/perfomance/nationalwealthfund/ (accessed on 25.10.2022).

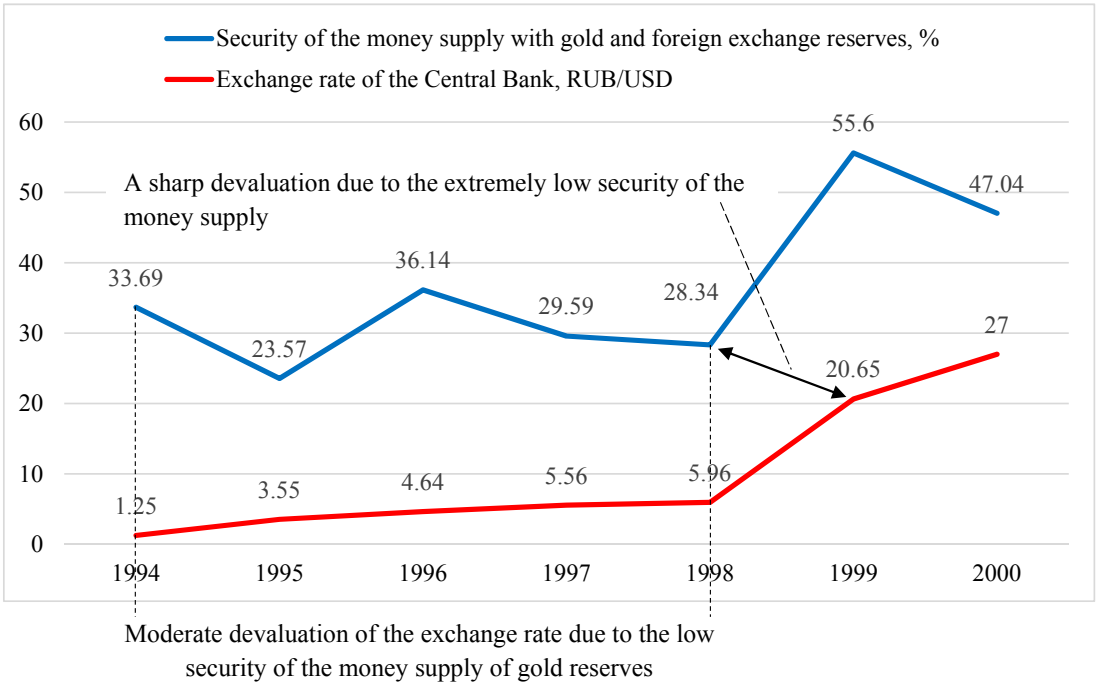

Fig. 3. **Analysis of Data for 1994–2000**

Source: Compiled by the author according to *Table 1*.

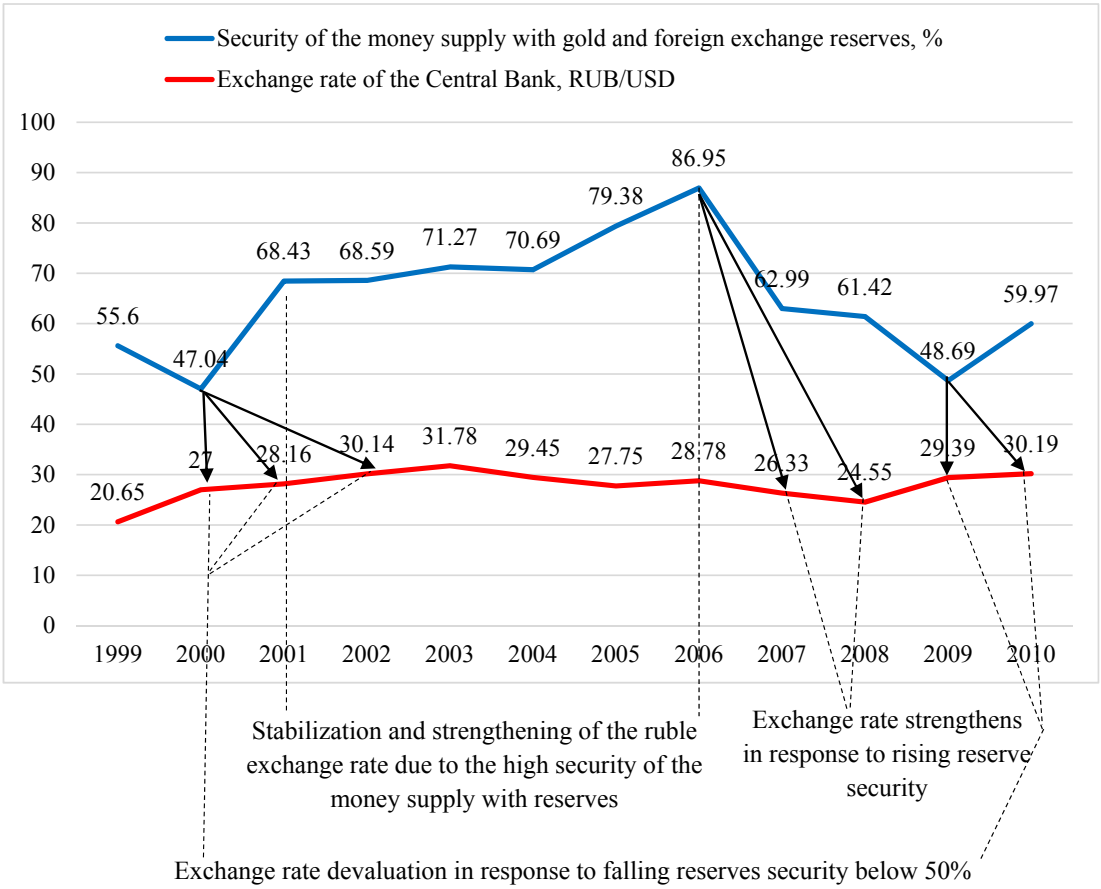

Fig. 4. **Analysis of Data for 1999–2010**

Source: Compiled by the author according to *Table 1*.

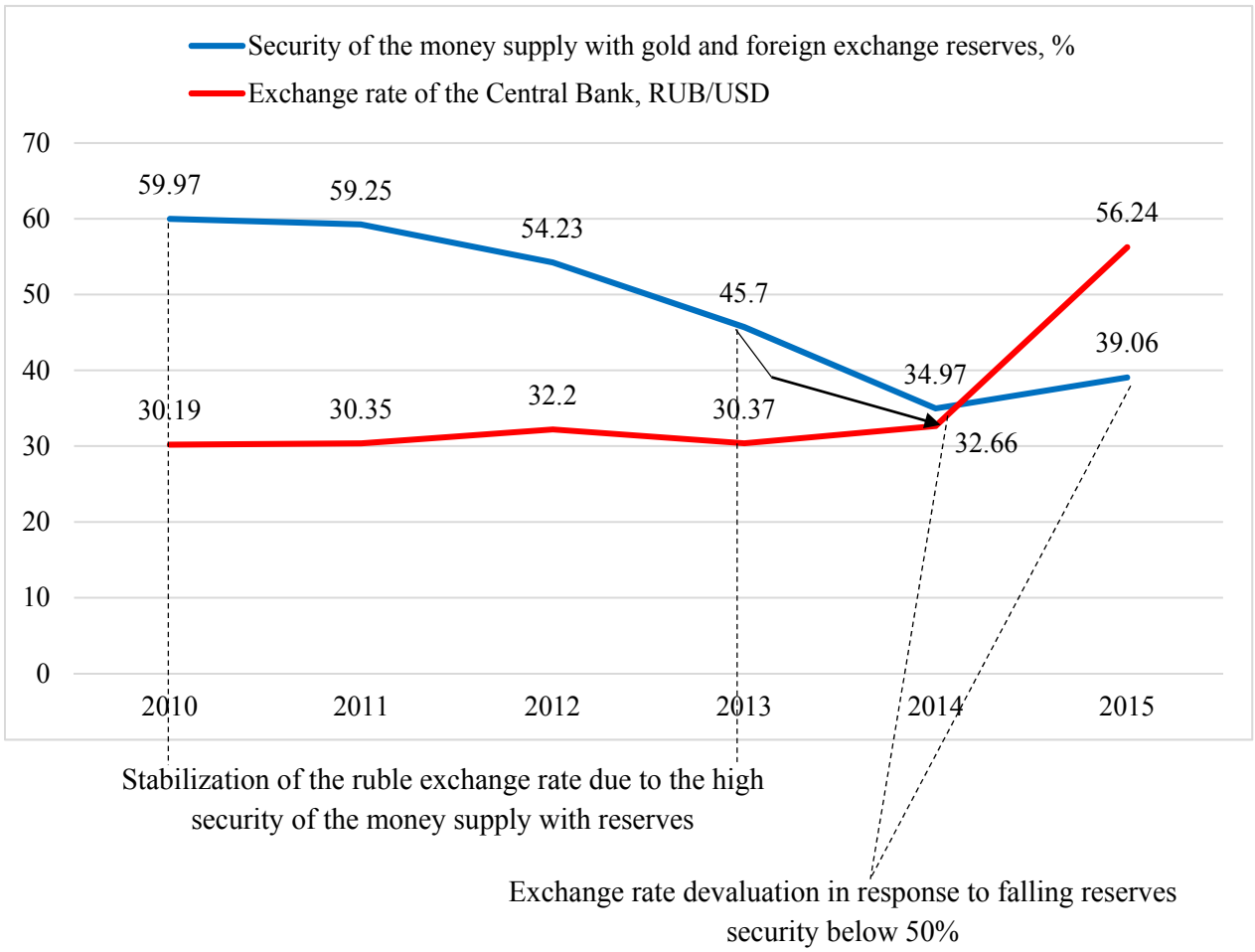

Fig. 5. **Analysis of Data for 2010–2015**

Source: Compiled by the author according to *Table 1*.

exchange reserves led to the stabilization of the ruble exchange rate in 2010–2013. At the same time, the decline in the money supply ratio below 50% in 2013 led to the devaluation of the ruble in 2014. The situation continued in 2014, when a further decline in security indicators preceded a nearly double devaluation of the ruble in 2015.

Data analysis for 2015 — early 2022 presented at *Fig. 6*.

Dynamics of analyzed values during 2015 — early 2022 illustrates the theoretical assumptions of analysis formed above. Decline in the country's money supply with gold and foreign exchange reserves below 50% in 2015, 2017 led to a sharp devaluation of the ruble. The situation was similar when the money supply was reduced to 50–51% (2016, 2020, 2021 years).

At the same time, the growth of the money supply reserves from 39.06% in 2015 to 51.15% in 2016 strengthened the exchange rate from 72.93 rubles per US dollar in 2016 to 60.66 rubles per US dollar in 2017. A similar situation was observed in 2019–2020.

The presented data of graphical analysis allow to conclude that, as a rule, the exchange rate responds to the change in the availability of the Russian money supply by gold and foreign exchange reserves (AR_t) with a time lag, usually equal to a year, less often — two years (R_{t+1}, R_{t+2}). This confirms the formed theoretical assumptions about the dynamics of the AR indicator as the leading indicator of the ruble exchange rate, but does not remove

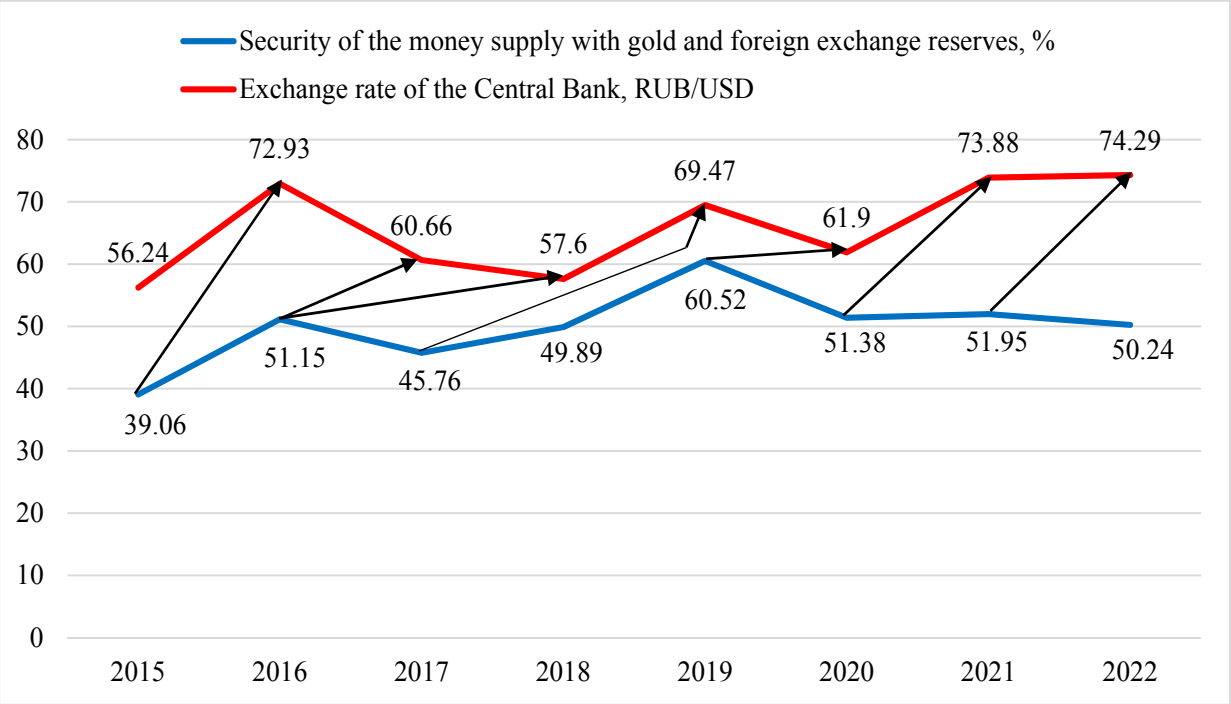

Fig. 6. **Analysis of Data for 2015 — Early 2022**

Source: compiled by the author according to *Table 1*.

the question of a possible correlation between these indicators.

Correlation coefficients between two data series from *Table 1* are analyzed to get a response: AR_t and R_{t+1}; AR_t and R_{t+2}.

The correlation ratio was 0.10377 for AR_t and R_{t+1}, for AR_t and R_{t+2} –0.00785. The acquired results answer the issue of whether there is a correlation between the investigated parameters.

In this situation, the exchange rate R_t, used in the period *t* to calculate the AR_t value, becomes a kind of technical indicator, which is necessary only for the transfer of the gold and foreign currency reserves, the reserve fund and the National Welfare Fund, in US dollars, in rubles.

The suggested method's practical application will enable the end user to foresee changes in the ruble exchange rate trend for the purpose of adjusting operational activity to reduce foreign currency risks or to earn more money in the form of exchange rate difference. And at the level of the state — for a purposeful impact on the volume of the money supply or gold and foreign exchange reserves of the country to influence the dynamics of the ruble exchange rate.

CONCLUSION

The change in the exchange rate of the ruble under conditions of its convertibility reacts to the change of the country's money supply with gold and foreign exchange reserves with some lag. It is usually the year (*Fig. 6*), but there are cases where the exchange rate response starts in the same year as the change in international reserves (2000, 2009), indicating the need for further analysis in shorter time periods (quarterly, monthly).

The decline of the country's money supply with gold and foreign exchange reserves below 50% (which allows to distinguish this value as a threshold) causes a fairly sharp devaluation of the national currency (2000, 2009, 2013, 2014, 2017 years).

Significant increase in money supply leads to a sharp strengthening of the ruble (2003–2006, 2016, 2019 years).

The persistence of the same trends over 27 years (1994–2022) indicates that the trends are not accidental, confirming the assumptions made in the theoretical part of the paper.

The scientific novelty presented by the study is that it is based on the introduction into the scientific sphere (mid-term and long-term analysis) of the method of graphical indicator analysis used in exchange trading for short-term analysis. Given that, in similar scientific publications [22, 23], graphical analysis is frequently utilized as an additional tool rather than as the primary tool. Novelty is scale of analysis — 27 years including data as of early 2022.

The results of the study are clearly implemented, allowing for the use of the quantity of Russian money supply with gold and currency reserves in the event of economic normalization:

1. As a leading indicator of the exchange rate change of the convertible ruble for investors and financiers to make decisions aimed at reducing the foreign currency risks of their activities, as well as — to obtain additional income.

2. As an active instrument in the management of the national currency.

The obtained result can be used by private and corporate investors in the Forex market (after the easing of sanctions pressure and normalization of the political and economic situation), companies whose activities involve large volumes of exports and imports, and Russian Federation authorities in the development and implementation of monetary policy as an integral part of the country's economic and foreign economic policy.

ACKNOWLEDGEMENTS

The article was prepared based on the results of research carried out at the expense of budgetary funds on a state order to the Financial University. Financial University, Moscow, Russia.

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

The article was submitted on 26.10.2022; revised on 10.11.2022 and accepted for publication on 27.01.2023.
The author read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2023-27-3-56-64
JEL E52, E58, G21

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Impact of Monetary Policy on Bank Loans in India

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ABSTRACT

This research paper **aims** to investigate the monetary transmission in India through bank lending channel, to know whether a change in monetary policy affects bank loans or not. A balanced panel data of 50 commercial banks covering a timeframe of 11 years from 2009 to 2020 has been undertaken for the **research methodology**. The outcomes of the dynamic panel have been considered by using the Generalized Method of Moment developed by Arellano Bond Blundell and Bover estimator. The **result** indicates that channel of bank lending has improved banks' resilience to monetary shocks. This paper finds the significance of bank characteristics like size, liquidity, and capital which have a substantial impact on bank lending. This research study **concludes** that repo rate, cash reserve ratio and weighted average call rate are imperative instrument of monetary policy transmission. Banks with small size, capital, and liquidity are more sensitive to any variation in monetary policy as compared to large banks.

Keywords: monetary policy; interest rate; monetary transmission; bank lending channel; dynamic panel; bank characteristics

For citation: **Kasana E., Chauhan K., Sahoo B.P. Impact of monetary policy on bank loans in India. *Finance: Theory and Practice*. 2023;27(3):56-64. DOI: 10.26794/2587-5671-2023-27-3-56-64**

INTRODUCTION

Monetary transmission is a process by which policy action of the central bank gets transmitted to encounter the objectives of inflation and growth. The mechanisms of transmission of monetary policy differ from one economy to another economy based on their financial and legal structures. At the beginning of 1990s, analysis of the mechanism of monetary policy transmission has gained attention through structural and economic reforms as well as later changes to new policy regimes. The subject of monetary policy transmission has remained by and large imprecise. The mechanism of monetary transmission has been a topic of major interest to central bankers, policymakers, and economists. Monetary policy affects the price and gross domestic product by various channels like credit, interest rate, exchange rate, and asset price channels. The monetary transmission is a perplexing process. There is no agreement on the functioning and significance of these channels in the previous studies and a debate has been seen on which of these channels prevail in the economy. Therefore, the mechanism of monetary transmission is usually referred to as "black box". From a traditional viewpoint, macroeconomic models stress the significance of banks in transmitting monetary policy actions to the real economy. However, bank lending channel (BLC) has been given special attention in empirical studies in exploring how policy impacts the economic activity by credit channel. A study by B. S. Bernanke, A. S. Blinder [1] worked on the notion of a BLC that examines how policy actions are transmitted into the real economy. The channel of bank lending emphasizes the influence of monetary policy on bank loans. It proclaims that monetary policy contractionary leads to a fall in bank deposits. Banks unable to substitute these diminutions without incurring any expenses cause them to decrease lending to their clients. The channel of bank lending is established on the idea of imperfect substitutes between bonds and bank lending, monetary policy affects the supply of bank credits [2]. A policy tightening enhances the opportunity cost of deposit holding, resulting in a reduction in bank credits in line with the decrease in funding resources. It has been examined in the US

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and Europe in studies of A.K. Kashyap, J.C. Stein [3] and Gambacorta [4].

A vital assumption behind an effective monetary policy transmission is that bank balance sheet should be robust. This assumption enables the banks to respond faster and optimally to policy changes. If the assumption is violated, then policy action may be less effective and operated with variable lags [5]. The issue of weak monetary transmission has been highlighted in India and reason is ascribed to protect bank profitability in the wake of declining asset quality and maintaining high provision. The transmission mechanism is considered as long, indefinite, and variable lags which make it complex to forecast the specific impact of policy actions on the GDP and price level. The uncertainty and variable lags persist because the policy actions induced by reserve bank do not have instantly transmitted in economy. From February 2019 to January 2020, RBI decreased its repo rate by 135 basis points. Though, Indian banks have reduced lending rates by 61 basis points in response to the policy rate [6]. The present situation provides an opportunity to inspect whether monetary policy is transmitted by banking lending channel.

This research investigates how monetary policy rates influence the bank balance sheet, specifically bank lending in India. We examine the response of credit supply to policy actions by using the research methodology [7]. The presence of a bank lending channel is recognized when banks react differently to changes in policy actions based on dissimilarities in size, liquidity, or capital as these determinants influence access to external finance that in turn affects their capacity to supply credit. This methodology is framed in the previous work on the bank lending channel. We examine the reaction of credit supply to policy actions by using panel data methodology. This paper contributes to existing literature, it provides empirical evidence on how adjustments in different monetary policies such as repo rate, cash reserve ratio, and call rate affect bank lending channel in India. The results propose that loan supply is inversely influenced by a variation in repo rate, cash reserve ratio, and call rate. Therefore, we support the perspective that these are effective monetary policy tools.

This research study is constructed as follows. Section II represents the literature review allied to monetary policy transmission of the bank lending channel. Section III is associated with the data and methodology used in the present study. Section IV presents the finding of dynamic panel data and Section V finally concludes.

LITERATURE REVIEW

The channel of bank lending is based on the perspective that banks play an exclusive and central role in the financial sector as banks are appropriate to resolve asymmetric information glitches in credit markets. This channel assumes that besides the marginal costs as well as earning considerations, the accessibility of funds is a significant factor in funding and investment decisions. The question about the importance of the lending channel has been highlighted in the previous study [8]. Though, in the developing period of globalization, the significance of lending channels has been increasing multitude. In particular, S. Ben Bernanke [9] and others put stress on the bank credit market as a part of the transmission process. To which extent policy shocks impact loan supply independent of impacting loan demand, theoretical concerns make it important for economist and monetary policymakers to give emphasize the channel of bank lending [1]. In another study by B. Bernanke, A. Blinder [10] investigate the mechanism of monetary transmission in the US. They revealed that monetary policy operates partly by affecting the structure of bank assets. We present some selected evidence on several aspects of bank lending discovered by previous studies.

The BLC mainly depends on two conditions. Firstly, the central bank manages bank credits by using monetary instruments. Secondly, no other substitutes to bank advance, at least for a few segments of borrowers [11]. A study by S. Ghosh, A. Prasad [12] analyzed the relationship between policy actions and corporate behavior in India, they establish that channel of interest rate has strengthened after 1988. Similarly, K. Singh, K. Kalirajan [13] shows that interest rate plays an imperative role in Indian monetary transmission in the post reform period. The empirical research investigates diverse channels of monetary transmission in Pakistan and showed the significance of interest rate channels and bank lending channels [14]. A. Aleem [15] investigates the monetary transmission channel in India by using a vector autoregression model. He found that the credit channel will be more significant out of three channels (credit, exchange rate, and asset price). The author infers

that banks play an imperative role in the transmission mechanism of policy shocks to the real economy. B.L. Padit, P. Vashisht [16] explore the policy rate of monetary transmission from viewpoint of demand for bank loans in India. This study used seven emerging economies including India by using monthly data. They find out that variation in interest rate is a significant factor of firms' demand for loans. Therefore, the research infers that monetary policy is a vital countercyclical instrument for controlling the pace of economic activities in India. A study [17] examines the significance of BLC in Malaysia by considering bank level disaggregated data. This study used a dynamic panel approach, namely GMM method to know the supply of dynamic banks' loan functions. The finding shows that monetary policy has negative significant influence on the supply of bank loans. A study by N. Sengupta [18] demonstrates that the bank lending channel remains a significant means of transmission mechanism of monetary authority actions in India by using VAR framework, but it has weakened during post LAF 2000 period. The interest rate and asset price become more effective, and the exchange rate, although feeble, shows a slight improvement in post LAF. An analysis by SN. Bhaduri, T. Goyal [19] shows the pragmatic evidence for the channel of bank lending by separating banks by liquidity and asset size. They found that small and less liquid banks are largely affected by policy changes, and the effect is more prominent in the zone of nonpriority sector lending. Lastly, domestic banks are sensitive to policy changes as compared to foreign banks. A. Simpasa, B. Nandwa, T. Nabassaga [20] also explore the influence of monetary policy on the BLC in Zambia by taking bank data. The econometric analysis of dynamic panel data is used to check the monetary transmission in Zambia. The results disclose that bank lending channels operate through big banks. The influence of monetary policy on medium bank size is moderate whereas nonexistence for smaller banks. Another study by BM. Tabak, TB. Moreira, DM. Fazio, AL. Cavalcanti, GH. Cunha [21] explores how policy changes influence the behavior of banks' loan supply. This study works in the five countries by taking 1254 banks for the period of 13 years from 2000 to 2012. The study demonstrates that the effect of money supply on the loan is not linear and inverted U shaped. The results exhibit that easing monetary policies do not rise the tendency of economic agents to take high risks on the market. A rise in money supply does not increase the negotiated loan after a level of money stock. A study by A. Mishra, K. Burns [22] runs a short run model to estimate interactions between monetary policy, liquidity, and bank lending in India by taking a unique liquidity index and structural VAR model. The finding of the research shows that monetary authority shocks have a robust and persistent impact on bank lending whereas bank liquidity shocks influence bank loans after a lag of 9 months. It also provides evidence of indirect feedback channel among monetary policy and bank loans operating by changes in bank liquidity.

Earlier research used VAR model, emphasize the interest rate channel of monetary transmission, and considered the whole banking sector as one, and majority of studies ignored the developing role of bank characteristics on the BLC of monetary transmission in India. The previous studies on bank lending channel established on the bank aggregate data suffer from identification problems because of their inefficiency in demonstrating whether changes in the behaviour of bank loans following policy changes are induced by the supply or demand of bank credit. Thus, the bank level data is imperative to know the monetary policy transmission across banks [2]. Pertinent to this discussion, we find one research S. Reddy, D. Bhardwaj [23] that uses the approach of A.K. Kashyap, J.C. Stein [7] on bank lending channel in India. S. Reddy, D. Bhardwaj [23] explored the impact of financial market innovation and bank characteristics on the BLC of monetary transmission in India by using dynamic panel data. This research includes 73 commercial banks from 2005 to 2015 for the analysis purpose. The study finds that liquidity, size, and capitalization are vital bank characteristics that have a substantial influence on bank loans. The research also discovers that with the financial innovation, bank lending channel of transmission mechanism has become weaker.

METHODOLOGY AND DATA

The empirical investigation of bank lending channel is based on A.K. Kashyap, J.C. Stein [3], A.K. Kashyap, J.C. Stein [7] and M. Zulkhibri [24] investigates the reaction of changes in bank loans due to bank size, liquidity as well as capitalization. The empirical model is defined as follows:

$$\Delta Loan_{it} = \alpha_i + \beta_1 \text{loan}_{i,t-1} + \beta_2 \Delta MP_t + \beta_3 X_{i,t-1} + \\ + \beta_4 X_{i,t-1} \Delta MP_t + \varepsilon_{it}.$$

Here, $\Delta loan_{it}$ denotes the changes in total advances by bank *i* at time *t*. In the model, α_i denotes a bank specific fixed effect, β is slope coefficient of variables and ε_{it} is an error term. ΔMP_t is a change in the policy rate calculated for every year by considering the difference between the rate of beginning and end of the financial year. The bank characteristics (size, liquidity, and capital) are indicated by $X_{i,}$ where Size is measured as the logarithm of total assets, liquidity is calculated as a share of liquid assets to total assets, while capital represents the equity to total asset ratio. These factors affect a banks' access to outside funding which influences the bank's capacity to provide loans.

These bank factors are considered based on the postulation that supply of credits for a given category of the bank is highly responsive to any monetary policy shocks. Usually, small banks are enforced to decrease their lending during tight monetary policy due to inefficiency to raise money as they have tiny bargaining power. Thus, when the Central Bank decreased the policy rates, small banks are affected by policy rate changes immediately by modifying their lending rates. And as size rises, transmission of monetary policy rate takes time [23]. Therefore, we expect a negative sign of bank size. Liquidity is calculated by liquid assets to total assets. Banks having low liquid balance sheets are comparatively less ready to protect their credit supply in the event of unpredicted deposit shocks and as a result, more likely to reduce their lending in case of monetary contractionary phase [4]. Thus, we expect negative sign of liquidity coefficient. In case of monetary tightening, there is a sharp contraction in loan supply by undercapitalized banks, but in monetary expansionary there is no such expansion in the loan supply [25].

The empirical framework also contains interaction terms of monetary policy along with bankspecific determinants (size, liquidity, and capital). Small banks with less liquid and poorly capitalized react more strongly to any variation in interest rates. Therefore, we expect positive coefficient for the interaction terms. M. Zulkhibri [24] demonstrates that banks pose these characteristics would decline their credit growth rate more strongly to a restrictive monetary shock as compared to large, liquid, and adequate capitalized banks.

The dependent variables and error term is correlated because of the presence of lagged dependent variable as an explanatory variable. To deal with this correlation, one of the standard methods is to use an instrument variable technique. Thus, we use the Generalized Method of Moment (GMM) developed by Arellano Bond Blundell and Bover (ABB) estimator, GMM includes two step estimation. The estimation method is consistent with the earlier work of R. Matousek, H. Solomon [26] to investigate the reaction of bank credits to monetary policy by using a dynamic panel model. This technique is useful to control weak instrument issues. One of the limitations with Arellano Bond estimator is the probability of first order autocorrelation in the residuals because instrument that deals with endogeneity are weakly exogenous. Hence, we use ABB estimator to control the weak instrument issues by taking instruments with differences and instruments in levels. The consistency of ABB estimator model is based on the assumption of no second order autocorrelation. We applied the autocorrelation test to know the absence of autocorrelation with an error term. Another test is Sargan test which checked the overall validity of the instruments.

DATA

The monetary policy and bank level data employed in the present study for scheduled commercial banks in India have been extracted from the reserve bank of India database. We consider data of 50 commercial banks covering a time frame of 12 years from 2008 to 2020 which provide us an unbalanced panel data comprising of 397 observations. The Central Bank used an extensive palette of monetary instruments such as repo rate, reverse repo rate, CRR, marginal standing facility, and the marginal cost of lending rate. We used changes in repo, CRR, and call rate as key monetary policy tools for transmission. The repo rate is one of the imperative conventional instruments in reserve banks' toolkit. The CRR is a ratio of bank deposits that banks are required to keep with the central bank in form of reserves. The interbank call rate is a short-term loan that banks offer to agents who in turn give money to investors. These monetary policy instruments have been formerly used as monetary policy indicators for India [2, 23].

DESCRIPTIVE STATISTICS

The summary statistics of specified variables have been represented in *Table 1*. This table presents the mean, standard deviation, maximum and minimum

Table 1

Summery Statistics

Variable	Description	Mean	Standard Deviation	Minimum	Maximum
Loan	Loan	111546.9	230911.6	148.47	2325290
Policy rate (%)	Repo rate	6.720833	.9551849	4.92	7.94
Policy rate (%)	Call Rate	6.625902	1.406918	3.281667	8.34
Reserve ratio (%)	Cash Reserve ratio	4.659367	1.072216	3.5	7.33
Size	Total Asset	187972.6	382572.9	42.27	3951394
Liquidity (%)	Liquid asset to total asset	.8568021	14.61915	.0014625	358.2289
Capital (%)	Equity to Total Asset	.6127833	11.21118	0.001	274.5

Source: Author's calculation.

to give insights into the distribution of the stated variable. The mean value can be observed from *Table 1* that scheduled commercial banks on an average disbursed a loan of Rs. 111546.9 crore; have Rs. 187972.6 crore assets; 0.8568021 percent of liquidity; and 0.6127833 percent of capital. The average value of repo rate, call rate, and cash reserve ratio is around 6.72%, 6.62%, 4.65%. The standard deviation indicates a slight variation in the dataset. A higher standard deviation can be seen in case of loans as well as size of banks, signifying few large and small banks run along with each other.

REGRESSION ANALYSIS

Table 2 represents the results of our estimations. By using the application of ABB estimator, we accept null hypothesis that instruments are valid according to the Sargan test. The result of second order autocorrelation shows that we do not reject null hypothesis. This proposes that our empirical model is appropriately specified. First, we investigate the impact of cash reserve ratio of the monetary policy transmission through bank lending channel. Then, we represent the estimations with other monetary indicators repo rate and weighted average call rate to know the effectiveness of monetary instruments through bank lending channel.

The regression estimation provides evidence that credit growth is inversely affected by a cash reserve ratio (CRR) tightening. The coefficient of CRR has negative significant influence on loan supply. A rise in CRR requires banks to keep high reserves with the central bank, which would reduce the growth of loans or vice versa. Therefore, we support the view that CRR is an effective instrument of monetary policy. The result is consistent with the study of Z. Fungáčová, R. Nuutilainen, L. Weill [2] who also reveals significant negative impact of reserve ratio on loan growth. Moreover, the interaction term of CRR with bank characteristics, the coefficient of specified variables have the same signs. The interaction term of CRR with specified bank characteristics (size and liquidity) has a positive significant influence on the growth of loans. Our empirical finding indicates that the interaction term of monetary policy supports the presence of BLC in India through CRR. This is consistent with previous work that small banks with less liquid react more sturdily to monetary policy tightening by decreasing their loan growth as compared to large and liquid banks.

The result discloses the significance of bank specific characteristics in respect to bank lending channels. The coefficient of lagged size shows significant negative impact on loan growth. It means bank with small size are forced to decrease their loan supply at the time of monetary contractionary due to their incapability to increase funds from other sources as they have small bargaining power. Small banks translate the policy rate immediately by modifying their lending rates when policy rates are decreased and as size increases, monetary policy

Table 2

Regression Result of Bank Lending Channel Using Different Parameters of Monetary Policy

	CRR			REPO			WACR		
	Coef.	Z	Std. error	Coef.	Z	Std. error	Coef.	Z	Std. error
$Loan_{t-1}$	.6917*	25.30	.0273	.6755*	17.97	.0375	.7454*	21.31	.0349
ChangeinMP	−1.186*	−6.31	.1878	−.4129*	−2.52	.1639	−.4518*	−5.07	.0891
$Asset_{t-1}$	−.1250*	−2.04	.0612	−.1146	−1.16	.0989	−.2072*	−3.38	.0613
$Liquidity_{t-1}$	−.4591*	−19.12	.0240	−.3754*	−13.74	.0273	−.3286*	−14.95	.0219
$Capital_{t-1}$	−.0008*	−2.24	.0003	−.0056	−1.95	.0028	−.0032*	−2.52	.0012
Change in MP* $Asset_{t-1}$	.1610*	5.12	.0314	.0484*	1.99	.0243	.0659*	4.46	.0147
Change in MP* $Liquidity_{t-1}$	.4598*	18.61	.0247	.2028*	13.75	.0147	.2849*	14.99	.0190
Change in MP* $Capital_{t-1}$	.0021	0.57	.0036	.0077*	2.10	.0036	.0068*	2.81	.0024
Intercept	3.292	.3190	10.32	3.453*	8.55	.4039	3.217*	13.29	.2421
Wald chi square	3620.32			1010.46			1771.11		
Prob >chi2	0.0000			0.0000			0.0000		
AR(2)	0.2542			0.1415			0.1427		
Sargan Test	0.2446			0.0667			0.1698		
No. of bank	50			50			50		
No. of Instruments	45			37			45		

Source: Author's calculation (STATA 14.0).

Note: GMM two step estimator suggested by Arellano Bond Blundell and Bover (ABB). MP stands for monetary policy, CRR denotes cash reserve ratio, and WACR is weighted average call rate, and * indicates significant at 5 per cent significance level.

transmission takes some time [23]. The coefficient of lagged liquidity is also significant negative impact on loan growth. It implies that banks having low liquidity are less prepared to protect their loan supply at the time of unexpected deposit shock, as a consequence, reduction in lending during contractionary monetary policy [4]. The result of capital shows significant negative influence on loan growth. It contrasts with the previous studies where capital adequacy is positively associated with bank lending.

Other instruments of monetary policy are repo rate and call rate. The coefficient of both monetary policies shows significant and negative impact, which captures the adverse influence of monetary policies on loan growth of scheduled commercial banks. The loan growth is negatively influenced when central bank tightens its monetary policy. These estimations indicate that interest rates are significant instrument of monetary policy in India. The results are similar to the study of Z. Fungáčová, R. Nuutilainen, L. Weill [2] and S. Reddy, D. Bhardwaj [23]. Moreover, the interaction term of monetary policy with bank specific characteristics shows the same sign for respective variable. The interaction term of monetary policy with three bank specific characteristics has a positive significant impact on loan growth rate. The regression estimation again provides the evidence of

BLC in the view that banks with low access to outside funding (proxies by less size, liquidity, and capital) are expected to react more quickly to any variation in monetary policy. The earlier work of AK. Kashyap, JC. Stein [7] and R.P. Kishan, T.P. Opiela [27] show that small banks with less liquid and capitalization are expected to increase their supply of loans at the time of the relaxed monetary policy. In some recent studies of Z. Fungáčová, R. Nuutilainen, L. Weill [2], S. Reddy, D. Bhardwaj [23], M. Zulkhibri [24], S. Sarkar [28] also reveal the significant positive impact of interaction terms of monetary policy with specified bank characteristics on loan supply of banks.

CONCLUSION

This research paper investigates the monetary transmission in India, where the execution of monetary policy varies from other economies in terms of regular adjustment to the policy rate, cash reserve ratio, and call rate. Therefore, it provides an important framework to examine the impact of monetary policy on bank loans. The results support the perspective that cash reserve ratio, repo rate, and call rate are significant instruments of monetary policy transmission. The result also shows that bank specific characteristics are significant with respect to the bank lending channel.

The research finding has imperative policy implications for monetary and banking policies in India. The changes in cash reserve ratio directly impact loan growth. The study finds that a contraction in cash reserve ratio negatively impacts loan growth. Therefore, the results of this study support the usefulness of monetary policy through the cash reserve ratio in India. This study also finds the same results for other monetary policy tools such as repo rate and weighted average call rate. Policymakers and economists can use cash reserve ratio, repo rate, and weighted average call rate for monetary transmission. The monetary policy authorities have to check the stability of these tools to stabilize the supply of banks' loans. This is due to any variations in monetary policy instrument influences the bank loans and further will impact the firm investment as well as economic activity.

In respect to transmission channel, bank lending channel plays a crucial role in monetary transmission in India, a tightening in monetary policy by decreasing the accessibility of funds with the banks may force them to modify their portfolio by decreasing the loan supply. The bank lending channel should be considered for the smooth transmission of monetary policy. Bank size, capital, and liquidity are noteworthy characteristics that affect bank loans. Small bank with less liquid and capital reacts more quickly to monetary policy tightening as compared to large banks. Further, research studies can work on the bank groupwise data, to know the bankwise effectiveness of monetary transmission through the bank lending channel.

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B.P. Sahoo — discussed variables, research methodology and research findings.

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

The article was submitted on 15.03.2022; revised on 29.03.2022 and accepted for publication on 27.12.2022.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-65-78
UDC 336.132.12(045)
JEL G21

Public-type MFOs as an Element of Financial System

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ABSTRACT

The **subject** of the research is to define the structure of microfinance organizations (MFOs) with the Russian Region's authorities within the founders (participants, shareholders). The **aim** of the paper is to define the role of the public-type MFOs, including the problems of their accounting, identification and supervision as an independent element of the MFOs market. The **relevance** of the research is due to the lack of list of public-type MFOs, the need of State Entrepreneurship Financial Support Policy control and measurement in the context of the new coronavirus infection and sanctions. The **scientific novelty** emerges, as there is no research about the public-type MFOs as the solid part of the Russian MFO market. The author develops an algorithm to identify public-type MFOs, analyzes the composition of this segment compared to the MFO Market structure in general. The author uses **methods** of statistical and content analysis, public data bases (the State Register of Legal Entities, registers of MFOs by the Bank of Russia, the Register of Infrastructure for SME Support). The **results** are the list of public-type MFOs, determination of the composition of this segment compared to the MFOs system as a whole. The author **concludes** that public-type MFOs have greater non-commercial orientation of this segment, its geographical distribution and its compositional unity in terms of organizational and legal forms and forms of ownership. The author **recommends**: to identify the RSMB Corporation in charge of the List of the public-type MFOs, to involve MFOs, created by the local authorities, into the SME Support activities, and public-type MFOs — into the preferential bank-loans Programs.

Keywords: entrepreneurship support; financial support; SME; microfinance organizations; MFO; public-type MFO

For citation: **Pyshkin A.N. Public-type MFOs as an element of financial system. *Finance: Theory and Practice*. 2023;27(3):65-78. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-65-78**

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INTRODUCTION

The concept of "microfinance" was formally established in the Russian Federation in 2010, and the Central Bank of the Russian Federation regulates and supervises micro-financial operations by publishing the State Register of MFOs.[1]

Microfinance organizations (further —MFO) activities are important for social and economic development in developing economies [1–3]: they provide affordable lending to low-income groups of the population [4], contribute to the expansion of lending to entities SMEs [5, 6], provide training to their borrowers [7], participate in the implementation of government programs [8], provide other services. Non-financial criteria [8, 10] are often applied to MFO performance assessments, which relate to "third mission", organizational and legal forms, etc.

The following characteristics of regulation and governmental support for the MFO are linked to the given tasks [11]: provision of subsidies only MFO, supporting SMEs, independent legal regulation for non-profit MFO, legislative allocation MFO, focused on support of socially vulnerable segments of the population and migrants.

Similar proposals have a place in the MFO system of Russia [12]. The main reason is the "predatory" reputation of MFO, due to the dominance of commercial PDL-loans with extremely high interest rates and "wild" market of work with overdue debts [13].

"Public microfinance organizations" (PMFO) is a separate legal category — MFO, one of the founders of which is a region of the Russian Federation, providing microloans to SMEs.[2] One of PMFO's preferences — is the potential of getting budget subsidies, for which the Ministry of Economic Development establishes the rules for their use of budget funds.

MFO providing microloans to SMEs and corresponding to the criteria established by the Central Bank of the Russian Federation in agreement with the Ministry of Economic Development[3] (*Table 1*), which are categorized as MFO business finance,[4] and whose list is likewise kept by the Central Bank of the Russian Federation.

Additional benefits available to MFOs of business finance include:

- guarantees for loans borrowed by MFOs;
- property support (access to State or municipal property on a preferential basis).

The necessity for proper segmentation of the MFO market is frequently overlooked in studies of the domestic financial and credit system, which greatly biases the results produced. For example, the entire MFO system can be assigned tasks to support small businesses, on which the entire study is based [14], whereas the change in the SME sector against the backdrop of the general deterioration of the economic situation is actually caused by the Central Bank of the financial system clearing unscrupulous MFOs with a reduction in their number [15, 16].

In a number of studies [17] the assessment of MFO's lending activities to SMEs is based on the inclusion of PDL-loans in the portfolio [18], which inflates the amount of such support. In contrast, it is possible to find an estimate of the effectiveness of state support for the whole MFO [19] — although it is provided by less than 10% of the total amount of MFO.

Consideration of the MFO market as homogeneous structure leads to the need to exclude the city of Moscow from analysis [20] as an extreme with extremely high concentrations of MFO or conclusions about the complementary nature of MFO to the banking system in regions where banks are concentrated [21]. A holistic perspective

[1] Official website of the Central Bank of the Russian Federation. URL: https://www.cbr.ru/vfs/finmarkets/files/supervision/list_MFO.xlsx (accessed on 28.02.2022).

[2] Part 4, Section I of the Decree of the Government of the Russian Federation No. 316 from 15.04.2014; Order of the Ministry of Economic Development No. 142 from 26.03.2021.

[3] Order of the Central Bank of the Russian Federation No. 3964 from 20.02.2016.

[4] Part 2, art. 15 of the Federal Law No. 209 from 24.07.2007 "On the Development of Small and Medium-sized Business in Russia".

Table 1

MFO's of Entrepreneurial Finance Criteria's

No.	Criteria's	Value
1	Share of microloan agreements concluded with legal entities and individual entrepreneurs	At least 70%
2	Share of microloans issued to legal entities and individual entrepreneurs	At least 75%

Source: Bank of Russia.

of the MFO system results in a mash-up of multiple ideas, such as *types* (microfinance firm) and *categories* (entrepreneurial) MFO [22], and some recommendations have already been implemented as a result of PMFO characteristics. Note that domestic authors note the expediency of highlighting various categories of MFO, for example, segmentation based on a risk-oriented approach [9], non-commercial MFO [11], MFO with priority on supporting entrepreneurs, bank MFO [23] etc.

This paper demonstrates that PMFOs are a homogeneous subsystem of the MFO market that, due to their genesis, are subject to additional regulation, with a focus on supporting entrepreneurship, with the dominance of non-commercial organizational and legal forms implementing preferential programs and additional services for the target segments.

THE GENERAL STATE AND DYNAMICS OF RUSSIA'S MICROFINANCE MARKET

In total, as of 28.02.2022, the State Register of MFOs includes 1 275 active MFOs and 8 540 records of deleted MFOs.[5]

As of the end Q2 of 2021, MFO's total portfolio of microloans reached a maximum of 305 billion rubles (+35% by the same period 2020), of which 21% were loans to legal entities and individual entrepreneurs (*Table 2*). Also the volume of microloans issued for the quarter reached the maximum — 158 bln rubles against 107 bln rubles for the same period 2020 (*Table 3*).

1 275 MFOs in Russia, which is 3.8 times the number of active banks (333 banks).[6]

According to the Central Bank of the Russian Federation, the microloan portfolio at the end Q2 of 2021 amounted to 304.8 bln rubles with a capital of 155.9 bln rubles (*Table 4*), which gives the portfolio's ratio to capital (multiplier) for MFOs of 1.95.

According to the Ministry of Economic Development, the total capitalization of the PMFO as of 01.01.2021 is more than 66.0 bln rubles (approximately 42% of the total capital of the MFO at the end Q3 of 2021), the portfolio — more than 53.8 bln rubles (18% of the total portfolio of MFOs and more than 84% of the loan portfolio to individual entrepreneurs and legal entities). But the multiplier for the PMFO is 2.41 times below the system average and is only 0.81.

At the end Q3 of 2021, according to BCH "Equifax",[7] the maximum credit cost decreased to 339 p.p. against 623 p.p. in Q3 of 2017 (–284 p.p.). At the same time, according to the Central Bank of the Russian Federation, the net profit of MFOs (excluding state) for the 9

[5] Some MFO's were removed from the State Register of MFO's more than once.

[6] Official website of the Central Bank of the Russian Federation. URL: https://cbr.ru/banking_sector/credit/FullCoList/ (accessed on 28.02.2022).

[7] Lagutkin O. Dynamics of MFI development. View of BCH. How has the sector changed since the regulation according to BCH? Presentation at the 20th Anniversary National Conference of NAUMIR. URL: https://files.rmcenter.ru/year/2021/12/presentation/Лагуткин_EquifaxMFOLagutkinOIpdf.pdf (accessed on 28.02.2022).

Table 2

Microloan Portfolio Dynamics, Billion Rubles

No.	Microloan Portfolio	Period (Year, Quarter)									
		2018	2019		2020				2021		
		IV	III	IV	I	II	III	IV	I	II	III
1	Individuals PDL	38	49	51	52	51	51	54	62	70	74
2	Individuals IL	96	116	120	125	115	121	134	145	97	106
3	Individuals POS	–	–	–	–	–	–	–	–	56	61
4	Legal entities	14	17	19	19	22	26	30	30	32	32
5	Individual entrepreneurs	16	19	22	23	24	27	31	31	32	32
6	TOTAL	164	201	212	219	213	226	249	268	287	305

Source: Bank of Russia.

Table 3

Microloan Issue Dynamics, Billion Rubles

No.	Microloan Issues	Period (Year, Quarter)									
		2018	2019		2020				2021		
		IV кв.	III кв.	IV кв.	I кв.	II кв.	III кв.	IV кв.	I кв.	II кв.	III кв.
1	Individuals PDL	38	41	47	40	33	39	47	53	66	57
2	Individuals IL	44	52	55	53	33	53	67	66	74	60
3	Individuals POS	–	–	–	–	–	–	–	–	–	28
4	Legal entities	5	6	7	4	6	8	10	5	7	7
5	Individual entrepreneurs	5	5	7	5	5	7	8	5	6	7
6	TOTAL	93	103	115	102	77	107	131	128	153	158

Source: Bank of Russia.

months 2021 increased by 80% compared to the same period 2020.[8] The Central Bank of the Russian Federation explains the growth of commercial MFOs' profit by approving loans to riskier customers,[9] while noting a higher percentage of approval of applications from state MFOs (69% versus 28% for commercial MFOs[10]). This is not exactly correct: with a larger degree of risk, commercial MFOs must establish additional reserves, reducing profit, and accept more bids with equivalent PMFO risk appetites, which contradicts the facts. An alternative explanation may be the commercial

[8] Official website of the Central Bank of the Russian Federation. URL: https://cbr.ru/Collection/Collection/File/39665/review_mfi_21Q3.pdf (accessed on 28.02.2022).

[9] See ibid.

[10] Official website of the Central Bank of the Russian Federation. URL: http://www.cbr.ru/analytics/microfinance/2021_1/#highlight=государственных (accessed on 28.02.2022).

Table 4

MFO's Key Indicators for the 2021FY 3rd Quarter

No	Criteria's	Value	
		Absolute	Percent's
1	Capital, mln rubles	155 937.9	100
2	Active portfolio of microloans, mln rubles, of them:	304 773.3	100
2.1	individual	31 707.2	10
2.2	entrepreneurs legal entities	32 155.9	11
3	Amount of microloans issued since the beginning of the year, mln rubles, of them:	440 028.6	100
3.1	individual entrepreneurs	17 440.9	4
3.2	legal entities	18 762.8	4
4	Total number of borrowers under existing contracts, un. (data for Q2 2021), of which:	15 173 049	100
4.1	individual	26 937	Less than 0.2
4.2	legal entities	18 251	Less than 0.2
5	Total number of existing contracts, un. of which:	16 714 100	100
5.1	with individual	35 233	Less than 0.2
5.2	with legal entities	23 722	Less than 0.2

Source: Compiled by author based on Bank of Russia Data.

MFOs focus on short-term PDL and IL high-value loans, which, provided that MFO business processes are internally efficient, provides high turnover and return on capital. This hypothesis is supported by a high multiplier (1.95), more than 2 times the PMFO multiplier (0.81).

SME' SUPPORT THROUGH MICROFINANCE WITHIN THE STATE

PMFO as one of the most important support tools for SMEs in Russia is included in the key strategic planning documents of this area.[11] In particular, the national project[12] includes activities to provide access to microloans at a preferential rate to self-employed citizens,[13] budding entrepreneurs[14] and SMEs.[15]

As a result, it is apparent that the PMFO sector requires particular attention to regulatory problems.

However, despite many public resources, identifying a PMFO is not an easy task, as there is no public MFO list of this category:

[11] The strategy of development of small and medium-sized entrepreneurship in the Russian Federation for the period up to 2030; the State program of the Russian Federation "Economic development and innovative economy".

[12] National Project "Small and medium entrepreneurship and support for individual entrepreneurial initiatives" and its component federal projects. Official website of the Ministry of Economic Development. URL: https://www.economy.gov.ru/material/file/65c7e743dffadf1f3f3a8207e31a0d99/Passport_NP_MSP.pdf (accessed on 28.02.2022).

[13] Official website of the Ministry of Economic Development. URL: https://www.economy.gov.ru/material/file/8e451e5404a8b9953cf1949b0a73d7ee/FP_Podderzhka_samozanyatyx.pdf (accessed on 28.02.2022).

[14] Official website of the Ministry of Economic Development. URL: https://www.economy.gov.ru/material/file/3d66461ed39217d375026b83842e03f5/FP_Predakseleraciya.pdf (accessed on 28.02.2022).

[15] Official website of the Ministry of Economic Development. URL: https://www.economy.gov.ru/material/file/99f141bfe7b5d2d6d26ff82ca51057d7/FP_Akseleraciya_sub_ektov_MSP.pdf (accessed on 28.02.2022).

- the category of PMFO is not recognized among 1 275 entities in the MFO State Register;
- the MFO List of Business Finance includes 195 organizations, including clearly commercial;
- in the Unified Support Infrastructure Register[16] (further — USI Register), there is no unambiguous identification of the MFO and (or) the PMFO: in particular, according to its data, microloans are issued including some business incubators;
- at the same time, according to the Ministry of Economic Development, as of 01.01.2021 there were 99 PMFO.[17]

This paper proposes an algorithm and attempts to identify and compile a list of organizations that meet PMFO criteria.

DATA SOURCES AND PMFO IDENTIFICATION ALGORITHM

MFOs included in a number of public registries are used as primary sources for identifying the PMFO (*Table 5*).

On the basis of tax identification number data (further — TIN), a consolidated list of 1 336 organizations was formed, not each of which is an MFO[18]:

$$List = \bigcup_{i=1}^{3} A_i,$$

where *List* — consolidated list of MFOs; A_i — *i*-register, containing *n* MFOs, $A_i = (a_{i,1}...a_{i,j})$, $j=1...n$; i — registry number (*Table 5*); $a_{i,j}$ — *j*-MFO from the *i*-register; *n* — number of MFOs in the *i*-register.

Further, for each of the 1 336 organizations in the consolidated list based on the data of the Unified State Register of Legal Entities,[19] an analysis of the composition of the founders included in the MFO State Register was conducted.

If among the founders of the organization there is a body of executive authority of the region of the Russian Federation (the code of Russian Classification of State Authorities and Management (further — RSAM code)[20] of the founder begins with 2 300), then the organization is assigned the sign "potential PMFO":

$$\forall a_{i,j} \in A_i \exists U_a = [\text{REA}] \Rightarrow f(a_{i,j}) = \text{PMFO'},$$

where U_a — feature (list) of founders of MFOs; REA — sign of presence among the executive authority' founders of the region of the Russian Federation (RSAM code founder begins with 2 300); PMFO' — assignment of the "potential PMFO" feature to an organization.

As a result, the total number of organizations marked as a "potential PMFO" is 92 MFOs (see *Appendix*).

The second criterion of MFO classification in the category "PMFO" is the provision of microloans to SMEs. In the lack of information on the loan structures granted by each MFO, the inclusion of an organization on the List of MFO for business financing is offered as an indicative of compliance with this requirement:

$$\forall a_{i,j} \in \cup\left(f(a_{i,j}) = \text{PMFO'}; A_2\right) \Rightarrow a_{i,j} = \text{PMFO},$$

where $a_{i,j}$ — *j*-MFO of *i*- MFO Register (*Table* 5); A_2 — List of MFO for business financing; PMFO' — presence of the MFO sign "potential PMFO".

The presence in the List of MFO for business financing condition is satisfied by 86 of 92 MFO, "potential PMFO" (see *Appendix*), and this list

[16] Official website of the SME Corporation. URL: https://corpmsp.ru/infrastruktura-podderzhki (accessed on 28.02.2022).

[17] Official website of the Ministry of Economic Development. URL: https://www.economy.gov.ru/material/file/2ba7942b3821dfde1d50a3119995ba20/gp_report_2020.pdf (accessed on 28.02.2022).

[18] According to the legislation of the Russian Federation, MFO includes 1 275 of 1 336 organizations included in the State Register of MFO's. A further 61 organizations appear in the Register of OIP as MFO's, but are not.

[19] Official website of the Federal Tax Service of Russia. URL: https://egrul.nalog.ru/index.html (accessed on 28.02.2022).

[20] Order of Rosstandart No. 60 from 26.04.2011 "On acceptance and introduction of the Russian Classification of State Authorities and Management OK 006–2011".

Table 5

MFO Public Registers

No.	Register	Holder	Register Location	Number of organizations
1	MFO State Register	Central Bank of the Russian Federation	https://cbr.ru/microfinance/registry/	1 275
2	List of MFO for business financing	Central Bank of the Russian Federation	https://cbr.ru/microfinance/registry/	195
3	Register of OIP *	SME Corporation	https://corpmsp.ru/infrastruktura-podderzhki/	190
TOTAL organizations				1 336

Source: Compiled by author.

Note: * only active organizations with type "microfinancial organization", "micro-credit company", "micro-finance company", "MFO", as well as organizations with forms and types of support indicated "microloan". In addition, among 189 organizations does not include JSC microcredit company "Guarantee Fund of the Samara region", because the OIP Register at the time of application (28.02.2022) no indication of its membership in the MFO.

may be considered a list of public microfinance organizations.

Additionally, we note of the 92 MFO, "potential PMFO" (i.e. relating to the set of PMFO'):

- 4 organizations are not included (there is no) in the OIP Register (see *Appendix*, lines 83–86);
- 5 organizations, which are marked in OIP Register as MFO, are not included in List of MFO for business financing (see *Appendix,* lines 87–91);
- 1 MFO assigned to the category of "potential PMFO", when increasing the provision of microloans to SMEs, can be further classified as PMFO (see *Appendix*, line 92).

STRUCTURE OF PMFO SEGMENT IN RELATION TO MFO MARKET AS A WHOLE

PMFO category includes 86 of 1 275 (7%) MFOs and 44% of MFOs business finance (*Table 6*). At the same time, PMFO unite more than half of MFO, created in non-commercial organizational and legal forms, and they account for all "exotic" forms:

- 80% of autonomous non-profit organizations;
- 47% of funds;
- 100% of autonomous public institutions;
- 100% of credit consumer cooperatives.

In total, the share of PMFO in non-commercial organizational and legal forms is 88% of the total, while in the MFO system as a whole — 12%, i.e. almost 8 times less. Limited liability companies among PMFO meet 43 times less often in comparison with the MFO system as a whole (2 against 87%, respectively), 10 of 11 MFO, owned by regions of the Russian Federation, belong to the category of State.

In addition, among PMFO there are no organizations with foreign property or the property of Russian citizens living permanently abroad, while under the MFO system there are 43 such organizations (or 3%).

As a result, PMFO is a broadly uniform non-profit sector focused on financing to SMEs. At the same time, 4 PMFO there are no in the OIP Register, and 59 organizations, contrary to the regulatory requirements, are marked in the OIP Register as MFO, although not among them,

Table 6

MFO's Distribution by the Organizational and Property Forms

No.	Criteria's	MFO's Types					
		MFO's		MFO's of entrepreneurship financing		Public-type MFO's	
		Number	In% to total	Number	In% to total	Number	In% to total
1	**Organizational and legal form, total: of them:**	1 275	100	195	100	86	100
1.1	Autonomous non-profit organizations	15	1	15	8	12	14
1.2	State autonomous institutions of the Russian Federation	1	0	1	1	1	1
1.3	Credit consumer cooperatives	1	0	1	1	1	1
1.4	Autonomous municipal institutions	4	0	4	2		
1.5	Non-public JSCs	8	1	5	3	5	6
1.6	Limited Liability Company (LLC)	1 111	87	44	23	2	2
1.7	Association of legal entities	2	0	2	1	1	1
1.8	Funds	133	10	123	63	64	74
2	**Form of ownership, total: of them:**	1 275	100	195	100	86	100
2.1	Private	1215	95	177	91	75	87
2.2	Private and foreign property	12	1	1	1	0	0
2.3	Regions of the Russian Federation	11	1	10	5	10	12
2.4	Russian citizens permanently residing abroad	1	0	0	0	0	0
2.5	Foreign legal entities	21	2	1	1	0	0
2.6	Foreigners and stateless persons	5	0	0	0	0	0
2.7	Mixed Russian with a share of property in regions of the Russian Federation	1	0	1	1	1	1
2.8	Mixed foreign	4	0	0	0	0	0
2.9	Municipal	4	0	4	2	0	0
2.10	Other mixed Russian	1	0	1	1	0	0

Source: Compiled by author based on FTS of Russia data.

Table 7

MFO Distribution by Regions of Russia

No.	Criteria's	MFO's Types		
		MFO's	MFO's of Entrepreneurship financing	Public-type MFO's
1	Number of organizations	1 275	195	86
Number of MFO's per region:				
2	Average	15	2,3	1
3	Median	8	1	1
4	Standard deviation	23.8	3.2	0.4
5	Minimum	1	0	0
6	Maximum	201	21	3
7	Asymmetry	5.76	3.96	1.29
8	Excess	41	17.4	9.4

Source: Compiled by author.

which indicates the need to adjust the content of this register. Legislation establishing and maintaining a public list of State microfinance institutions is included. As part of the MFO's support to SMEs, these tasks might be moved to the SME Corporation, which coordinates the operations of the support infrastructure organizations, including the MFO.

By region MFO are not distributed uniformly, while almost every region has an average of 1 PMFO (*Table 7*) — and in this interesting difference not only from the MFO, but also from the banking sector, closely tied to the population density of the region [21].

For example, 16% of MFIs (201 un.) are concentrated in Moscow, and only 1 MFO operates in the Yamal-Nenets Autonomous District. Average quantity of MFO per 1 region is 15 organizations, median — 8.

In the case of PMFO, the situation is the opposite, for example, in the Trans-Baikal Region there are 3 organizations, while in five regions the PMFO-related microfinance organizations are not identified:

- in four regions (Astrakhan region, Kabardino-Balkar Republic, Kaliningrad region, Republic of North Ossetia-Alania) due to lack of MFO, assigned to the category of financing "potential PMFO", in the List of MFO for business financing;
- in one region (Moscow) due to the absence of MFO, among which there are executive authorities of regions of the Russian Federation.

In seven regions (Magadan region, Nenets Autonomous District, Pskov region, Republic of Ingushetia, Republic of Kalmykia, Chukotka Autonomous Region, Yamal-Nenets Autonomous District) microfinance is presented exclusively PMFO, and in nine other regions (Sevastopol, Jewish Autonomous District, Ivanovo region, Kamchatka region, Karachaevo-Cherkess Republic, Republic of Adygea, Republic of Dagestan, Chechen Republic, Yaroslavl region), one third to one

half of the MFOs operating in the region are State-owned.

CONCLUSION

The PMFO identification algorithm presented by the author in this research enables the author to evaluate the structure of the PMFO sector in relation to the MFO market.

The list of PMFO based on real material allows for the determination of the structure of this sector in contrast to MFO as a whole, partially resolving the issue of the domestic micro-financial market's lack of such research.

Furthermore, the paper includes a conclusion about the autonomy of the PMFO segment within the MFO system as a result of its greater non-commercial orientation, geographical distribution uniformity, and compositional unity in terms of organizational-legal forms and forms of ownership, and it can be used as a starting point for future research.

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

The article was submitted on 10.03.2022; revised on 24.03.2022 and accepted for publication on 27.01.2023.
The author read and approved the final version of the manuscript.

Appendix

Public-Type MFOs and "Potentially Public-Type" MFOs

No.	MFO's Tax No.	MFO's in Registers		
		MFO's of Entrepreneurship financing	Register of Infrastructure for SME Support	Public-type MFO
1	0105981150	+	+	+
2	0275066729	+	+	+
3	0323072429	+	+	+
4	0571035216	+	+	+
5	0602017266	+	+	+
6	0816038986	+	+	+
7	0917015985	+	+	+
8	1001019831	+	+	+
9	1101205905	+	+	+
10	1215046127	+	+	+
11	1326211337	+	+	+
12	1326960625	+	+	+
13	1435175512	+	+	+
14	1655259599	+	+	+
15	1701035719	+	+	+
16	1831045838	+	+	+
17	1901098681	+	+	+
18	2013002707	+	+	+
19	2016013062	+	+	+
20	2130058291	+	+	+
21	2221171632	+	+	+
22	2310981029	+	+	+
23	2464154029	+	+	+
24	2634091033	+	+	+
25	2721052016	+	+	+
26	2901204067	+	+	+
27	2983010493	+	+	+
28	3123095826	+	+	+
29	3250690063	+	+	+
30	3257065816	+	+	+
31	3328999318	+	+	+

Appendix (continued)

No.	MFO's Tax No.	MFO's in Registers		
		MFO's of Entrepreneurship financing	Register of Infrastructure for SME Support	Public-type MFO
32	3444265068	+	+	+
33	3525251257	+	+	+
34	3666144160	+	+	+
35	3728015495	+	+	+
36	3801990027	+	+	+
37	4027015435	+	+	+
38	4101091354	+	+	+
39	4207043015	+	+	+
40	4345045088	+	+	+
41	4401062636	+	+	+
42	4501153372	+	+	+
43	4632066518	+	+	+
44	4704104363	+	+	+
45	4824047100	+	+	+
46	4909131840	+	+	+
47	5038072003	+	+	+
48	5100000331	+	+	+
49	5260248556	+	+	+
50	5321059541	+	+	+
51	5406570716	+	+	+
52	5503134176	+	+	+
53	5610046774	+	+	+
54	5753990187	+	+	+
55	5835073174	+	+	+
56	5902198365	+	+	+
57	6027123709	+	+	+
58	6164109350	+	+	+
59	6228033318	+	+	+
60	6315007931	+	+	+
61	6450939546	+	+	+
62	6501287362	+	+	+

Appendix (continued)

No.	MFO's Tax No.	MFO's in Registers		
		MFO's of Entrepreneurship financing	Register of Infrastructure for SME Support	Public-type MFO
63	6671118019	+	+	+
64	6731027048	+	+	+
65	6829127793	+	+	+
66	6952000911	+	+	+
67	7017128812	+	+	+
68	7106015641	+	+	+
69	7204137581	+	+	+
70	7325096925	+	+	+
71	7453313646	+	+	+
72	7536165141	+	+	+
73	7604192192	+	+	+
74	7838029258	+	+	+
75	7901550330	+	+	+
76	8001004443	+	+	+
77	8001017379	+	+	+
78	8601042850	+	+	+
79	8709908439	+	+	+
80	8901023569	+	+	+
81	9102023109	+	+	+
82	9204014946	+	+	+
83	0411018879	+		+
84	2540256748	+		+
85	2801249882	+		+
86	6829151813	+		+
MFO category "potential PMFO"				
87	0726016321		+	(potential)
88	1515918749		+	(potential)
89	2013800720		+	(potential)
90	3015028318		+	(potential)
91	3906905082		+	(potential)
92	7838028737			(potential)

Source: Compiled by author.

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DOI: 10.26794/2587-5671-2022-27-3-79-91
UDC 336.144,332.144(045)
JEL G28, H68, O18, P25

Forecasting the Socio-Economic Development of the Municipality: The Budgetary Aspect

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ABSTRACT

The article considers the issues associated with the formation of a forecast for the socio-economic development of a municipality in the context of budgetary resources. **The relevance** of the study is due to the variety of theoretical and practical approaches to forecasting the socio-economic development of municipalities, which are used in the activities of local governments with different degrees of effectiveness, which has a negative impact on strategic planning at the municipal level as a whole. **The purpose** of the study is to develop an integrated approach to the formation of a forecast for a socio-economic development of a municipality with emphasis on the budgetary sphere. **The research methodology** is based on the use of complex and statistical analysis, methods of economic and mathematical modeling. Approbation was carried out on the example of the municipality "City of Kirov". Conceptual scheme for construction of economic and mathematical model of a municipal formation is substantiated and proposed, and also allow to form a forecast of socio-economic development of a municipality for long-term period, in which factors are identified and influence on the local budget parameters. To build an economic and mathematical model, a municipal statistical base for the city of Kirov was formed for a twenty-year period. On the basis of the collected statistical series, balance ratios and factor dependencies of the model parameters were identified and formalized in accordance with the logic of the relationship of indicators within the model of the socio-economic system of the municipal level by constructing a system of econometric equations and conducting a correlation-regression analysis. On the basis of the constructed economic and mathematical model, a scenario forecast was implemented and estimates of changes in the budget parameters of the city of Kirov for the period up to 2035 were obtained. It is **concluded** that the approach developed by the authors to the formation of the forecast for a socio-economic development at the municipal level is universal for various types of municipalities in the Russian Federation and can be applied as for municipal socio-economic system as a whole and for its individual subsystems and spheres.

Keywords: municipality; socio-economic development forecast; local budget; strategic planning; economic and mathematical modeling

For citation: **Fattakhov R.V., Nizamutdinov M.M., Pivovarova O.V., Oreshnikov V.V., Stroev P.V. Forecasting the socio-economic development of the municipality: The budgetary aspect. *Finance: Theory and Practice*. 2023;27(3):79-91. (In Russ.) DOI: 10.26794/2587-5671-2023-27-3-79-91**

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INTRODUCTION

Ensuring effective management of municipalities' socio-economic development is a key task of local self-government bodies, for which a wide range of administrative, legal, economic, and institutional instruments are used, of which strategic planning plays an important role as a set of strategic planning, forecasting, and management, including forecasting over different time periods [1–3].

The forecasting process itself is complex and rather complex, there are a large number of different methods and approaches to the construction of forecasting, the degree of formalization which can be divided into two aggregated groups: intuitive and formalized [4]. Intuitive forecasts are quite widespread in various areas, especially in the context of dynamic reality, as they are based on expert assessments obtained during interviews and questionnaires [5]. However, there are considerable risks involved with these methodologies, including a high level of subjectivity, which would significantly influence the quality of the forecast if experts are not competent. In this regard, most researchers use formalized methods to supplement the obtained predictive estimates of quality, the most common of which are economic and mathematical modeling, because they allow to evaluate the behavior of the object, causes and patterns of change, impacts, opportunities, and costs of influencing these changes [6].

Application of various economic and mathematical methods for forecasting the development of territories was considered by both domestic [7–14], and foreign scientists [15, 16].[1] Despite the diversity and unconditional benefits of the presented methodologies, as well as the practice of their implementation, a set of problematic elements inherent in projecting socioeconomic growth at the municipal level may be asserted:

- application of trend forecasting methods, especially when the developers are municipalities, which leads to insufficient accuracy of model results;
- low level of statistical information provision;
- individual indicator group forecasting is inconsistent, resulting in a poor balance of modeling results;
- high level of influence of the environment [17];
- fragmentation of long-term development priorities and operational decisions between levels of government, resulting in situational solutions to problems at the local level and insufficient integration of long-term priorities;
- limitations of scenario modeling tools [18].

The solution of these issues necessitates the development and implementation of integrated methodologies to forecasting the socio-economic growth of municipalities.

The municipality "Kirov of City", which is the administrative center of Kirov region, was chosen as the object of this study. Employees of the Financial University under the Government of the Russian Federation are members of the scientific team for the development of the "Strategy for the socio-economic development of the municipality "Kirov of City" for the period up to 2035" and the plan of measures for the implementation of the "Strategy economic development of the municipality "Kirov of City" for the period up to 2035",[2] which determines the choice of the object of research and confirms the successful approbation of the proposed approaches in the study.

RESULTS

The complex structure and specific properties

[1] Amisano G., Geweke J. Prediction using several macroeconomic models. URL: http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1537.pdf (accessed on 04.06.2022).

[2] Decision of the Kirov City Duma No.39/1 from 28.10.2020 "On approval of the Strategy for the Socio-Economic Development of the Municipality "Kirov of City" for the period up to 2035". URL: https://docs.cntd.ru/document/570981689 (accessed on 07.06.2022).

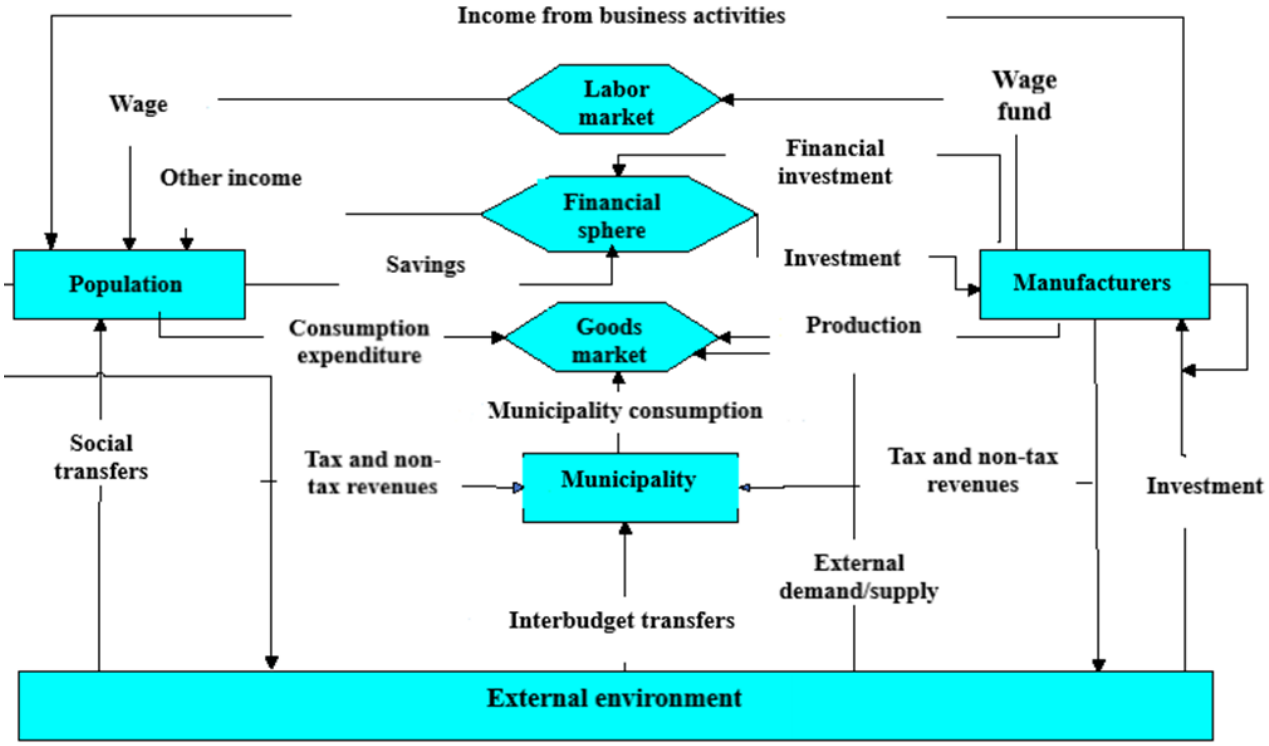

Fig. 1. **Socio-Economic System of the Municipal Level as an Object of Modeling**

Source: Compiled by the authors based on the materials [21].

of the social and economic system of the municipality, noted in the studies V.B. Zotov [19], D.B. Sergeev [20], predetermine the interconnectedness and interdependence of the system elements and spheres of activity of the municipality, which is expressed in various interactions of demographic processes, labor market, budget, financial and production spheres. Long-term influences on the municipal budget can be classified as demographic and economic. For example, the transformation of the demographic structure caused by population ageing leads, on the one hand, to an increase in expenditure on health and social services and, on the other — to a decrease in the proportion of the working population, slows both the growth rate of the economy and the growth rate of budget revenues. The birth rate and migration have an impact on budget factors. The formed structure of the municipal economy, labor productivity, and the level of growth of small and medium-sized firms, as well as investment activity, all have a substantial impact on the budget's tax revenues, prompting the inclusion of relevant data.

As a result of the systematic description of the socio-economic system of the municipality as a set of basic elements and interrelationships [21], the following main subsystems were identified and interconnected for modelling purposes (*Fig. 1*).

In order to determine the quantitative relationships between the indicators and the factors influencing them, a municipal statistical base for the 20-year period was established, containing reporting data on more than 250 indicators provided by the Kirov city administration, territorial body of the Federal Service of State Statistics on the Kirov region, as well as placed in other official statistical yearbooks.

On the basis of the presented structure of the model of socio-economic development of the municipal formation and the formed statistical base of the city of Kirov, a

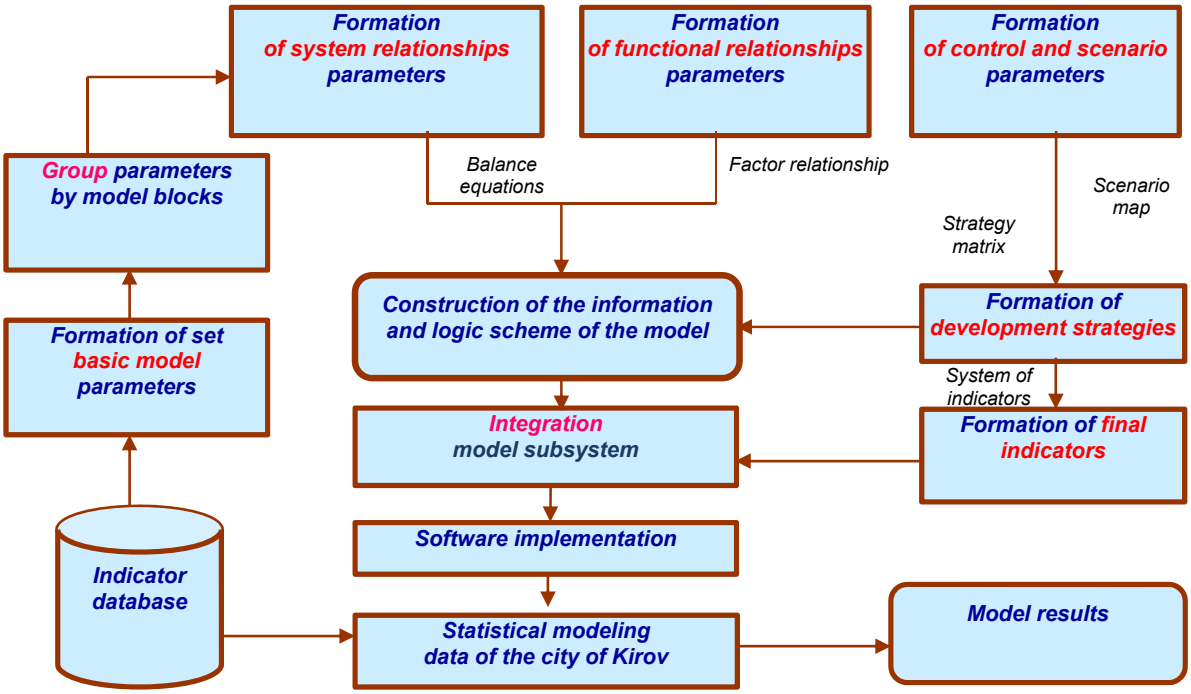

Fig. 2. **Conceptual Scheme for Construction an Economic and Mathematical Model of a Municipality**

Source: Compiled by the authors.

conceptual scheme for the construction of an economic and mathematical model of the municipality was developed, which includes the following main stages (*Fig. 2*).

The application of the suggested conceptual scheme results in the construction of a long-term projection of the socioeconomic growth of the municipality "Kirov of City", including financial parameters. Despite differences in the quantitative correlations of socio-economic indicators within each municipality, the application of the proposed conceptual framework of municipality economic and mathematical model development is universal for various types of municipalities. Over the years, the author's team has refined the approach to modeling various socio-economic sectors of municipalities which has been regularly tested in forecasting demographic evolution [22, 23], however, this is the first attempt to apply it to the budgetary sector, which is the scientific novelty of this work. To solve the tasks, the process of forecasting the development of the budget sphere of the city of Kirov is presented in detail.

Calculation of indicators of the socio-economic development model of Kirov was implemented using several approaches. Regression equations describing the dependence of this indicator on other indicators were developed for the main part of the indicators. At the same time, the mathematical criteria for equation adequacy and the actual correlation of the generated findings with retrospective data were examined. Other indicators are balanced and represent the difference of private indicators, including the amount of income and expenses of an economic agent. This calculates the deficit/surplus of the budget.

Population is forecast based on the movement of age for each individual age group. Thus, in order to forecast the size of the population of each age group in a municipality, a model of population replacement was built. There are some differences in the population composition in the under-one age group, where the birth rate is the most important factor.

The model forms a balance sheet, a

formalizing structure of the monetary income of the population, which consists of wages, social transfers, income from business, property and other income (1):

$$MP_t = MP_t^W + MP_t^B + MP_t^S + MP_t^P + MP_t^{Ot}, \quad (1)$$

where MP_t — money incomes of the population in *t*-year; MP_t^W — wage in *t*-year; MP_t^B — income from business activity in *t*-year; MP_t^S — social payments and transfers in *t*-year; MP_t^P — property income in *t*-year; MP_t^{Ot} — other money incomes of the population in *t*-year.

Directly the dynamics of these factor indicators is determined by the change of their components. Thus, income from wages depends on the number of employed in the economy and the average monthly wage, and social benefits depend on the number of pensioners and the average pension.

The population's monetary income determines the equivalent monetary spending. However, an analysis of historical data shows that the difference between these indicators is on average 1.5% per year. Within the financial flow model, a regression equation of the following type was created:

$$EP_t = 6595.12 + 0.95\ MP_t, \quad (2)$$

where EP_t — the value of monetary expenditures of the population in *t*-year.

The assessment of the quality of the equation ($R^2 = 0.99$, $F = 2576.46$) demonstrates that it is acceptable to use it in the problem.

The production model includes, among other things, the measurement of the volume of goods shipped, the number of employed populations, the value of fixed assets, etc. Fixed investment is the most important determinant of economic development. Investments from both personal and generated funds are considered as part of the model's development. The first of these are determined by the formula:

$$I_t^o = 455.24 + 1.01 * (D_t + I_t^{pr}), \quad (3)$$

where I_t^o — investments in fixed capital from own funds of enterprises in *t*-year; D_t — depreciation volume in *t*-year; I_t^{pr} — investment from the profit in *t*-year.

The determination factor for this equation was 0.96 and the Fisher criterion was 270.4, which is above the critical significance level.

Subsystem "Municipality" reflects budgetary component of territory functioning. The income part of the budget can be represented by the amount of tax revenues, non-tax revenues and inter-budget transfers (4):

$$BI_t = BI_t^{tax} + BI_t^{ntax} + BI_t^T, \quad (4)$$

where BI_t — budget income of municipality in current period; BI_t^{tax} — tax revenues to municipality budget in *t*-year; BI_t^{ntax} — non-tax revenues to municipality budget in *t*-year; BI_t^T — inter-budgetary transfers in *t*-year.

Tax revenues are defined in the model according to the most significant for the municipal level of taxes — personal income tax (BI^{PIT}), on total income (BI^{TI}) and property (BI^P). The first component was defined as a function of the income from wages (MP^S) according to the formula (5):

$$BI_t^{PIT} = -419\,585.98 + 55.69 * MP_t^W. \quad (5)$$

The determination coefficient was 0.84, the Fisher criterion value was 20.86, which is above the thresholds and indicates the quality of the resulting equation.

Total income tax revenue is determined based on the volume of goods shipped and previous period trends in this indicator. Property taxes are based on taxes on the property of individuals (BI_t^{TPI}) and land tax (BI_t^{LT}) according to the formula:

$$BI_t^P = 344\,326.29 + 1.04 * (BI_t^{TPI} + BI_t^{LT}). \quad (6)$$

The corresponding determination factor was 0.89 and the Fisher criterion — was 80.92.

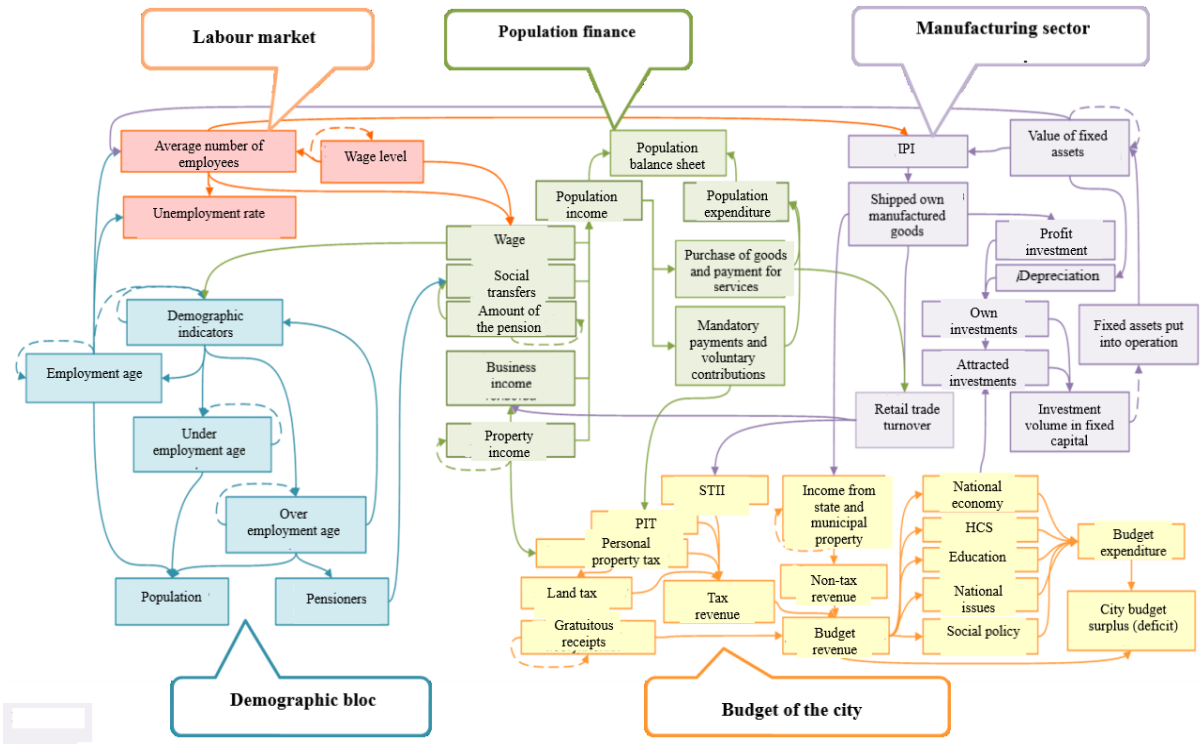

Fig. 3. **Aggregated Scheme of Interrelation of Indicators of the Socio-Economic System of the Municipality**

Source: Compiled by the authors based on the materials [24].

In turn, the value of taxes on property of individuals is determined by the formula:

$$BI_t^{TPI} = -660\,733.95 + 4.78 * BI_t. \quad (7)$$

For this equation, significant estimates of the determination coefficient (0.89) and the Fisher criterion (17.13) were found.

Non-tax revenue and inter-budget transfers are based on historical values, with appropriate conversion rates based on historical averages based on actual budget implementation reporting data.

Similarly, additional parts of the municipality model were formalized, allowing for the description of the key financial flows within the given system and the prediction of future changes. It should be noted that in the model construction all financial indicators were brought into comparable prices, which allowed to avoid the influence of the price factor.

The suggested system of balance and factor equations formalizes the major reproduction processes within the context of Kirov's complex model of the economy, which gives a balanced medium and long-term projection *(Fig. 3)*.

This model features a detailed description of the elements of the revenue and expenditure of the city budget.

Three different development scenarios get created.

1. The conservative scenario predicts that present trends and socio-economic development criteria of the municipality would be maintained.

2. The base scenario keeps critical performance metrics.

3. The target scenario includes the development of positive trends at all levels and a favorable external environment, along with the realization of the municipality's current potential parameters.

Scenario differences are determined in accordance with the parameters of the main strategic planning documents of the Kirov region and the Russian Federation. Based on the

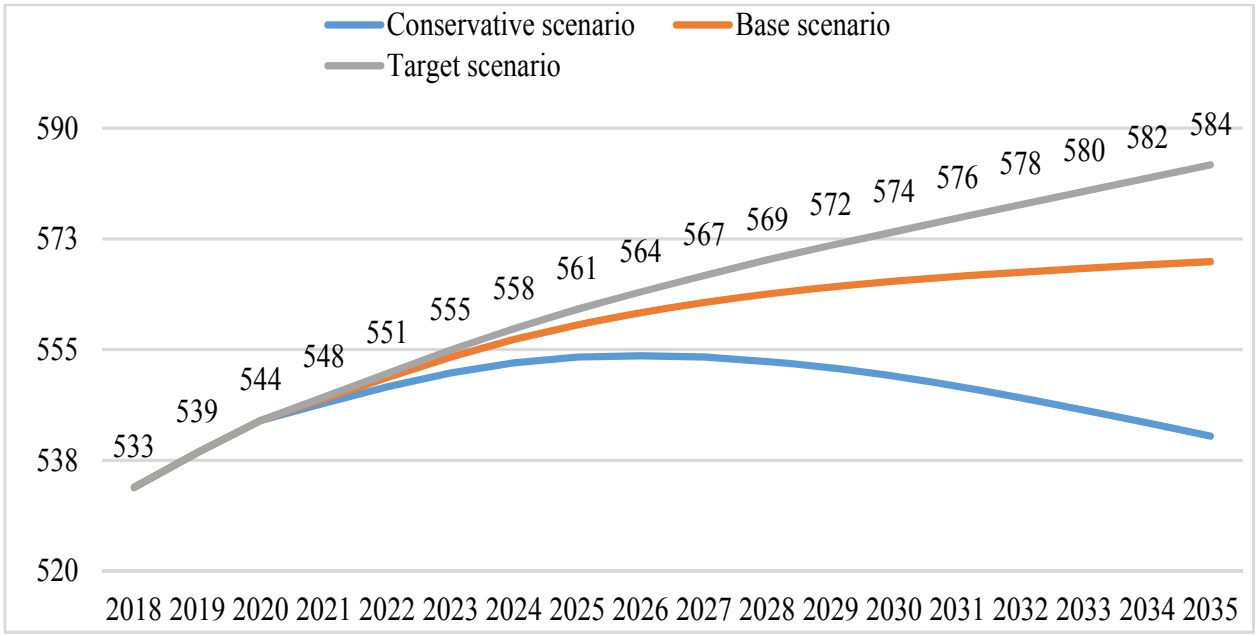

Fig. 4. **Forecast of the Population of the Municipality "City of Kirov" until 2035, in Thousand People**

Source: Compiled by the authors.

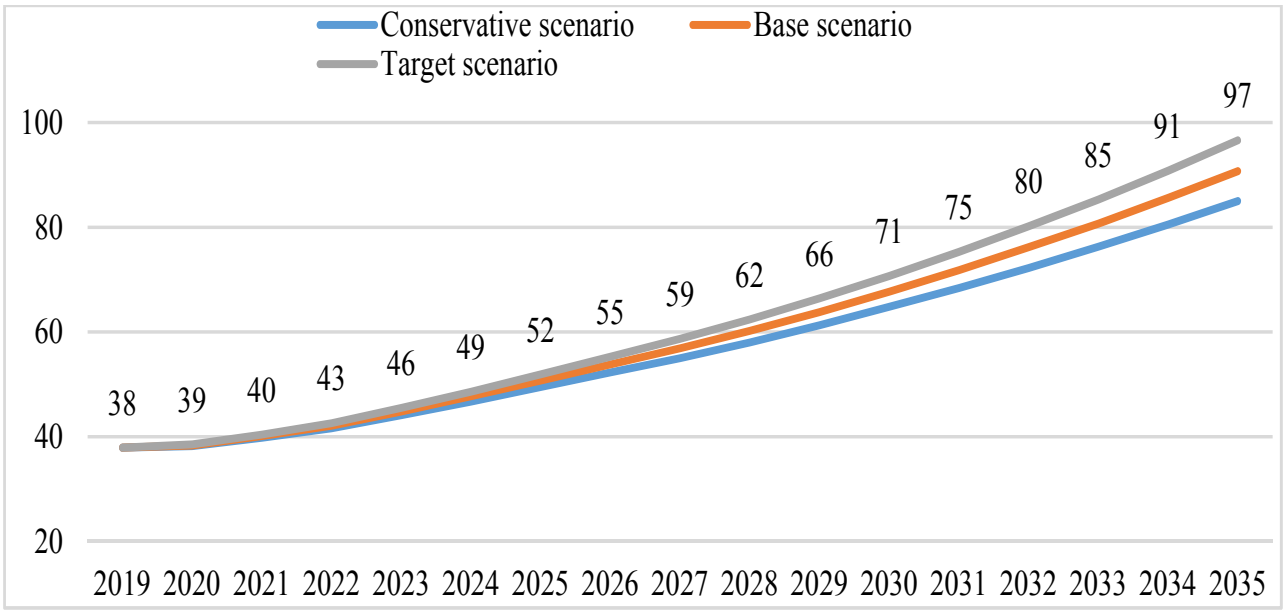

Fig. 5. **Forecast of Average Monthly Nominal Wages Per Employee (for Large and Medium-Sized Enterprises) of the Municipality "City of Kirov" Until 2035, in Thousand Rubles**

Source: Compiled by the authors.

analysis of the forecast of the Central Bank of the Russian Federation,[3] the influence of actions to prevent coronavirus infection and global financial and economic instability was evaluated.

As a result, a demographic forecast was created to project budget parameters up until 2035 (*Fig. 4*).

[3] Bank of Russia press release dated 24 April 2020. URL: https://cbr.ru/press/pr/?file=24042020_133000Key.htm (accessed on 15.10.2020).

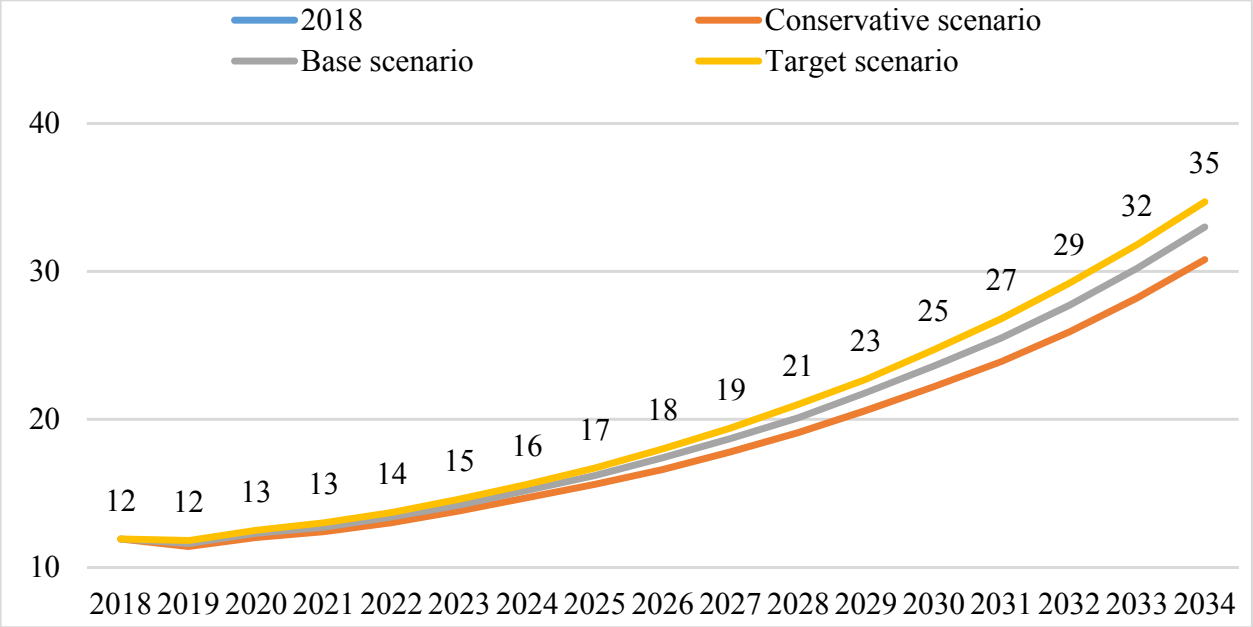

Fig. 6. **Forecast of Tax and Non-Tax Revenues of the Budget of the Municipality "City Of Kirov" Per Capita Until 2035, in Thousand Rubles**

Source: Compiled by the authors.

Based on statistical data characterizing the labor market and production volumes in Kirov city, a forecast of wage growth was formed, which has a significant impact on budget parameters (*Fig. 5*).

Dynamics of average per capita incomes of the population of Kirov in general corresponds to the forecast of dynamics of wages. In the base and target scenarios, the share of social transfers in the income structure of urban residents decreases, indicating that the growth rate of wages exceeds the growth rate of total incomes of the city's population. In a conservative scenario, average per capita incomes increase by a factor of 2.3, but a relatively high consumer price index will allow only 12.6% of real growth. The base and target scenarios suggest an increase in average monthly incomes to 70.3 and 72.4 thous. rubles respectively, i.e. 29.5 and 46.8% in comparable prices.

These changes in the economic parameters of the development of the municipality "Kirov of City" will entail an increase in the revenue part of the municipal budget by 2035 under the relevant scenarios: conservative — up to 17.3 bln rubles (24.7% increase in comparable prices), base — up to 20.0 bln rubles (37.6% growth), target — up to 22.8 bln rubles (52.4% growth). Simultaneously, a significant amount of budget income will continue to be used for inter-budget transfers. Dynamics of tax and non-tax revenues of the budget of Kirov is presented on *Fig. 6*.

However, it is expected that the growth of tax and non-tax revenues, as well as fiscal security, will be somewhat slowed in the first three years of the projection period due to the effects of coronavirus infection.

In addition to the pandemic's impact, risks associated with current developments in macroeconomic and geopolitical situations should be considered. Once the relevant information is available, iterative adjustments to the model parameters will be required, but the methodological approach to its development remains relevant, so a common tools and base forecast can be applied to management decisions.

Forecast of budgetary parameters of the municipality "Kirov of City" for three scenarios is presented in the *Table*.

Table

Forecast of Budgetary Parameters of the Municipality "City of Kirov" for the Period up to 2035

Indicator name	2020	2022	2024	2027	2030	2033	2035
Growth of tax and non-tax revenues (in comparable prices), % to the previous year							
– Conservative	91.8	99.6	101.6	102.1	102.8	103.3	104.2
– Base	94.2	100.6	102.8	103.5	104.3	104.7	105.3
– Target	96.5	101.5	103.7	104.6	105.5	105.8	106.3
Fiscal capacity by income, thous. rubles / people							
– Conservative	24.8	27.4	30.6	36.8	44.9	55.4	64.3
– Base	26.2	28.7	31.8	37.9	45.8	56.0	64.4
– Target	27.4	29.9	33.0	39.0	46.7	56.6	64.8
Tax and non-tax revenues per capita, thous. rubles							
– Conservative	11.4	12.4	13.8	16.6	20.6	25.9	30.8
– Base	11.6	12.7	14.2	17.4	21.8	27.7	33.0
– Target	11.8	13.0	14.6	18.0	22.7	29.2	34.7

Source: Compiled by the authors.

Results indicate that the long-term financial parameters of the municipality "Kirov of City" are heavily influenced by demographic and economic variables. And the level of wages and incomes of the population determines the economic factors. Despite unfavorable macroeconomic and geopolitical situations, the prediction reveals that the city's socioeconomic development is usually positive purposes. It should be noted, that the growth rate of tax and non-tax revenues of the local budget is low and does not exceed 7% even in the target development scenario.

Such a resource budget requires, on the one hand, the revitalization of local government activities in order to participate in federal projects and programs, which will help to attract additional resources from higher budgets, and, on the other hand, the development of a set of measures to increase extrabudgetary sources of financing, which include stimulating investment activity in the territory of Kirov.

CONCLUSION

The analysis of existing approaches to forecasting the socio-economic development of municipalities, as well as their application, allowed for the identification of issues affecting the quality of forecasts and, as a result, the effectiveness of municipal management decisions, among which: application of trend forecasting methods, low level of statistical information support, uncoordinated forecasting for individual groups of indicators, high influence of the external environment, mismatch of long-term and short-term development priorities, limitations of scenario modeling tools.

To reduce the negative impact of the identified problem aspects, the authors substantiated, proposed, and characterized a conceptual scheme for the development of an economic and mathematical model of a municipality, allowing for the formation of a forecast of the municipality's social and long-term economic development. The proposed approach differs from the existing systematization and interconnection of the main subsystems, elements and interrelations of the municipal socio-economic system, as well as consideration of external externalities at various levels, which allows through the application of economic-mathematical modeling methods to determine the key factors influencing the predicted socio-economic parameters.

The author's approach has been evaluated in the formulation of a socio-economic development prediction for the municipality of "Kirov of City" for the period up to 2035. Given the special significance of the budgetary sphere within the municipal socioeconomic system, the authors developed a list of minimum requirements and a set of statistical indicators for the assessment, in addition to a detailed presentation of the process of forecasting budgetary parameters for the city of Kirov under three scenarios: conservative, base and target. The collected results served as the basis for the "Kirov City" municipality' socio-economic development strategy.

The authors presented an integrated strategy to developing a forecast of the municipality's socioeconomic development with an emphasis on the budgetary aspect, proposals for the formation of the Unified Interdepartmental Statistical and Information System are universal for different types of municipalities and can be used by state and municipal administration bodies.

ACKNOWLEDGEMENTS

This article was prepared in accordance with the results of the research carried out with the financial support of the Russian Scientific Foundation, project No. 23–28–00871. Financial University, Moscow, Russia.

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R. V. Fattakhov — scientific management of research, formation of scientific and methodological apparatus.
M.M. Nizamutdinov — description of methods and calculations, analysis of obtained results, formation of conclusions of the research.
O.V. Pivovarova — collection, systematization and generalization of statistical data, graphical and tabular presentation of the results, analysis of results.
V.V. Oreshnikov — calculations; verification of scientific conclusions of the paper.
P.V. Stroev — development of the research concept, formation of the article structure, selection of indicators for analysis, formulation of conclusions and their verification.

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

The article was submitted on 16.01.2023; revised on 10.02.2023 and accepted for publication on 27.02.2023.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

DOI: 10.26794/2587-5671-2023-27-3-92-104
UDC 330.43,336.71,336.74(045)
JEL C53, E44, E47, E59, D83

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Predicting the Outflow of Household Deposits Based on the Intensity of Search Queries

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ABSTRACT

The **subject** of the study is the intensity of targeted search queries as a leading indicator of bank deposits outflow. The **goal** is to propose a mechanism for accounting information about the dynamics of search queries, able to signal changes in the volumes of deposits of individuals. The study was conducted using time series analysis models. Statistical data of Rosstat, Bank of Russia, searches in Yandex wordstat, Google Trends for the period from February 2009 to May 2022 were used. The relationship between the intensity of targeted search queries and household decisions to withdraw money from deposits and bank accounts was revealed. An assessment of the short-term predictive ability of search queries on dynamics of deposits was carried out. The use of statistical indicators on the dynamics of targeted search queries as a leading indicator of the outflow of funds of the population from deposits in commercial banks is substantiated. It was revealed that the use of the intensity index of targeted search queries as a signal indicator of the outflow of the placed funds by the population increases the accuracy of forecasting on the horizon in 1 month by 0.15–0.25 p.p. to assess the dynamics of ruble deposits and by 0.20–0.35 p.p. to assess the dynamics of foreign currency deposits. The use of information from search queries for the management of commercial banks is especially useful in the event of a threat of a sharp outflow of deposits of the population. The obtained **results** indicate the prospects of using textual information, including targeted search queries in order to form leading indicators of deposits outflow of the population. Preventive identification of negative trends associated with the outflow of deposits of the population can ensure the credit institution's stability against negative macroeconomic influences.

Keywords: commercial bank deposits; search query; forecasting; management of commercial banks

For citation: **Gurov I.N., Kartaev F.S., Vinogradova O.S. Predicting the outflow of household deposits based on the intensity of search queries. *Finance: Theory and Practice*. 2023;27(3):92-104. (In Russ.) DOI: 10.26794/2587-5671-2023-27-3-92-104**

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INTRODUCTION

Individual deposits account for a large portion of commercial banks' liabilities; hence it is critical for management not to allow an abrupt outflow of cash put by the population. The management of household deposits in commercial banks is directly linked to the concept of alternative choice (trade-off), which determines the relationship between profitability and credit institution sustainability. Under favorable macroeconomic conditions, it is considerably easier to maintain the optimal equilibrium between sustainability and profitability; nevertheless, the crisis dictates stochastic processes, which might result in imbalances. When applied to the subject of the research, the crisis may cause a cash outflow from the population's commercial banks, an increase in the cost of attracting new deposits, and a significant change in their structure. As a result, when prospective changes in household behavior are identified in advance, bank management can take necessary actions to minimize negative effects.

Before making financial decisions or taking active activities, contemporary economic actors must examine information by constructing relevant Internet queries. In particular, if you focus on research processes in online retail in Russia, the share of which is growing rapidly and in 2022 is about 10%,[1] then even before buying in offline stores, many consumers search and compare offers in the Internet. The share of advertising budgets that are directed to the online segment is growing steadily.[2] Sales of financial products has become increasingly established through online channels. All this determines the greater level of involvement of economic agents in online processes and, accordingly, identifies the relationship of behavior of the population with their targeted requests on the Internet.

Despite the existence of scientific articles in which the dynamics of search queries are used as the leading indicator [1–5], as well as factors of population dynamics of deposits [6–9], no works on the forecasting of the dynamics of deposits taking the intensity of targeted search queries are presented in the scientific literature. Therefore, the goal of this study is to develop a mechanism for recording information on the dynamics of search queries, able to signal in advance changes in the deposits of individuals in commercial banks. To achieve this goal, it is necessary to solve the following tasks: (1) the relationship between the intensity of search queries and the desire of households to close deposits and withdraw money from bank accounts was substantiated; (2) the influence of the population's bank deposits on the intensity of search queries was evaluated; (3) the use of statistics on the intensity of targeted search requests to obtain a forecast of the outflow of deposits of the population from commercial banks was substantiated.

Under conditions of macroeconomic volatility, which is characteristic of the current stage of development of the Russian economy, there is a high volatility of the level of confidence in the banking system. This is confirmed, for example, by households' willingness to withdraw form bank accounts in response to external negative macroeconomic signals. In the academic literature this mechanism is described on the example of studying the crisis of confidence in the closed and open economies of different countries. There have been found regularities and models of crisis development of this type: model "short of a bank run" [10] and model "bank panic" signals. [11]. In these models, investors want to withdraw money from commercial banks in the face of a serious deteriorating in the macroeconomic environment, hence generating a larger gap between the lending institution's obligations and assets. The bank's imbalances, especially in the context of macroeconomic instability, have a negative impact on the sustainability of the credit

[1] According to the Association of Internet Trade Companies. URL: https://akit.ru/analytics/analyt-data (accessed on 14.08.2022).

[2] According to the Association of Communications Agencies of Russia. URL: https://www.akarussia.ru/knowledge/market_size/id10015 (accessed on 14.08.2022).

institution and its ability to resist the crisis.

According to model D. Diamond and P. Dybvig [10] the banking panic process — is self-sustaining, i.e. when disseminating information about the deterioration in the ability of the bank to meet its obligations in a timely manner, an increasing number of depositors seek to recover their funds from the accounts of the credit institution, thereby negatively affecting its continued ability to issue funds. In the paper of A. Postlewaite and X. Vives [12] "bank panic" is considered as a spiral process, which on each new turn creates a larger gap in the structure of liabilities and assets of the credit institution, leading the bank to bankruptcy. Behavioral theories explain the mechanism of bank panic, characterized by the massive withdrawal of deposits by the population, the notion of "philosophy of the crowd" [13] when there is a general panic that spreads, initiating the actions of economic agents (for example, on withdrawals from commercial bank accounts).

Analyzing the prerequisites for the emergence of "bank panic" and considering the gradual development of this process, it is possible to assume that in the framework of identifying behavioral tendencies in the population, it is prudent to take into account the characteristic patterns of behavior of economic agents, particularly the frequency of targeted searches. Understanding public sentiments as reflected by appropriate Internet queries prior to making financial decisions and taking active actions will allow commercial bank management to proactively adjust its development strategy, thereby increasing the credit institution's sustainability.

In the papers of F. Allen, D. Gale [14] and V. Chari [15] the market mechanisms of maintaining the stability of the credit institution through changes of interest rates on active and passive operations in response to changes in the mood of depositors are defined. But the implementation of such a strategy by the management of the commercial bank is necessary and appropriate only in the case of identification of panic.

Prompt identification of the mood of economic agents is possible on the basis of text processing. Thus, the study [2] proposes a strategy for forecasting Russian population inflationary expectations using machine learning algorithms based on news monitoring on the Internet. The result is generalized in the work of A.A. Pestova and co-authors [16], which developed a system of indicators of financial instability based on high-frequency data. These studies demonstrate that the inclusion of text information in the network allows to improve the quality of forecasting of some key macroeconomic indicators, as well as to describe the dynamics of expectations of the price level and the exchange rate of the national currency. This paper contributes by demonstrating the capacity to use text data analysis to enhance estimates of changes in public deposits.

In a number of studies, textual information on the Internet, in particular from social media, has been used to assess investor sentiment and predict capital market conditions [1, 4, 5]. In the paper of T. Preis and co-authors [17] based on Google search query data, we managed to obtain indicators that identify scenario behavior of investors in the stock market, which, in the opinion of the authors, can be used to early identify a potential financial crisis.

The paper of G. Kurovskiy [3] shows that the data of search queries in Google and Yandex allow to improve the quality of forecasts of unemployment dynamics, as well as developed a methodology that can be used to predict macroeconomic indicators in the short term, including for nowcasting.

Thus, in most studies, the significant relationship between the dynamics of key macroeconomic indicators and the frequency of search queries was identified. At the same time, proactive identification of household actions that can lead to the outflow of bank deposits is necessary both to ensure the activities of a separate commercial bank and to maintain the stability of the financial system. As a result, the

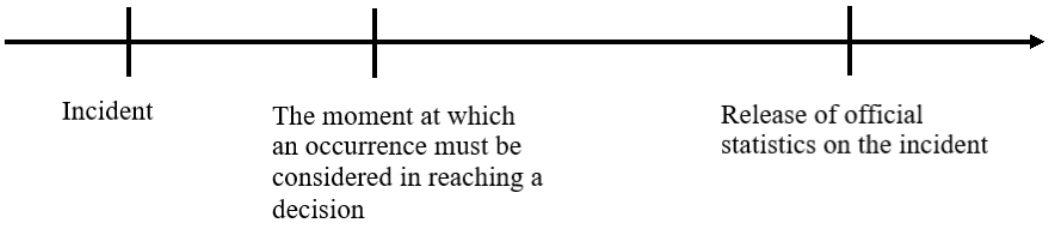

Fig. 1. **The Time Structure of the Event, the Release of Official Statistics and the Moment to Make Decisions**

Source: Compiled by the authors.

main research hypothesis is that using data on the intensity of focused search searches allows forecasting people' actions to withdraw cash from deposits.

SEARCH QUERIES AS A SOURCE OF INFORMATION ON THE DYNAMICS OF POPULATION DEPOSITS

As more and more information is available to households on the Internet, they are more likely to search through search services before making a decision to close a deposit, withdraw money from a bank account and then allocate it. n Russia, more than 98.5% of search traffic is accounted for by Yandex and Google systems,[3] so in these systems should be expected to increase the intensity of queries that may indicate the intention of individuals to close deposits and withdraw funds.

In the context of macroeconomic instability, there are risks of sudden shocks that transformation into the willingness of economic agents to close deposits and withdraw money from bank accounts. Thus, due to panic and growing general uncertainty, the population may make "short of a bank run", which will lead to a sharp outflow of client funds. Considering the specifics of the Russian financial system, the risks of ruble outflows and foreign currency deposits should be examined individually. The reasons for the decisions to close ruble deposits may include general fears about the possibility of withdrawing or using non-cash rubles as a means of payment, the expected devaluation of the ruble, the sharp rise in inflation [18–19]. The main reason for decisions to close foreign currency deposits is the fear that they may be withdrawn or used in the future. Not all deposit outflows have undesirable condition. Due to a lack of demand for foreign exchange borrowing and significant risks, several banks began to actively cut foreign exchange liabilities in mid-2022.

Information on search queries can be obtained in real time, which makes it possible to use it for the purpose of studying economic indicators, in particular forecasting the dynamics of deposits of the population. Macroeconomic statistics are published with lag, which prevents such efficiency (*Fig. 1*).

DATA AND AN EMPIRICAL STRATEGY

Methods such as synthesis, analysis, descriptive and correlation analyses were used in the study of the relationship of intensity of targeted search queries and dynamics of deposits of the population. Quantitative study with time series analysis models was conducted.

The research used monthly data from February 2009 to May 2022 (160 observations). Data have a time structure. Due to the non-stationary of variables, the first differences were used in the calculations, which are stationary.

Sources were databases of Rosstat, Bank of Russia, data on search queries Google Trends and Yandex wordstat. Since the data

[3] According to Yandex.Radar. URL: https://radar.yandex.ru/search (accessed on 14.08.22).

Table 1

Search Queries Used in the Study

Query text	Orientation to:	Implied influence mechanism
Deposits	Search	Increased intensity reflects interest in bank deposits, which can result in both deposit inflows and outflows.
Inflation		The increase in queries intensity reflects the interest in price increases; it will result in the outflow of ruble deposits and, maybe, the inflow of foreign currency deposits.
Ruble exchange rate		Increased intensity of queries reflects devaluation expectations, will lead to outflow of ruble deposits
Exchange rate		
Default		
What will happen to the ruble?	Forecast	
What will happen in Russia?		
Withdraw dollars	Action	An increase in the number of queries expressing the desire to withdraw funds from bank accounts (both in foreign currency and in rubles for eventual conversion into cash foreign currency) will result in an outflow of deposits.
Withdraw euros		
Where to buy currency?		

Source: Compiled by the authors.

on the intensity of search queries in Yandex are available only for the last 24 months, the assessment used the approach suggested in the paper of G. Kurovskiy [3].

The following equation was used to assess the dynamics of household ruble deposits while taking information from search queries into consideration:

$$\ln(DEP) = const + b_1 S + b_2 X + \varepsilon, \qquad (1)$$

where DEP — amount of ruble deposits of households; $const$ — constant; S — proxy search query intensity; X — set of control variables explaining the deposit volume dynamics; b_1, b_2 — coefficient vectors; ε — regression error.

The search queries used in the research were conditionally divided into three types:

- aimed at searching for information;
- aimed at forecasting;
- aimed at action.

The research used data on the intensity of the following search queries (*Table 1*).

Fig. 2 shows dynamics of intensity of search queries.

Since a number of factors influence the dynamics of deposits of the population, the following indicators are used as control variables [8, 9]:

- natural logarithm of money supply M2 in national definition;
- return exchange rate of dollar to ruble and euro to ruble;
- ruble inflation over the last 12 months;
- rates on bank deposits in rubles $DepRate_{RUB}$, in dollars $DepRate_{US}$ and euros $DepRate_{EUR}$ with a maturity of up to 1 year;

Fig. 2. **Search Query Intensity**

Source: Compiled by the authors based on data from Google Trends, Yandex wordstat.

Table 2

Descriptive Statistics of Variables

Variable	Min	Average	Max	SD
Growth of household ruble deposits, (%)	–4.1	0.9	7.0	1.9
Growth of household foreign currency deposits, in ruble equivalent, (%)	–17.4	0.7	18.2	4.7
Growth of household foreign currency deposits, in dollar equivalent, (%)	–21.5	0.1	5.6	2.8
Growth of money supply M2, (%)	–4.2	1.1	10.7	2.3
Annual ruble inflation, (%)	2.2	6.8	17.8	3.4
Return exchange rate of dollar to ruble	29.0	57.0	93.6	16.4
Rate on bank deposits in rubles, (%)	3.2	6.2	18.8	2.4
Rate on bank deposits in dollars, (%)	0.4	1.5	6.4	1.3
Rate on bank deposits in euros, (%)	0.1	0.9	5.2	1.2
Spread between deposit rate and zero-coupon yield in rubles, (%)	–3.8	–1.5	18.8	2.2
Spread between deposit rate and zero-coupon yield in dollars, (%)	–1.4	0.6	5.4	1.5
Spread between deposit rate and zero-coupon yield in euros, (%)	0.8	1.4	5.3	1.0

Source: Calculated by the authors based on Rosstat and Bank of Russia data.

Note: SD — Standard Deviation.

- spreads between the average deposit rate and the zero-coupon yield on sovereign debt:

$$Spread_{RUB} = DepRate_{RUB} - YTM_{RUB},$$
$$Spread_{US} = DepRate_{US} - YTM_{US},$$
$$Spread_{EUR} = DepRate_{EUR} - YTM_{EUR},$$

where $DepRate$ — average rate on bank deposits with a maturity of up to 1 year; YTM — yield to maturity of sovereign bonds in the respective currency with a maturity of up to 1 year.

Autoregression models are often used to predict indicators [3, 19, 20]. This paper used forecasts based on both the ARIMA model and the simple least squares method, with the addition of ruble deposits from households with a lag of 1 and 12 months to explain the natural logarithm variables, which allows you to take into account the potential trend and cyclical components of the dynamics of deposits. All models included control variables.

Descriptive statistics of variables are given in the *Table 2*.

In general, the set of control variables accurately describes the dynamics of population deposits (corrected coefficient R^2 exceeds 75%). However, many of these indicators refer to the same month as the change in the amount of deposits, and become visible after the end of this month (for example, for various specifications, it is robust to estimate an increase of 0.7–0.8% in deposits per 1% of M2 money supply growth, but statistics on this increase are published after the end of this month). When modeling for the purpose of research, preference was given to specifications in which the dynamics of deposits for each month are

Table 3

Model for the Dynamics of Ruble Deposits of the Population Based on Search Queries

Search query	St. forecast error in the pseudo-sample period (July 2021 — March 2022)	MAE for the pseudo-sample period (July 2021 — March 2022)	The significance of the regressor in the dynamics of search queries	Akaike Criterion
–	1.33%	1.05%	–	–592
Deposits	1.18%	1.05%	–	–591
Inflation	1.32%	1.20%	***	–597
Ruble exchange rate	1.13%	0.96%	**	–595
Exchange rate	1.17%	1.01%	***	–597
Default	1.12%	0.99%	***	–603
What will happen to the ruble?	1.07%	0.98%	***	–624
What will happen in Russia?	1.01%	0.89%	***	–604
Withdraw dollars	1.02%	0.80%	***	–601
Withdraw euros	0.91%	0.81%	***	–602
Where to buy currency?	1.19%	0.98%	*	–594

Source: Calculated by the authors.

Note: * significant at 10%; ** significant at 5%; *** significant at 1%.

established on the basis of information known at the beginning of the corresponding month, as they are more appropriate for predicting.

RESULTS AND DISCUSSION

The results indicate the use of search query data in the formulation of leading indicators for operational risk management in the context of macroeconomic insecurity.

Table 3 shows that the inclusion in the model of information from search queries increases the predictability of withdrawals from ruble deposits. The improvement in forecast accuracy is 0.05–0.25 p.p. (with a standard deviation of the dependent variable of 1.73%). Most estimates of coefficients at the variable popularity of textual queries are significant and negative, which suggests that the growth of the number of such queries is an earlier indicator for the outflow of ruble deposits of the population. On average, queries expressing worry about the ruble exchange rate and calls for action caused the fewest prediction mistakes. Dynamics queries aimed at searching for information also had

Table 4

Dynamics of Foreign Currency Deposits

Period	Increase in foreign currency deposits of the population, nominated in dollars	Increase in foreign currency deposits of the population, nominated in rubles
01.02.22–01.03.22	–21.5%	18.9%
01.03.22–01.04.22	–0.2%	–11.5%
01.04.22–01.05.22	–1.3%	–16.1%

Source: Calculated by the authors based on data from the Bank of Russia. URL: www.cbr.ru

Table 5

Model for the Dynamics of Foreign Currency Deposits of the Population Using Information on the Search Queries

Search query	St. forecast error in the pseudo-sample period (July 2021 — March 2022)	MAE for the pseudo-sample period (July 2021 — March 2022)	The significance of the regressor in the dynamics of search queries	Akaike Criterion
–	6.58%	2.91%	–	–410
Deposits	6.57%	2.87%	–	–409
Inflation	6.56%	2.92%	–	–409
Ruble exchange rate	5.91%	2.72%	***	–432
Exchange rate	6.47%	2.91%	–	–408
Default	6.53%	2.93%	–	–409
What will happen to the ruble?	6.50%	2.91%	–	–408
What will happen in Russia?	5.91%	2.71%	***	–435
Withdraw dollars	5.46%	2.57%	***	–464
Withdraw euros	7.19%	3.22%	***	–422
Where to buy currency?	6.62%	2.93%	–	–408

Source: calculated by the authors.

Note: * significant at 10%; ** significant at 5%; *** significant at 1%.

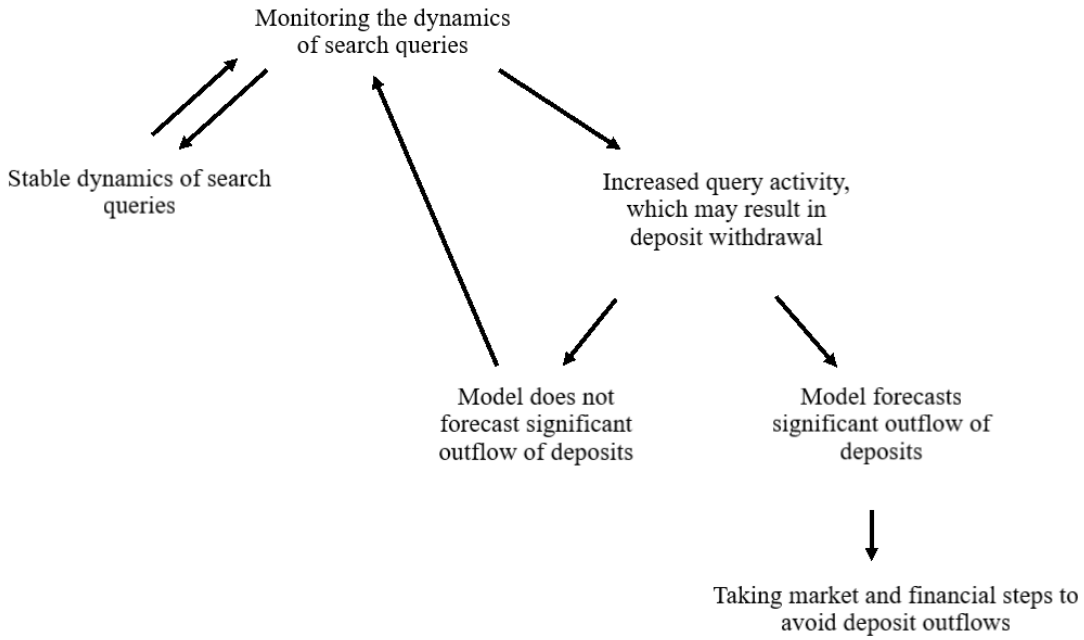

Fig. 3. **Operational Monitoring of the Intensity of Search Queries**

Source: Compiled by the authors.

a negative impact on the dynamics of ruble deposits.

The analysis of the impact of the intensity of search queries on the dynamics of foreign currency deposits was conducted. Statistics on the volume of foreign currency deposits are published in ruble. However, for the present research, it is important to analyse the evolution of foreign currency deposits expressed in a major foreign currency. Indeed, *Table 4* shows that in February 2022 the volume of foreign currency deposits, expressed in rubles, increased, which, however, is connected with the weakening of the ruble. The outflow of foreign currency deposits almost stopped in March-April, but the volume of foreign currency deposits, expressed in rubles, declined in these months, due to the appreciation of the ruble.

Table 5 presents forecasts of currency deposits expressed in US dollars. Similar results are obtained with the use of a bicurrency basket consisting of 50% of US dollars and 50% of euros. Forecasting of the dynamics of currency deposits of the population is comparatively less accurate (the standard error of the forecast is about 5 times higher, and the average absolute error of the forecast is about 2.5 times higher than when forecasting the dynamics of ruble deposits of the population). However, the inclusion of search queries, especially those expressing concern about the exchange rate of the ruble, allows to increase the accuracy of the monthly forecast of the dynamics of currency deposits of the population by 0.20–0.34 p.p. The improvement of forecasting accuracy is observed when using indicators that directly or indirectly express concern about the exchange rate of the ruble in the future and are also action-oriented. At the same time, the inclusion of some requests, such as those indicating a desire to exit from the euro, reduces prediction accuracy.

The study examined the prediction ability of models for various off-sample intervals. The inclusion of information on the intensity of search queries allowed to increase the accuracy of forecasting ruble deposits of the population not only at the beginning of March 2022, but also in the following months — at the beginning of April and May 2022. Foreign currency deposit forecasts for early April and May 2022 were less accurate compared to early March 2022. This

might be because, by April, aggressive efforts had been taken to halt the outflow of cash from bank deposits: the refinancing rate had been raised, and limitations on the withdrawal of foreign currency from settlement accounts had been imposed.

Comparable results of forecasting of rouble and foreign currency deposits were also obtained using MNCs with the addition of indicators of intensity of search queries, control variables, lagged dependent variable (with lags 1 and 12 months).

Thus, the main research hypothesis is confirmed, the data search queries allow to increase the accuracy and efficiency of forecasting the dynamics of ruble and currency deposits of the population and at the same time can be used to prevent undesirable outflow of deposits. Online monitoring of search queries can be organized as follows to avoid deposit outflow (*Fig. 3*).

The study was conducted using monthly observations. Within the month, the impact of search queries on deposit dynamics is even more significant. High performance of textual information to predict household financial decisions can be observed in nowcasting for short periods (within one week). In conditions of macroeconomic instability, it is efficient forecasting on such a horizon that is especially important, in order to manage to undertake necessary measures. Banks will be able to generate such estimates over any short-term horizon since they have immediate access to their own information on the evolution of deposits.

CONCLUSION

An increase in the frequency of search inquiries reflecting households' plan to withdraw money from ruble deposits or convert money into currencies precedes active household activities. Information on the intensity of search queries determines the possibility to anticipate the outflow of deposits and, based on the projected potential change, to take measures aimed at preventing undesirable outflow.

The results of the study lead to the conclusion that in the innovative model of development of fintech-directions in the banking sector of the Russian Federation it is advisable to distinguish one of them, in the framework of which methodological bases of formation of leading indicators of population behavior as a reaction to macroeconomic instability will be created, based on analysis of big data. It is vital to continuously monitor the risks of unwanted outflows of deposits of persons from commercial banks based on changes in the frequency of targeted search queries of the public. To build forecasts it is advisable to use data on the frequency of search queries from search Yandex and Google systems. It was revealed that among the search queries have the greatest predictive ability, those in which directly or indirectly express concern about the future rate of the ruble. To assess the potential change in the volume of ruble deposits of the population, it is advisable to use the following formulations: "default", "what will happen in Russia", "what will happen with ruble", "exchange rate of ruble", "withdraw dollars", "withdraw euro". For currency deposits the most predictive ability are the requests of "ruble exchange rate", "what will happen in Russia", "withdraw dollars". The use of data on the intensity of such requests makes it possible to increase the accuracy of forecasts of outflow of ruble deposits on a 1-month horizon by 0.05–0.25 p.p., currency deposits — by 0.2–0.34 p.p.

To guarantee the bank's financial stability, prompt action is required to avoid undesirable outflows of deposits. Monetary authorities and commercial banks can utilize data on the intensity of search searches as part of nowcasting, predicting deposit cash outs, and taking rapid and early action based on collected projections to avoid undesirable deposit outflows.

It is recommended to monitor the dynamics of search queries in online. When there is a rise in the number of searches that directly or indirectly signal the desire of economic agents

to withdraw funds from deposits targeted at retaining bank deposits, marketing and financial actions (depending on the sources of prospective outflows) are suggested.

ACKNOWLEDGEMENT

The research funded by Moscow State University in the priority area of state task scientific research "Development of economic theory based on system analysis and formation of the Russian model of innovative economy": "The current stage of development of the financial system of Russia using financial technologies (Fintech)", the grant topic: "Innovative model of development of fintech directions in the banking sector of the Russian Federation in the context of macroeconomic instability". M.V. Lomonosov Moscow State University, Moscow, Russia.

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

The article was submitted on 31.08.2022; revised on 15.09.2022 and accepted for publication on 06.12.2022.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-105-114
UDC 336.11:336.77(045)
JEL G01, G14, G21

Finance in Russia and the World: Conceptual Aspects

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ABSTRACT

The modern digital economy requires "new finance". The **subject** of the study is to clarify their content, and the **goal** is to develop the author's view of the term of "finance". The **relevance** of the topic is dictated by the need to analyze complex theoretical questions of technological transformation of financial markets and activities of financial intermediaries. The **scientific novelty** consists of the theoretical contribution of the theory of finance evolution in the digital era. The main **research methods** are systemic and logical approaches, the method of theoretical cognition, the historical method and the method of scientific abstraction. The results of the study are clarification the essence of finance and applied issues of their use in Russia and abroad. It will contribute to the development of a scientific doctrine of digital assets circulation; will allow to refine the model of the activities of financial intermediaries' regulation in our country and lay the foundation for the formation of global norms and rules for the development of national and international financial markets of the CIS, the EAEU, the SCO, and BRICS countries. The **conclusions** of the study are: a) confirmation of the author's position on the essence of finance. The paper indicates that, in the context of the economy's digital revolution, the substance of economic categories stays constant, although their forms vary according to innovation, behavioral characteristics, and other factors; b) without rejecting the rational knowledge formed in the Western scientific school, the authors emphasize that the social sciences cannot be global, they have a national character; c) based on the investigation, the author defines "finance" as a distribution category in the development and utilization of financial resources.

Keywords: finance; financial system; financial market; financial intermediaries; business model; platform-type company; ecosystem

For citation: **Panova G.S., Larionova I.V. Finance in Russia and the world: Conceptual aspects. *Finance: Theory and Practice*. 2023;27(3):105-114. DOI: 10.26794/2587-5671-2023-27-3-105-114**

INTRODUCTION

Any science can only progress if its subject and object are properly defined. The science of finance — is no exception. It has a centuries-long history that dates back to Ancient Egypt, Assyria, Babylon and Greece. Etymology of the term "finance" derives from Latin "finis" — limit, border. The term "finance" (from the French "finances") meant the management of the financial affairs of the State. It was first used in Europe in the 17th century.

The systematization of financial science extends back to the late 18th and early 19th centuries

In the era of feudalism and the period of initial capital accumulation, issues of finance are presented in the papers by D. Caraffa (1406–1487), Niccolo Machiavelli (1469–1527), Jean Bodin (1530–1596), Giovanni Botero (1530–1596), Johannes Justi (1720–1771), Joseph Sonnenfels (1732–1817), Karl Rau (1792–1870) [1–2] etc.

Representatives of the German school made significant contributions to the development of finance theory in the late 19th and early 20th century. The "classical theory of finance" was formed, the main thesis of which is considered to be the idea of finance as a set of administrative and economic knowledge on the management of the State's finances through the raising and spending of funds. Its founders were K. Rau (1867), F. Nitti (1904), V.A. Lebedev (1882); L. Cossa (1990) [3–5]. This interpretation was then expanded to include funds (i.e. not only money but also tangible assets) belonging to municipalities, counties, lands, etc.

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The First World War, the October Revolution in Russia (1917), the construction of a planned economy in the USSR led to the fact that the development of the science of finance stalled and only in the middle of the 20th century appeared new papers of Soviet and foreign scientists. The publishing analysis indicates a debate concerning the conceptual apparatus of finance science, highlighting two primary approaches — Western and Soviet.

In the *Western interpretation* based on cameralism,[1] finance was seen as the management of public revenues. By the beginning of the 20th century, the main types of finance were identified: public, corporate and personal.

The science of Soviet about finance, not rejecting the Western approach, was adapted to the conditions of the planned economy. Three main scientific doctrines of finance were formed in the USSR: reproductive, distributive and legal. Representatives of these scientific schools interpreted finance as an economic category, i.e. industrial relations arising between the subjects of the economy.

The distribution concept was predominant and revealed the essence of finance through their distributive function. Its representatives were V. P. Dyachenko, L. A. Drobozina, V. M. Rodionova, G. B. Polyak, V. I. Shchedrov, V. E. Cherkasov, S. I. Lushin, S. V. Barulin, N. G. Sychev, V. G. Chantladze [7–10].

The author of the *reproductive concept* of finance was A. M. Alexandrov. Defining "finances of socialism", he did not divide the monetary relations of organizations into distributive and reproductive, considering that they represent a single whole in the process of "enabling the production process". This concept was followed by A. I. Arkhipov, D. A. Allakhverdyan, P. S. Nikolsky, V. K. Senchagov [9, 11, 12], etc.

According to the *legal concept*, which is often called the concept of E. A. Voznesenskii,[2] finance — is a system of monetary relations, which have an imperative form, i.e. the exception were only personal finances.

In the traditional course of domestic economic science, finance was accepted to be interpreted, on the one hand, as industrial relations, and on the other — as flow of funds. Finance was considered as one of the most difficult economic categories in textbooks; it was defined as all aspects of cost flows linked to the mobilization, distribution, and use of monetary resources.[3]

Extended and narrow interpretations of the concept of "finance" are used in modern world practice. In a broad sense, finance is defined as the movement of all economic categories, including monetary. This approach prevails in American scientific literature. In analyzing the formulation and use of the budget and/or other money, a narrow interpretation of the term "finance" is used.

The classical science of finance "moved" into a practice around the beginning of the 20th century, becoming *neoclassical*. The focus on financial resources and their use is identifiable in the papers of V. V. Kovalev (2001, 2002) [12], R. H. Parker (1992), L. Gitman (1989) [8] etc.

Z. Bodie and R. Merton [13] defined finance as a scientific discipline that studies the distribution of scarce funds in time and uncertainty, emphasizing that "finance — it is the science about how the people lead spending the deficit cash resources and incomes in the definite period of time". J. C. Van Horne held a different position, arguing that "finance — is primarily concerned with cash additions and cash flow" [14].

Later publications, such as D. Brümmerhoff "The Theory of Public Finance" suggest that "...the subject of finance is public finances, it is connected with the analysis of the public sector, the use of state revenues and expenditures, which are reflected in the state budget" [15].

The current stage of the financial science development is characterized by the effect of the

[1] Cameralism is a science that studies the development and use of state treasury funds for the purpose.

[2] Gryaznova A. G., Dumnaya N. N., Yudanov A. Yu., Ed. Economic theory: express course. Textbook. M.: Knorus; 2005:381, 382.

[3] See ibid.

Fourth Industrial Revolution, changes in people's behavioral stereotypes, and their attitude to usual business and phenomena. Digital transformation affects almost all aspects of life. The *forms* of economic categories are changing (new form became digital currencies), as well as ways of communication, interaction of financial intermediaries and their clients (remote forms of service; the use of artificial intelligence, robots); business models of financial intermediaries (there are hybrid forms, platform type companies, non-banks, ecosystems).

When, on the one hand, finance is equated with money and credit, blurring the limits of these concepts, and on the other hand, under the conditions of the implementation of the pilot project for the release of digital ruble, the media makes statements that money is a smart contract, and the financial system is a financial market, there are claims that banks will soon die, and financial transactions will be made directly from the budget. Obviously, there is a need to clarify the conceptual framework of the science of finance, define the positions of scientists and practitioners on conceptual issues of the essence of finance, money and credit.

We used bibliometric analysis based on the software product VOSviewer v.1.6.10, which allowed to demonstrate the frequency of mentioning and reference to theory and empirical data on finance, for visually illustrate the relevance of problems of finance theory.

1 446 scientific publications indexed in the Scopus International Science Metric Database in 2021 were selected to formalize the content analysis of research conducted in the scientific environment on finance (keyword "finance") by category "Economics; Econometrics; Finance and Business"[4] (see *Fig.*).

The frequency of references to the phrase "finance", as indicated in the *Figure*, clearly illustrates the problem's importance.

[4] Scopus. 2021. Documents search. URL: https://www.scopus.com/search/form.uri?display=basic#basic (accessed on 21.05.2023).

METHODOLOGY

The methodological basis of the study was the review, analysis and synthesis of the works of domestic and foreign scientists; legislative and regulatory acts on finance, link between theory and practice in the new digital economy. As the main methods of research system and logical approaches, the method of theoretical knowledge was used, as additional: historical and scientific abstraction method. The analysis was based on the materials of international financial and credit institutions and national financial regulators.

RESULTS

There are two types of modern conceptual approaches to understanding the basic principles of finance. A particular group of scientists sees finance as a wide economic category that absorbs and dissipates money and credit. Another group understands finance narrowly, emphasizing that finance has specific features that set it separate in the system of economic categories. It is this position that seems to us to be economically and logically justified.

The science of credit as a distinct economic category in comparison to the science of finance was born relatively recently. The major contributions to its development, which were based mostly on the reproductive notion, were made by: Z.S. Katsenelenbaum, I.I. Trachtenberg, G. A. Schwartz, Yu. E. Schönherr, M. S. Atlas, N.D. Barkovsky, I.V. Levchuk, O.I. Lavrushin, V. I. Rybin, M. A. Pessel and others. V.S. Gerashchenko, V.S. Zakharov, L.I. Kolychev, R.V. Korneeva, N.I. Valentseva, I.D. Mamonova, and M.M. Yampolsky also received important research credit.

The papers of E.A. Voznesenskii (1985), I. M. Croll (1983), and F. S. Masarygin (1982) emphasized the qualities of the loan, resulting in a similarity and contrast with the categories of finance and money. In particular, the connection of credit with money was not denied, but it was stressed that the monetary nature of the relationship does not yet express the essence of credit and credit

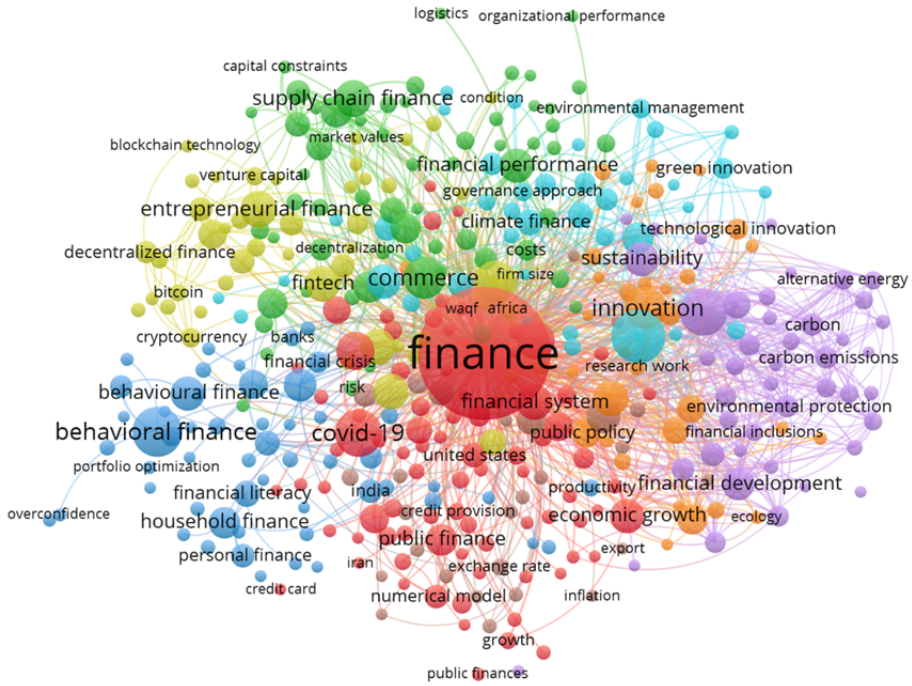

Fig. **Etymology of the Word "Finance" in 2021**

Source: Built by the author using VOSviewer v.1.6.10 based on Scopus data.

relations. A.M. Birman [18] correctly pointed out that monetary form does not determine other economic categories such as finance. Participation of money in intermediation of financial relations does not turn finance into a money category [20].

The main motive for the differences between credit and finance is the cost. Before acting in the form of finance, value can manifest itself in monetary form in the form of profits, wages, depreciation, etc. The distinction between credit, finance, and other economic categories is based on their relationship to cost rather than their participation in monetary transactions. The focus of credit and finance study is frequently transferred to the presence of *monetary* relations rather than the *value* of categories, resulting in a lack of attention to the specific features of finance and credit, leading to their being equated. Similarly, the credit nature of money does not mean that money has a credit quality. In the process of lending, there is a credit issue of money that enters the money circulation, but does not acquire a new essence, the properties of the loan.

In the discussion about the relationship between finance and credit, some economists argued that there is repayment in financial relations, i.e. they become credit [19]. However, the main difference of the return movement of value is the credit "squared recurrence", which is not peculiar to finance. "Squared recurrence" implies the completion of a circular turnover of the value at its starting point (the first phase), the second comes at the transfer of a part of the returned value as a percentage, as payment of the consumer cost of credit to the real owner — creditor" [21].

Funds of the budget or other state funds can be channeled in the form of "credit" and reimbursed, for example, after the implementation of state projects and programs or the commissioning of facilities, etc. In this case, the budget is not provided to the recipients irrevocably, not just spent. They have a social effect [9] and can be

profitable, but in this instance, the refund has additional consumer qualities.

The confusion of concepts inevitably leads, firstly, to a *decrease in the role and the cessation of the existence of economic categories*

Broad interpretation of the essence of economic categories complicates their use in science and practice, leveling specific tools of financial and credit methods in the economy. No wonder that O.I. Lavrushin wrote: "Since credit may be other value formations, its limits are mobile, changeable, but always express the essence of credit; deviation from this essence means breaking the limits of the substantive application of credit, ending its existence" [19]. This approach is applicable to the definition of the essence of finance as an economic category.

The mixing of the concepts of "money", "finance" and "credit" actually level the limits of these economic categories, does not allow to define clearly the necessity and expediency of their use in different conditions. In this sense, we agree with M.A. Pessel, who said: "The essence of money, finance, credit, and other economic categories is represented in their functions, and money and finance functions differ. Finance, credit, prices and other economic categories are based on the functioning of money, but this does not mean that these categories are money by themselves" [20].

The following ideas regarding the essence of money are prevalent in current science. "Money can be anything that individuals take in exchange for money in order to perform their functions".[5] "Money, any common means of payment that can be exchanged for goods and services and used to pay debts. One of the two most important categories of any commodity economy. Money — is a special commodity, universal equivalent, form of value of all other goods".[6] All of this emphasizes specific characteristics of money. However, all economic categories have their own manifestations. The classification of forms of money includes: full-fledged (the value of which corresponds to their nominal value); symbolic or inferior (the value of which is below their nominal).[7] The emergence and expansion of crypto currencies, and later state digital currencies, served as a trigger for discussion about forms of electronic money. The place of digital money in economic science is still discussed, and in practice they are gradually gaining the world financial markets.

In contrast to money and finance, credit is usually defined as a form of repayment of funds in the economy. The definition of credit, which became anthological, indicates that *credit* — is a form of movement of funds on the terms of repayment, used to attract and direct them to the purposes of expanded reproduction and meeting the needs of the population.

The main *forms of credit* classify: a) by subjects (banking, commercial, state, consumer, personal, usurious, international, etc.); b) by physical properties (monetary, commodity, mixed); c) by repayments (cash and natural).

Given specific features of finance and credit, two ways of fund-raising and use are separated based on the type of the money released: credit and budget. *The budget method* is characterized by the fact that the accumulation of funds and their use is irrevocable (companies send funds to the budget in the form of mandatory payments, irrevocably, the State provides funds to budgetary organizations also irrevocably). *The credit method* assumes that the accumulation of funds and their use is carried out on the terms of return and payment.

In contrast to money and credit, the diversity of interpretation of the essence of finance is due to the different objectives of using this definition (academic or applied approach). Finance is sometimes described as "a general economic term referring to both monetary funds, financial resources as they are created and moved, distributed and redistributed, and economic relations conditioned by mutual

[5] Russian Banking Encyclopedia. M.: ETA; 1995:133–134.

[6] Raizberg B.A., Lozovskiy L. Sh. Dictionary of Modern Economic Terms. 4th Edition. M.: Iris-press; 2008.

[7] Russian Banking Encyclopedia. M.: ETA; 1995:133–134.

settlements between economic entities, monetary circulation"..[8]

The term "finance" is defined in several ways in contemporary Russian scientific and educational literature. In the textbook "Finance" by L. A. Drobozina, we reviewed: "Finance is the economic relationship associated with the creation, distribution and use of centralized and decentralized funds of money for the performance of the functions and tasks of the State and the provision of conditions for expanded reproduction".[9]

In the textbook "Finance" by A. G. Gryaznova and E. V. Markina,[10] finance is defined as "a set of monetary relations regarding the distribution of the value of GDP, income from foreign economic activity and part of the national wealth, as a result of which monetary incomes, receipts and savings are formed from individual business entities, the state, used in the future to solve economic and social problems".[11]

Secondly, *different approaches to understanding the economic essence of finance give rise to discussions regarding the scope of financial relations, methods of formation and use of financial resources, the composition of participants in financial relations, etc.*

The definition of the relationship between the economic essence of finance and external forms of manifestation of the category of finance, relationships of theory and practice are important. At the same time, the absence of defined limits in the definitions of "finance" and "credit" leads to concept confusion, with phrases such as *financing and lending* used as synonyms.

It is therefore important to consider the limits of finance in relation to their functions and roles in the economy. Otherwise, the differences between the sources of money used in the financing and lending process of end users (recipients of financial resources or borrowers) are eliminated. In foreign publications, these concepts are often used as synonyms, which is reflected in Russian practice. Banks are not financing, but they do provide project finance, trade financing and structural financing. These terms appeared in Russian banking turnover from foreign practice. However, experts clearly understand the essential differences between these terms.

Blurring the limits between financial and credit resources leads to differences between financial intermediaries — financial companies and banks, for example. In these circumstances, risks are rising, and they multiply by the global economy's insecurity, the global recession, regional imbalances, more frequent crises, and sanctions.

Thirdly, *the ambiguity of the interpretation of the essence of finance, money and credit leads to the leveling of differences between such concepts as the financial system, the monetary system and the credit system*.

The essence and role of these concepts are determined by the national features of development and society's economic structure. Modern publications often use the financial system and the financial market as synonyms, which is unacceptable.

The Financial and Credit Encyclopedic Dictionary presents the authors' broad view of the financial system, which is defined as "set of interrelated and interacting parts, links, elements directly involved in the financial activity and contributing to its implementation...and consists of *financial institutions* (organizations, institutions conducting and regulating financial activities, Ministry of Finance, Treasury, Central Bank, Tax Office, Tax Police, stock and currency exchanges, financial and credit institutions) and *financial instruments* that create the necessary conditions for financial processes" [22].

F. S. Mishkin defines the financial system as complex, combining non-State financial

[8] Drobozina L. A., ed. Finance. Textbook. M.: Finance UNITY; 1999:14.

[9] Gryaznova A., Markina E., Sedova M. and others. Finance. Textbook. 2nd edition. M.: Finance and statistics; 2012.

[10] Financial and credit encyclopedic dictionary. M.: Finance and statistics; 2003:1020.

[11] Markina E.V., ed. Finance. Textbook. 3rd edition. M.: KNORUS; 2019:11.

institutions, including banks, insurance companies, mutual funds, financial companies whose activities are strictly regulated by the State.[12] In the later edition (2016) the author also refers to financial markets and infrastructure.

Financiers often polemicize, determining which approach has priority — functional or institutional. Some authors, combine these approaches in the content of the concept of "financial system", including its composition financial relations and financial institutions.

Under the institutional approach, the financial system can be defined as a system of State and non-State financial institutions. V. M. Rodionova (1993) defines the financial system as a set of spheres and links of financial relations interconnected; V.V. Kovalev (2013) — as a form of organization of value relations between all subjects of financial relations on distribution and redistribution of the aggregate social product; N.I. Berzon (2013) — as a set of markets, institutions and instruments that are used for financial transactions.

The analysis of the issues leads us to reach a conclusion about the necessity to characterize the financial system using an integrated (functional and institutional) approach. In this regard, *the financial system is defined by us, on the one hand, as an economic subsystem, and on the other — as a set of interdependent, interconnected elements, forming in its unity system: a) financial relations between economic entities; b) financial instruments (techniques, methods of organizing these relations); c) financial institutions performing these relations.*

The discussion on the structure of the financial system allows the representatives of the St. Petersburg School of Science of Finance to highlight their position, which allocates the state budget (federal and regional), extra-budgetary funds, and state credit (government borrowing system) in the composition of public finances. Following an expanded view of public finance, other scholars consider insurance funds and the stock market as different parts. By contrast, some authors limit financial relations in public finances to the State budget, extra budgetary and other special funds. We are it is appropriate to categorize the structural parts of the financial system in various ways, such as: budgets at all levels; extra budgetary funds; government foreign exchange reserves; money funds of companies and organizations. Or the financial system can be defined as the relationship of public finances, finances of economic entities and the population.[13]

So, from an ***institutional point of view, the structure of the national financial system*** includes public financial institutions (Ministry of Finance, Treasury, Tax authorities, Sovereign funds) and commercial organizations — financial companies and funds, as well as financial infrastructure institutions, including exchanges, clearing centres, depositories, etc.

At the global level, the ***global financial system*** can be understood institutionally as a set of national financial systems, as well as the international financial institutions in their interaction.

In this regard, the question arises: do all financial market participants relate to the financial system? Most scientists characterize the financial market as a place, a platform, which creates conditions for matching between demand and supply for financial assets. So, V.V. Kovalev characterizes the financial market as an organized and informal system of trading financial assets and instruments. [1]. Other scientists (e.g. G.G. Beloglazova, 2013) consider that the financial market — is a market where free monetary capital and savings are redistributed between different economic entities through transactions with financial assets.[14]

[12] Gryaznova A.G., Dumnaya N.N., Yudanov A. Yu., Ed. Economic theory: express course. Textbook. M.: Knorus; 2005:381–382.

[13] Krinichanskiy K.V., Rubtsov B.B., Tsyganov A.A., ed. Modern financial markets. Textbook. M.: Knorus; 2021.

[14] Beloglazova G., Krolivetskaya L., eds. Financial markets and financial-credit institutions. Textbook. The standard of the third generation. SPb: Peter; 2013:8.

Other interpretations of financial markets can also be treated. For example, it is defined as the sphere of economic exchanges of money resources, in which demand and supply for these resources are balanced when transactions are concluded, and the price of cash resources is formed. [23].

Indeed, the market — is the place where the subjects of economic relations interact, performing, including financial transactions. The *financial market* is thus understood as the mechanism of redistribution of financial resources on the basis of supply and demand (purchase and sale).

Notably, the authors' interpretation, describing the *financial system*, imply a set of organizations specializing in the conduct of their business in the financial market, as well as a system of rules (institutions) by which the participants of this market operate.[15] In other words, the institutions of the financial system include monetary institutions — banks that is, in fact, fallacious. Banks, as providers of credit in the economy, are not part of the financial system, but form a credit system with other credit institutions (including non-bank).

With digital transformation, financial markets are highly volatile, traditional financial intermediaries are declining, and digital financial ecosystems are dominating faster than traditional markets. Differences in the activities of financial intermediaries are eliminated, banks are merged with fintech companies, receiving additional competitive advantages. But this does not mean that banks «leave» financial markets or that the differences between the concepts of "finance", "money" and "credit" are blurred, and lending can be called financing and vice versa.

In 1970–1980, there were also discussions about banks losing their influence and reducing their role in the economy under the influence of scientific and technical progress, automation, development of new technologies. At the beginning of the 21st century, discussions about promising business models of banks were again intensified under the influence of internationalization and regionalization of global financial markets, the financial and banking crisis (2008–2009), the COVID-19 pandemic. However, banks retain their position as the base of monetary systems of many countries of the world. Russia — is no exception. The share of banks in total financial assets exceeds 80%.

The variety of opinions that have developed in modern finance and credit shows the value of a broad discussion on these fundamental problems, because the formation of an incorrect, although widely shared, position can have a negative effect on the economy.

CONCLUSION

For many years, the development of finance science has been a topic of discussion. Theoretical questions of a substantive nature in the context of rapid changes in practice require unequivocal interpretation, leading to renewed reflection on the purity of theory and its interrelationship with practice. We consider finance as an objective economic category with specific characteristics (attributes) that separate it from the general system of economic categories.

In recent years, the definition of "finance" has been increasingly used by the media in the context of monetary relations between companies, firms, banks and not only government revenues and expenditures. Authors sometimes do not distinguish in terms of "bank capital" and "financial capital". J.M. Keynes, for example, recognized finance as a monetary form of capital. Similar approach to the interpretation of finance is found in modern authors.

In the *Western scientific literature,* there is no universally accepted definition of finance. Expansive interpretation prevails, specify only types of finance: public, corporate or personal. Most foreign scientific schools are connected with the need to solve a

[15] Krinichanskiy K.V., Rubtsov B.B., Tsyganov A.A., ed. Modern financial markets. Textbook. M.: Knorus; 2021.

specific economic problem. The applied character of the development of economic theories predetermined the consideration of finance in foreign literature as a means of solving problems at macro- and micro levels. Therefore, in the academic and scientific literature, finance is often defined as a science of management of cash flow, or as an economic instrument of State regulation.

In general, it can be concluded that finance is a definition that currently there is no unity. Different points of view of representatives of philosophical and economic schools are predetermined by different tasks of use of finance.

But it is important not to confuse the essence, functions, role and significance of the economic categories of finance, money and credit, relying on essential and institutional approaches for their definition and implementation in practice.

The essential feature of finance is their distributive character, i.e. the formation and use of monetary funds of economic entities, the State and municipalities, which allows for a systematic consideration of emerging financial relations.

Finance indicates its essence through the *distributive function* in the development and use of financial resources, whereas credit, in contrast to finance, expresses its essence through the *redistributive relations* of economic entities.

Previous evidence leads us to conclude that the substance of economic categories remains constant, although the forms of these relationships grow and adapt according to a variety of causes.

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

The article was submitted on 19.09.2022; revised on 19.10.2022 and accepted for publication on 27.12.2022.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-115-125
UDC 336.2(045)
JEL E62, H22

Improvement of the Mechanism of Collecting Windfall Taxes and Fees in the Era of International Sanctions and the Growth of Public Spending (2023–2024)

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ABSTRACT

The **subject** of the study is modernization of budget relations based on horizontal decentralized connections. The **relevance** of the study is mitigation of the shortcomings and risks in 2023, especially the tax on excess profits of previous years. The **goal** of the study is to develop a fundamentally different scheme for financing a part of government spending on the principles of "uberization" that is mutually beneficial for the state and business. The objective of the study is to improve the mechanism of the one-time fee on large business (windfall tax). The research method is the analysis of business community opinions, foreign experience, results of research work of the Department of Public Finance and the Department of Taxation and Tax Administration of the Financial University. The basic principles of building a new decentralized electronic platform are described. Specific examples of federal budget expenditures that should be "uberized" in the first place are considered: federal subsidies for NPOs and financing of the "Krug Dobra" fund. The **scientific novelty** and **practical significance** of the proposed new mechanism for additional financing of public expenditures is direct connection of payers and recipients of budget subsidies on an electronic platform while preserving the control functions of the State. The **conclusion** is made about the practical applicability of the proposed new scheme of "uberization" of budgetary relations as a mechanism for collecting the one-time fee on large businesses (windfall tax), which can actually unload the federal budget, "liberating" it from part of expenses, without creating additional sanctions and other risks for participants.

Keywords: State finance; uberization; budgetary relations; international sanctions; EBITDA; windfall tax; tax on excessive profits of previous years

For citation: **Burdelova T.N. Improvement of the mechanism of collecting windfall taxes and fees in the era of international sanctions and the growth of public spending (2023–2024).** ***Finance: Theory and Practice*****. 2023;27(3):115-125. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-115-125**

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INTRODUCTION

The Russian budgetary system needs periodically to receive emergency additional fees under the pretext of exemption, according to the Minister of Finance A. G., "part of raw materials over rent".[1] This was in 2018, when A. R. Belousov —the assistant to the President of the Russian Federation at the time — proposed to further withdraw 513.7 billion rubles from the enterprises of the chemical and metallurgical industries to implement the May Decrees of the President[2] (the initiative was ultimately not implemented). This was in late 2020, when the government proposed 3.5 times increase in the mining tax on selected solid minerals by 2021, which was done by introducing the Krent coefficient of 3.5 in 2021.[3] So it was in 2021, when the Government was given a task to withdraw an additional 130 billion rubles from metallurgists in the form of a new increase in the mineral extraction tax (further — MET) and the introduction of excise tax on liquid steel. This happens in 2023, when the Federal Law No. 443 from 21 November 2022 "On amendments to article 4 of part one, part two of the Tax Code of the Russian Federation and individual legislative acts of the Russian Federation" among other measures sharply increased (for 380 rubles per ton, i.e. approximately 30 billion rubles) MET for coal in the first quarter 2023.

Such an annual "readjustment" of the tax system in manual mode will be in demand further, as government expenditures increase against the background of a difficult international situation. The budget does not require tens, but hundreds of billions of rubles, so it was necessary for a large business to agree to the prompt payment of a one-time fee on excessive profits of previous years of about 300 billion rubles, not provided for in the federal budget law. And while the government announced before 2023 that it would limit itself to a one-time increase in taxes on coal and mineral fertilizer production, windfall tax applies to almost all sectors of the economy except oil, gas and coal.

Current legislation and its deadlines for the introduction of new taxes and fees (art. 5 of the Tax Code of the Russian Federation) do not allow for a rapid increase in taxes and fees in the middle of the year. And the change of the bases of the legislation threatens to destroy the confidence of taxpayers in the tax system of the Russian Federation.

Therefore, the author of the article suggests to approach the problem from a non-standard side and consider an alternative way to cover the deficit of the federal budget, which is in the modern trend of decentralization of financial and economic relations, and taking into account the risks and concerns of taxpayers.

INTERNATIONAL EXPERIENCE

In foreign practice, there are cases when urgently introduced so-called windfall tax. The most famous case of the introduction of such windfall tax in the UK in 1997.

The Labour Government of the UK was dissatisfied with the results of the massive privatization of state-owned companies by the Conservatives. In a speech to Members of Parliament on 2 July 1997, Gordon Brown, then Chancellor of the Exchequer announced that it was necessary to introduce a windfall tax (an unforeseen tax) on previously privatized utilities. This tax would bring the United Kingdom up to 5.2 billion pounds to fund employment programs. The concept of "privatized utility companies" has been broadly defined to include all

[1] The principle of "do no harm" is the right one. RBC. URL: https://www.rbc.ru/economics/24/10/2022/63529d159a7947efb82a59eb?from=newsfeed (accessed on 05.05.2023).

[2] Withdraw 500 billion rubles: where Belousov found excess income on May decrees. RBC. URL: https://www.rbc.ru/business/09/08/2018/5b6c5ee59a7947e3df0554a3?ysclid=lbs4dhc75s952130341 (accessed on 05.05.2023).

[3] Article 342.8, para. 1 of the Tax Code of the Russian Federation.

former public companies privatized through the placement of shares and regulated by the relevant privatization laws. This definition includes British Telecom, BAA, PowerGen, Railtrack, electricity companies (excluding National Grid) and water supply companies. The taxable base was the difference between the company's market capitalization in privatization and the fair valuation calculated as the product of the average annual profit for four years after privatization by the P/E coefficient [1]. This tax was paid in instalments from December 1997 to December 1998.

There are also recent examples of discussion and collection of extraordinary taxes with windfall profits (super-profits).

For example, in 2017–2018, the European Union widely discussed the introduction of a tax on excessive profits of nuclear power plants, resulting from the rise in carbon emissions prices in the EU ETS trading system (general quota trading system, operating as a single market in the EU, Norway, Liechtenstein and Iceland, in which more than 11 thousand enterprises of energy, industry and air carriers have access to buy and sell carbon quota) [2], as well as due to the prolongation of the normative service life of nuclear power plants [3]. In the EU was a different point of view, and on 30 September 2022 pan-European windfall tax ("solitary contribution") was established in the form of a temporary tax rate of 33% levied on companies producing or processing oil and gas, with the amount exceeding their profits in 2022 or 2023 (depending on the legislation of each EU member country) by more than 20% over the average annual profit for the four previous years. The amount of windfall tax in the EU as a whole is approximately 25 billion euros. At the same time, the large oil and gas company Exxon in late 2022 initiated court appeals contesting this tax. Exxon's claim was motivated by concerns about the long-term side effects on the competitiveness of European industry. According to the plaintiff, this "counterproductive" tax will "undermine investors' confidence, will discourage investments and will increase dependence on imported energy and fuel products" will not eliminate the power shortage in the EU and will not be able to positively influence on energy prices.[4]

In Russian economic and political realities, the business community is much more loyal to increase one-time payments to the budget. For example, when in September 2021 the Russian Ministry of Finance proposed a bill on the introduction of windfall tax in the form of an increased corporate income tax rate of 25 or 30% for Russian companies that have dividends paid in the previous five years, exceed the amount of investment in business [4], taxpayers have proposed some amendments, but in principle were not against the idea of the bill. The view that business is a priori always against additional payments to the budget system, does not take into account all the circumstances and motives of such a possible negative reaction.

BUSINESS CONCERNS

In the context of a difficult international environment and foreign policy pressure, companies were reluctant to whether their agreement to a one-time increase in the tax burden would be perceived as a reason for long-term tightening of the State's tax policy. In other words, business requires guarantees of one-time fees.

Another important reason to alarm the business is fear of sanctions consequences. The fee formula stimulates the voluntary contribution of the full amount already in 2023, i.e. before the official date of its introduction (1 January 2024). Anticipatory "voluntary" financial support of the state can potentially bring the company new sanctions from the western countries. It

[4] Exxon sues over EU fossil fuel 'windfall tax'. URL: https://www.politico.eu/article/exxon-sues-european-council-over-eu-fossil-fuel-windfall-tax/amp/ (accessed on 05.05.2023).

should be noted here that international sanctions at the present stage have become a systemic problem of the Russian budget system. The list of the main sources of budgetary risks in the current conditions in 2023 (economic slowdown, changes in the structure of GDP, deterioration of trade and balance of payments, instability of the ruble's exchange rate, growth of borrowing costs on foreign and domestic financial markets [5]) should be added sanctions risks, to reduce which need new decentralized mechanisms of budgetary relations.

The third reason for the concern of business representatives is the effect of the additional one-time fee on EBITDA (i. e. profit before interest, taxes and depreciation), which is one of the most demanded financial indicators by investors, traditionally used by all public companies and published in mandatory investor reports [6]. Depending on its form, a one-time fee could potentially reduce the EBITDA value, making it difficult to achieve key performance indicators and financial results that meet investors' expectations.

Russian Union of Industrialists and Entrepreneurs (further — RUIE) already applied to the Government of the Russian Federation with a request to introduce a moratorium on further growth of the tax burden in October 2022. RUIE engaged experts of the Financial University led by Professor D. I. Ryachovsky to study the impact on economic growth of increased tax burden on business. Research concluded that, in the medium term, an increase in the tax burden could slow the growth of tax revenues. According to the experts of the Financial University, an increase in the tax burden in Russia by 1% would slow the annual economic growth rate by 0.12%, which in turn would reduce the tax collection in budgets at all levels.[5] Many foreign and domestic researchers have come to similar conclusions [7, 8].

The business concerns described above are not groundless. Therefore, the author of the article proposes to reformat the one-time fee so as to solve the task of filling budgets of all levels, while minimizing the associated risks for business.

"UBERIZATION" IN THE MODERN ECONOMY

"Uberization" is the organization of economic activity coordinated through online services that minimize transaction costs by reducing the role of intermediaries in economic relations [9]. This relationship model has the following characteristics:

- use of Internet-sites, platforms;
- product standardization;
- maximum automation and optimization of business processes;
- attraction of resources;
- minimization of intermediaries between suppliers and end-users [10].

"Uberization" as a new economic model comes from two principal reasons. Firstly, from the need to connect the seller and the consumer. Here, bilateral technology platforms play a significant role, replacing entire institutions that previously acted as intermediaries. Secondly, from the need to realize surplus arising in the production or consumption process on the principles of the economy of shared consumption (sharing economy): it is more convenient to pay for temporary access to the product than to own the product [11].

Examples of "uberization" spheres include the following:

- transport;
- retail;
- real estate and recreation;
- delivery services;

[5] Official website of the Russian Union of Industrialists and Entrepreneurs. URL: https://rspp.ru/events/news/rspp-prosit-pravitelstvo-rf-vvesti-moratoriy-na-dalneyshiy-rost-nalogovoy-nagruzki-635fe99fa98a4/?ysclid=lbt8ocfp kd813786783 (accessed on 05.05.2023).

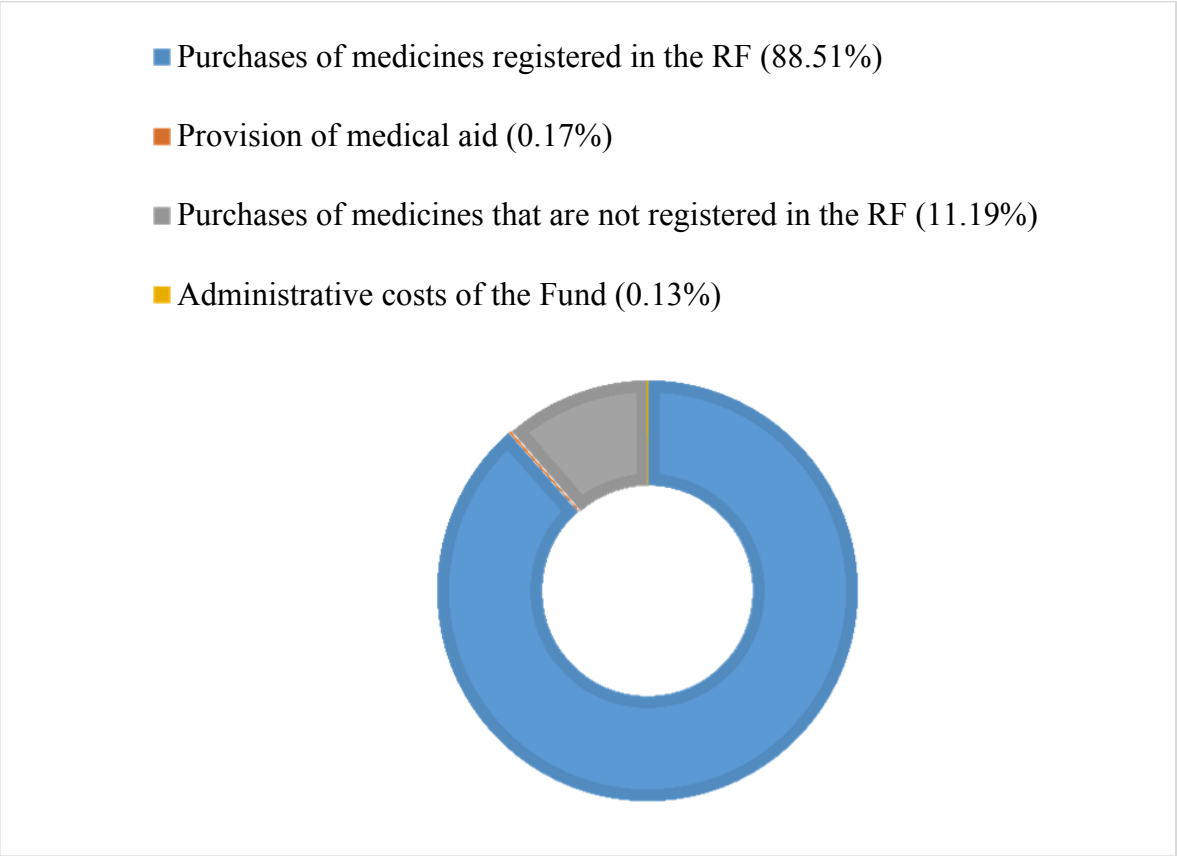

Fig. **Share in Costs of the "Krug Dobra" Fund (2021)**

Source: Annual report of the "Krug Dobra" fund (2021). URL: https://xn-80abfdb8athfre5ah.xn--p1ai/%D0%BE-%D1%84%D0%BE%D0%BD%D0%B4%D0%B5/%D0%B3%D0%BE%D0%B4%D0%BE%D0%B2%D0%BE%D0%B9-%D0%BE%D1%82%D1%87%D0%B5%D1%82-%D0%B7%D0%B0-2021-%D0%B3%D0%BE%D0%B4/?ysclid=levl6xbf25445291179 (accessed on 05.05.2023).

- other services (e.g., platforms connecting professionals in the field of consumer services and users);
- video game industry [11].

But the term "uberization" has become much more widely used in recent years than only in the service sector — it can also be found in relation to the relations of subjects in the field of culture, education [12] and other areas in which previously significant role played by state institutions, organizations and agencies. "Uberization" of such spheres has allowed to eliminate asymmetry of information as a cause of mutual distrust of parties of economic relations, influencing the possibility of transferring certain functions to the "flat" environment [13] without centralized regulation.

All this, according to the author of the article, gives grounds for uberization of budget relations as a traditional centralized sphere.

"UBERIZATION" AS A TOOL TO REDUCE BUSINESS RISKS

In the context of this article, author talk about "uberization" in relation to the financing of some types of budget expenditures directly by representatives of large business without the Federal Treasury.

Among the federal budget expenditures for 2023 and for the planning period 2024 and 2025 are those that could reasonably be financed from extrabudgetary sources, shifting the burden of such expenditures directly to taxpayers, such as federal infrastructure and social programmes. Let's

analyze this mechanism in more detail on a particular example.

The fund "Krug Dobra" was created by the Decree of the President of the Russian Federation No. 16 from 05.01.2021 "On the establishment of the Fund for the support of children with serious life-threatening and chronic diseases, including rare (orphan) diseases, "Krug Dobra".

Orphan are rare diseases with a prevalence of no more than 10 cases per 100 thousand people [14]. In 2022 the total amount of funds actually collected due to the increased rate of tax on income of individuals and directed to the implementation of the main tasks of the "Krug Dobra", amounted to 148.5 billion rubles.[6]

The cost structure is shown in the *Figure*.

According to the Decree of the Government of the Russian Federation No. 4153 from 23.12.2022 at the end of 2022, the Ministry of Health was allocated 69 920 627.8 thousand rubles from the Government Reserve Fund to provide a grant in the form of a subsidy to the "Krug Dobra" fund. At the same time, the general financing of the purchase of the necessary medicines from the federal budget for 2023 is significantly higher: the head of the Federation Council Committee for social policy I. Yu. Svyatenko in December 2022 announced that more than 144 billion rubles were allocated for 2023.[7]

However, the tasks of the fund are achievable through extrabudgetary sources. Instead of paying a one-time fee to the budget system, large enterprises may, through their charitable funds or NPOs, purchase expensive medicines and provide charitable assistance to medical institutions. In order to implement this idea without losing control over the receipt and use of these funds to "Krug Dobra", it is necessary to transform and focus on the control of "transactions" in the new information system within "uberization" (electronic platform), allowing participants to find beneficiaries from whom the turn to purchase an expensive drug. Document management will not be complicated: the requirement of the written form of the donation contract is fulfilled in this case with an electronic platform that allows reliable identification of the payer [15].

This solution will solve all the main cause of concern for businesses that mentioned at the beginning of this paper.

First, there is no need to change the tax legislation in the middle of the year.

Second, there is no risk of medium- or long-term increases in tax burden. Moreover, it will even slightly reduce the tax burden of those enterprises that have not used the full tax deduction limit on charitable donations (1% of the taxpayer's income provided that the recipient is included in the register of socially oriented NPOs — pp. 19.6, para., art. 265 of the Tax Code of the Russian Federation).

Third, since payer funds will not reach the accounts of the Federal Treasury, the risks of falling under the new international sanctions for business are significantly reduced. Charitable assistance to children or medical institutions with a high probability from the point of view of foreign countries will not be equated with funding of the Government.

Fourth, charitable contributions do not reduce the most important KPIs of company management — EBITDA, as not deducted when calculating operating profit (EBITDA in practice is often calculated by deducting from operating surplus the depreciation and impairment of assets) [16].

At the same time, the federal budget takes off the expenditure on grants to the "Krug Dobra"

[6] Annual report of the "Krug Dobra" fund (2022). art. 26. URL: https://xn-80abfdb8athfre5ah.xn — p1ai/%d0%be-%d1%84%d0%be%d0%bd%d0%b4%d0%b5/%d0%b3%d0%be%d0%b4%d0%be%d0%b2%d0%be%d0%b9-%d0%be%d1%82%d1%87%d0%b5%d1%82-%d0%b7%d0%b0–2022-%d0%b3%d0%be%d0%b4/ (accessed on 15.06.2023).

[7] Personal income tax rates will help 19-year-old patients of "Krug Dobra" fund. Tass, 16 December 2022. URL: https://tass.ru/ekonomika/16608953%20?ysclid=lc3ilj4vhs120655872 (accessed on 05.05.2023).

Table

Dynamic of Federal Budget Subsidies to NPOs

Types of organisations	Subsidies from the federal budget (bln ruble)					
	Average for 2018–2020	2020	2019	2018	2017	2016
Funds	125.84	93.26	186.43	97.83	40.10	22.06
Autonomous non-profit organizations	35.93	49.23	40.57	18.00	15.49	8.35
Public unions	6.73	4.67	10.66	4.84	3.48	5.92
Associations, bureaus	6.89	2.05	13.42	5.20	2.81	0.52
Entities	1.42	1.05	2.26	0.94	0.77	1.47
Non-profit organizations	0.40	0.44	0.76	0.00	0.95	0.00
Non-profit partnerships	0.41	0.48	0.57	0.16	0.24	0.19
Religious organisations	0.07	0.12	0.00	0.10	0.06	0.02
Sundry	268.27	43.37	621.95	139.47	155.46	290.75
Total	445.95	194.67	876.63	266.56	219.37	329.28
Including the first three categories	168.50	147.16	237.66	120.68	59.07	36.33

Source: Analytics: total amount and number of subsidies granted to NPOs from the federal budget. URL: https://openngo.ru/analytics/nko-subsidies-sum/ (accessed on 03.05.2023).

fund. In addition, the funds from the increased personal income tax can be redirected to the budgets of the constituent entities of the Russian Federation, which will not only simplify tax calculations, but also reduce the amount of inter-budget transfers required by the regions. As a result, the "uberization" of the funding of the programs of only one fund "Krug Dobra" will reduce the expenditures of the federal budget by about 0.5%.

Similarly, you can "uberization" funding of social, educational and research programs of other NPOs. The purpose of public finance is large and consists in the fact that they provide the state authorities and local self-government with money for the performance of their functions, including social [17]. The proposed funding mechanism does not question the social function of the State and does not reduce its importance, but gives the State a modern tool to rapidly increase the funding of NPOs.

The *Table* shows that among the NCBs, funds, autonomous non-profit organizations (ANOs) and public unions receive a significant share of federal budget subsidies as a result of several years of progress — average 168.5 billion rubles of subsidies per year,[8] or more than half of the target amount of the windfall tax.

"Uberization" is offered first of all by the NPO of the above three categories, as their legal status allows to accept donations from legal entities.

Currently, there is a global trend to increasingly include the non-governmental sector in social security issues due to budgetary constraints [18]. In this trend, the proposed new mechanism for financing part of public expenditures is relevant. If ten years ago IT-technologies were not ready for such "uberization" and could not provide control over the fulfillment of obligations, the absence of abuse and targeted spending of funds, now there are no technological barriers. With modern automated information systems used by the Federal Tax Service of the Russian Federation, the process of tracking the financial flows of business entities has become more accessible [19].

The system of fees for using this service should be thought out. So that it does not turn out that the state should be spent on the administration of the new system, it is proposed to set a tariff for both connection (registration) and payments. This is a modest amount compared to windfall tax. There are already working many years examples of electronic control systems of tax collection and quasi-tax: this application of the Federal Tax Service of Russia "My tax" and the system "Platon" to collect fees from owners of heavy trucks for traffic on public roads. At the same time, the system "Platon" is self-supporting — as of April 15, 2023 (i.e. for seven and a half years) collected about 224 billion rubles, while only 10.6 billion rubles per year are allocated for the maintenance of the operator.[9] Such high unit costs (more than 35 cents per ruble) are due to the high cost of line control on the roads for about 1.8 million registered vehicles belonging to almost 800 thousand truckers. In the case of large taxpayers who meet the windfall tax criteria (the number of which is more than a hundred times less than the participants of the system "Platon"), the amount of transaction costs will be, respectively, a hundred times less than in the system "Platon" (10.6 billion rubles per year), i.e. will not exceed 100 million rubles per year. With the target total amount windfall tax 300 billion rubles can be considered low total unit costs 0.033 cents per ruble from the raised funds. The

[8] The "Krug Dobra" fund is not included in this amount as it has not yet functioned in the years indicated in Table 1.

[9] Key statistics of «Platon» system at 15 April 2023. URL: https://platon.ru/wp-content/uploads/2023/04/%D0%98%D0%BD%D1%84%D0%BE%D0%B3%D1%80%D0%B0%D1%84%D0%B8%D0%BA%D0%B0_%D0%9A%D0%BB%D1%8E%D1%87%D0%B5%D0%B2%D0%B0%D1%8F-%D1%81%D1%82%D0%B0%D1%82%D0%B8%D1%81%D1%82%D0%B8%D0%BA%D0%B0_15-%D0%B0%D0%BF%D1%80%D0%B5%D0%BB%D1%8F-2023.pdf (accessed on 05.05.2023).

federal budget allocates 50 billion rubles per year for the maintenance of the Federal Treasury (data of the departmental structure of the federal budget expenditures for 2023 and the planned period 2024 and 2025), at the same time, the accounts of the Federal Treasury account more than 50 trillion per annum revenues of budgets at all levels and extra-budgetary funds, i.e. Federal Treasury expenses of just under 0.1 cents per ruble from the raised funds. Thus, the new platform will be more efficient in terms of transaction costs than the Federal Treasury.

Low unit costs may be the best way to ensure the operation of a new platform under concession, with the determination of the developer and operator on a competitive basis. In order to reduce the sanctions risks, the controlling stake of the operator should belong to investors without sanction. In order to ensure transparency and control of transactions in the system, participants should use for payments "digital rubles", all transfers in which are as transparent and controlled as possible.

The key financial criterion for determining the winner of the competition for the role of the system operator should be the amount of commission of the electronic platform. The tariff of 0.033% of the collected sums is significantly lower than the tariffs for acquiring plastic cards (which according to the Central Bank of the Russian Federation is 1.2–2.2%[10]) and will be unencumbered for payers. When assessing the payback and effectiveness of the proposed budget financing mechanism, must be taken into account, that mechanism avoids increasing transaction costs of the Federal Treasury.

After a successful approbation of a new electronic platform on the most technologically advanced segment of a large business, the state can expand its scope of application by involving medium business enterprises, increasing the number of projects, decentralized funding through such a mechanism.

CONCLUSION

Given the low rates of economic growth and increase uncertainty, the State must prepare for possible recessions while maintaining a balance between growth and sustainability objectives. The solution to this problem requires improving the tax system, increasing the efficiency of social budget spending, as well as increasing budget investments in infrastructure [20].

The proposed transformation of windfall tax into a system of decentralized direct financing of certain types of public expenditures needs to be improved. But such a decentralized system, being implemented, can really unload the federal budget, "freeing" it from part of the costs, without creating additional sanctions and other risks for participants. In this case, such a system will provide a flexible, operational and universal tools for solving the problems of windfall tax in the future.

[10] From the website of the Central Bank of the Russian Federation. URL: https://cbr.ru/press/event/?id=12769 (accessed on 05.05.2023).

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

The article was submitted on 10.01.2023; revised on 22.02.2023 and accepted for publication on 27.02.2023.
The author read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-126-138
UDC 336.767.3:51(045)
JEL G120, Y80

On the Yield to Maturity of a Coupon Bond

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ABSTRACT

The article is devoted to one of the main characteristics of the bond-the yield to maturity. **The subject** of the study is the type of yield to maturity indicator. It is known, that there are two approaches to determining the yield to maturity of a bond: the nominal interest rate and the effective interest rate method. **The relevance** of the study is due to the fact that, as preliminary comparison has shown, these two approaches to determining the yield to maturity may be unequal in research. **The purpose** of this paper is to conduct a study of the dependence of the research results on the type of yield to maturity indicator. For this purpose, the problem of the dependence of the interest rate risk of a bond on the number of coupon payments per year was chosen. The literature contains reports on the dependence on the frequency of coupon payments of the duration of a bond that evaluates interest rate risk. The problem of the dependence directly of the interest rate risk of a bond on the number of coupon payments per year has not been considered in the literature. The task was set to determine which of the two approaches to determining the yield to maturity allows us to obtain results for interest rate risk that are consistent with the dependence of the duration of the bond on the number of coupon payments per year. **Methods** of differential calculus are used to solve the problem. As a **result,** it was proved that the use of the yield to maturity determined by the effective interest rate method allows us to obtain results consistent with the dependence of the duration of the bond on the number of coupon payments per year. The results obtained by using the yield to maturity determined by the nominal interest rate method do not agree with the dependence of the duration of the bond on the number of coupon payments per year. It is **concluded** that the yield to maturity determined by the nominal interest rate method in researches may lead to incorrect results, in contrast to the yield to maturity in the form of an effective interest rate. Results of the work can be useful to both the bond issuer and the investor, as well as in theoretical studies of investments in bonds.

Keywords: yield to maturity; mathematical methods; effective interest rate; nominal interest rate; interest rate risk of bonds; number of coupon payments per year

For citation: **Popova N.V. On the yield to maturity of a coupon bond. *Finance: Theory and Practice*. 2023;27(3):126-138. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-126-138**

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INTRODUCTION

By definition, annual yield to maturity (YTM) — is a compound interest rate at which the current (present) value of the expected bond payment flow is equal to its current price. The type of discount rate depends on the approach to determining the YTM indicator. There are two approaches to determining annual yield to maturity bonds[1] — the nominal interest rate and the effective interest rate methods. According to the first approach, if coupon payments on bond, the price of which P, are m times a year, then the annual nominal rate for yield to maturity $r^{(m)}$, corresponding to compound interest m times a year is applied for discounting the cash flow:

$$P = \sum_{i=1}^{n} \frac{q}{\left(1 + r^{(m)}/m\right)^{m t_i}} + \frac{A}{\left(1 + r^{(m)}/m\right)^{mT}},$$

where A — bonds' nominal value; q — amount of each coupon payment; t_i years (i = 1, 2,..., n) — payment terms for coupons; T years — maturity period. YTM as annual nominal interest rate $r^{(m)}$ is used under the Fair Credit Reporting Act[2] (the USA, 1969). According to this Act the annual rate of yield to maturity is determined as follows: 1) yield to maturity is calculated for the period equal to the minimum interval between coupon payments, i.e. for the coupon period equal to $1/m$ year; 2) the interest rate received is multiplied by the number of coupon periods per year m. This rule of calculating the annual yield to maturity is called the market agreement,[3] adopted "to reduce the problems" of market participants. On the basis of this Act in the markets it is accepted to consider the yield to maturity is the annual nominal rate of return [1, p. 65].

Another approach, the effective interest rate method uses an annual rate r to discount cash flow, corresponding to compound interest once a year:

$$P = \sum_{i=1}^{n} \frac{q}{(1+r)^{t_i}} + \frac{A}{(1+r)^{T}}.$$

As follows from the papers [2–8], the calculation of YTM by the method of effective interest rate is used in the Russian securities market, in particular, on the Moscow Stock Exchange. According to [7, 8] the method of calculating the yield to maturity of the coupon system of public debt in the form of an effective interest rate is regulated by the Bank of Russia (OFZ-AD, OFZ-PK2 etc.).[4]

F. J. Fabozzi refers to the rate $r^{(m)}$ as approximation [1, p. 62], which may be explained by the rate $r^{(m)}$ origin. As we have seen, according to the Fair Credit Reporting Act, the rate $r^{(m)}$ value is given formally — by simply multiplying the rate over the period by the number of periods per year, which does not guarantee the exact value of the annual rate.

THE ROLE AND IMPORTANCE OF YIELD TO MATURITY

According to L. J. Gitman and M. D. Joehnk, the authors of the famous investment guide [9], yield to maturity — is the most important and widely used measure of bond valuation. The following are the primary comments concerning the YTM indicator that have been made in the financial literature: 1) YTM rate of a fairly priced bond[5] is roughly equal to that of an alternative investment with comparable risk [1]; 2) yield to maturity — is the rate of return on a bond investment, obtained

[1] Fabozzi F.J. Investment management. Moscow: Infra-M; 2000:486, 908. University textbook.

[2] Sharpe W.F., Alexander G.J., Bailey J.V. Investments. Moscow: Infra-M; 2018:127. University textbook.

[3] Fabozzi F.J. Investment management. Moscow: Infra-M; 2000:486, 908. University textbook.

[4] Letter from the Bank of Russia No. 28–1–2/39 from 19.01.1998. URL: https://gkrfkod.ru/zakonodatelstvo/pismo-banka-rossii-ot-19011998-n-28–1–239/ (accessed on 10.08.2021).

[5] Sharpe W.F., Alexander G.J., Bailey J.V. Investments. Moscow: Infra-M; 2018:421University textbook.

by an investor under two conditions: the investor owns the bonds until maturity, and all bond payments are reinvested at a rate equal to the yield to maturity at the time of purchase.[6] In this case, a significant part of the return on the bonds during its validity period is derived from reinvestment of coupons [9].

The second statement implies that if the investor follows this strategy, yield to maturity is a measure of return on the investment in the bond [9, p. 473], at the same time, YTM representing the minimum return on the investment in the bond expected by the investor [9, p. 469].

Because of the YTM indicator's significance role in bond valuation, in the literature factors, influencing this indicator, receive a lot of attention. According to [1] the YTM value of the bond is the sum of the basic risk-free interest rate and risk premium. Base, or benchmark, the interest rate is the yield to the treasury securities of the same duration. Thus, the YTM value is directly related to the risk of investing in this bond. One of the main types of risk — is credit risk, i.e. risk that the note issuer may default on payment on bonds. In this regard, the literature first of all investigates the link between bond yield and indicators characterizing the state of the issuing company: bond rating, debt to equity ratio (DER), return on assets (ROA), firm size, as well as factors that create investor risks: inflation, interest risk bonds, interest rate, bond parameters. Detailed lists of factors that influence the yield to maturity are given in monograph [10]. Let us now discuss the major findings of the research on the effect of factors on the YTM indicator that were conducted in the papers [11–22]. The [11–20] research obtained findings by sampling several dozen bond-issuing corporations over a period of time. Data were analysed using statistical methods such as correlation, regression, determination coefficient and variance analysis. For example, the [12] sample consisted of 104 corporate bonds from 40 companies traded on the Indonesian Stock Exchange (IDX) in 2017–2018. Panel data regression was used for analysis. In the paper [14] results are based on data collected on 67 companies and 138 bonds of the Indonesian bond market for the period January 2015 — July 2016. Multiple linear regression analysis was used for data analysis and interpretation. Main results of works [11–22] are as follows.

According to [11, 12, 14, 16, 18, 21] bonds ratings are negatively correlated with YTM. The higher the bond credit rating, the lower the bond yield rate. Companies with low bond ratings will offer high yield bonds to attract investor interest and provide greater YTM as compensation for higher risk. High-grade bonds are usually issued by companies with good financial performance, so the risk is lower. Bond ratings are considered by investors as a guide in decision making, as well as to determine the risk level and expected value of YTM.

Investors can assess the state of the company by comparing the company's equity and debt. If net worth is more than borrowed, then the company is healthy and it is not easy to bankrupt [17]. Debt-to-equity ratio gives an idea of the company's capital structure and assesses the risk of default on the company's bonds. The DER coefficient equal to the company's debt-to-equity ratio, also called solvency,— is one way to measure the company's ability to meet its long-term obligations. The lower the DER, the higher the company's ability to meet its obligations. The higher the debt (DER), the higher the expected yield [13, 21].

According to [10–12], ROA (return on assets) demonstrates the efficacy of the issuer's asset management. The higher the return on assets ratio, the lower the investment risk and hence the yield of corporate bonds.

[6] Fabozzi F.J. Investment management. Moscow: Infra-M; 2000:494. University textbook.

According to [11, 12, 15–17, 20] company size (total assets) has a significant negative correlation with yield to maturity. The larger the company size, the smaller the YTM. Although on the results of [19] firm size does not affect the bond yield.

Interest rate — basic risk-free interest rate, for example, the yield of State certificates. According to the author [13], the interest rate — is the most likely measure for investors to use bonds. Based on [13], which presents the research results of companies whose bonds were traded on the Indonesian Stock Exchange (IDX) from 2009 to 2013, the optimal rate of yield was considered the interest rate of certificates of the Bank of Indonesia (SBI). This is due to the fact that SBI is supported and fully guaranteed by the government, in this case by the Bank of Indonesia (BI), which forces securities market participants to consider SBI as expensive and risk-free certificates. According to the paper [15] 7-day repo rate of Bank of Indonesia (BI) is used as base interest rate. In line with [13, 15, 18–20], an increase in interest rates raises bond yields, whereas a fall in interest rates lowers bond yields.

Based on [21], inflation in the currency in which a particular issue is denominated is the fundamental factor determining the yield of corporate bonds. According to the authors [9, p. 467], investors are most concerned about inflation. It depreciates the principal value of the loan, forcing the issuer to compensate for inflation losses. According to the research [21], inflation and bond yields are in direct correlation: the more inflation, the more YTM.

According to [18, 21], investors are usually interested in a large risk premium when buying long-term bonds, as the uncertainty is higher for the long-term of circulation period. The more "long" bonds should provide the investor with an additional premium for the risk associated with higher duration and interest rate risk. In line with [14, 16, 18, 21], period to maturity has a significant positive correlation with yield to maturity. Coupon rate also has a significant positive impact on bond yields [14].

Based on [18, 21], bonds that have repayment options have a lower yield rate. Secured bonds have lower yields, while unsecured bonds have higher yields.

In paper [21] the influence of such a factor as the share of state participation in the company is considered. Investments in companies with a large share of state participation are considered less risky as there is a guarantee of state assistance in difficult economic conditions. In this regard, corporate bonds of private companies provide higher yields than those of government-affiliated companies.

According to [22] the value of YTM is influenced by the quality of the non-financial information disclosure about the company. According to [22] companies that provide more quality information on corporate social responsibility, it gets higher ratings and lower yields on bond issues.

The value of YTM, as evidenced, reflects almost all the information that an investor needs to make a decision to bond purchases. According to [9, p. 467] the yield to maturity is the single most important criterion in the bond market. This criterion is intended to monitor market performance as well as to determine the return on invested capital. This paper is devoted to the adequate use of indicator YTM in research.

PURPOSE OF THE STUDY

The [23] researches of the coupon bond price dependence on the number of coupon payments per year revealed that using the nominal interest rate in the bond price formulas produced results that made no economic sense, in contrast to the results obtained in the paper [24] when using the yield to maturity method of effective interest rate. In this regard, the purpose was to study the impact of the type of yield to

maturity indicator on research results. The problem of the impact of the number of coupon payments per year on the interest rate risk of the bond was chosen.

The task selection is explained as follows. It was necessary to consider bonds of the same type as in the works of [23, 24], i.e. bonds without credit risk, such as federal loan bonds in the Russian market. As highlighted, for instance, in the paper of O. V. Buklemishev [25, p. 208], in fixed income securities markets without credit risk the main risk factor is interest risk — the possibility of bond price change due to market interest rate change. Interest rate risk of a bond is estimated by the relative (interest) change in the price of the $\Delta P/P$ bond when the market interest rate changes by a given amount. According to [1, p. 87] the essence of $\Delta P/P$ — is the reaction of the bond price to the change in the market interest rate.

The literature provides reports of the dependence of $\Delta P/P$ on the main parameters of the bond: coupon rate, period to maturity, and yield to maturity [1, p. 91]. In the paper [26], the proof of the dependence of the bond duration, which estimates the value of $\Delta P/P$, on the secondary parameter, the number of coupon payments in the year m, was obtained. However, the problem of the influence of this parameter directly on the value of $\Delta P/P$ has not been considered previously. Thus, a task was chosen to achieve the purpose of the paper, which, on the one hand, was not considered earlier, on the other hand, the results of this task is predictable based on earlier studies. In this paper, the solution to the problem is obtained for two approaches to the determination of yield to maturity bonds: method of nominal interest rate and method of effective interest rate. It was necessary to determine which of the two types of yield to maturity would produce results, consistent with the dependence of the bond duration on the number of coupon payments per year established in [26].

METHODS

Methods of differential calculus was used to solve the problem. Suppose, at the moment, there is a bond in the market with a YTM of y, where $y = r^{(m)}$ or $y = r$ — the initial annual nominal or effective rate of return. Bond price is equal $P(y)$. The change in the price of the bond we will consider for an instantaneous change of the market interest rate, similar to F. J. Fabozzi [1, p. 89]. Let $\tilde{y}$ — bond yield, that the nominal $\tilde{y} = \tilde{r}^{(m)}$ or effective $\tilde{y} = \tilde{r}$, as a result of an instant change in the market interest rate. Bond price will be equal $P(\tilde{y})$.

The relative (percentage) change in the price of the bonds due to the change of the market interest rate by the value $\Delta y = \tilde{y} - y$ is equal by definition[7]:

$$\frac{\Delta P(y)}{P(y)} = \frac{P(\tilde{y}) - P(y)}{P(y)}. \qquad (1)$$

Since the price of the bonds is a decreasing function of the yield, then $P(\tilde{y}) > P(y)$ at $\tilde{y} < y$ and $P(\tilde{y}) < P(y)$ at $\tilde{y} > y$. Then it follows from (1) that $\Delta P(y)/P(y) > 0$ when the interest rate is lowered and $\Delta P(y)/P(y) < 0$ when the interest rate is increased. As already noted, $\Delta P(y)/P(y)$ value estimates the interest risk of the bonds. Since the $\Delta P(y)/P(y)$ may be positive or negative, we will consider a module of this value $|\Delta P(y)/P(y)|$. By definition, this value is non-negative. Therefore, $|\Delta P(y)/P(y)|$ — is a percentage change in the price of a bond when the yield to maturity is changed by Δy, without a sign. Sign $\Delta P(y)/P(y)$ means interest growth or percentage decline in bond price. Thus, we have a task regarding the value dependency of $|\Delta P(y)/P(y)|$ on parameter m.

Result Criterion

The solution of the problem of the dependence of the value $|\Delta P(y)/P(y)|$ on

[7] Encyclopedia of financial risk management. Lobanov A.A., Chugunov A.V., ed. Moscow: Alpina Business Books; 2005:59.

parameter m is obtained for two approaches to determination of yield to maturity of the bond: the method of nominal interest rate and the method of effective interest rate. To obtain the criterion of choice of results was used from the work [26] dependence of the duration bond, estimating the value $\Delta P(y)/P(y)$, on the number of coupon payments in the year m. According to [26], at fixed values of basic parameters the bond duration decreases with increase of parameter m:

$$D_{m=m_2} < D_{m=m_1}, \quad (2)$$

where $m_1 < m_2$. As it is known [27, p. 751], Macaulay duration D is related to the percentage risk of bond under the formula:

$$\Delta P(y)/P(y) \approx -D\frac{\Delta y}{1+y} .$$

Hence

$$|\Delta P(y)/P(y)| \approx D\frac{|\Delta y|}{1+y}. \quad (3)$$

Then on the basis of formulas (2) and (3) it is possible to formulate the select result criterion:

$$\left|\Delta P(y)/P(y)\right|_{m=m_2} < \left|\Delta P(y)/P(y)\right|_{m=m_1}, \quad (4)$$

where $m_1 < m_2$, $y = r^{(m)}$ или $y = r$.

Ratio (4) means that as the parameter m increases, the interest risk of the bond should decrease. The purpose of the paper — is to determine which of the two types of yield to maturity will allow to obtain results that meet the criterion (4).

Algorithm to solve the problem

To study the influence of parameter m, where $m = 1, 2, \ldots$, on the value $|\Delta P(y)/P(y)|$ we consider the auxiliary function $\varphi(x,y)$, where ($x \geq 1$, $0 < y < 1$). The variable y makes sense yield to maturity of bond, $y = r^{(m)}$ or $y = r$. The expressions for the function $\varphi(x,y)$ we get from the corresponding expressions for the bond price by replacing the discrete variable m on continuous variable $x \geq 1$. The function $\varphi(x,y)$ and price of bonds at y and $\tilde{y}$ yields are related by the ratios:

$$\varphi(m,y) = P(y), \ \varphi\left(m,\tilde{y}\right) = P\left(\tilde{y}\right),$$

where m — positive integer, $\tilde{y} = \tilde{r}^{(m)}$ or $\tilde{y} = \tilde{r}$.

Then

$$\left|\Delta P(y)/P(y)\right| = \left|\Delta\varphi\left(m,y\right)/\varphi\left(m,y\right)\right|. \quad (5)$$

The function $\varphi(x,y)$ is differentiable by variables x and y. The effect of a variable x on the function $\left|\Delta\varphi\left(x,y\right)/\varphi\left(x,y\right)\right|$ will be studied by differentiating this function by variable x.

If $\tilde{y} < y$ we get:

$$\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_x = \left(\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right)'_x = \left(\frac{\varphi(x,\tilde{y})}{\varphi(x,y)} - 1\right)'_x = \frac{\varphi(x,\tilde{y})}{\varphi(x,y)}\left(\frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})} - \frac{\varphi'_x(x,y)}{\varphi(x,y)}\right). \quad (6)$$

If $\tilde{y} > y$ we get:

$$\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_x = \left(-\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right)'_x = \left(1 - \frac{\varphi(x,\tilde{y})}{\varphi(x,y)}\right)'_x = \frac{\varphi(x,\tilde{y})}{\varphi(x,y)}\left(\frac{\varphi'_x(x,y)}{\varphi(x,y)} - \frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})}\right). \quad (7)$$

To establish the derivative sign $\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_x$ in expressions (6) and (7), need to set the difference sign $\left(\frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})} - \frac{\varphi'_x(x,y)}{\varphi(x,y)}\right)$ in (6) and difference sign $\left(\frac{\varphi'_x(x,y)}{\varphi(x,y)} - \frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})}\right)$ in (7). In turn, to set the signs of these differences, it is necessary to study the monotony by the variable y function $\frac{\varphi'_x(x,y)}{\varphi(x,y)}$.

This action algorithm is used in each of the two problem solutions. The solutions are obtained at the given values of the basic parameters of the bond: term to maturity of T years, where $T > 1$ (otherwise at $m = 1$ bond is not coupon), coupon rate f and initial yield to maturity $r^{(m)}$ or r. Relative price changes of bonds that do not contain accumulated coupon income are considered.

RESULTS AND DISCUSSION

Theorem 1. With a specified term to maturity, coupon rate and initial yield to maturity $r^{(m)}$, determined by the method of nominal interest rate, the percentage change in the bond price when the market interest rate changes by a given amount increases with an increase in the number of coupon payments per year.

A proof of the theorem 1. According to the condition, $r^{(m)}$ — initial yield to maturity of the bond, determined by the method of nominal interest rate. Then the initial bond price is equal:

$$P\left(r^{(m)}\right)=\sum_{i=1}^{n}\frac{q}{\left(1+r^{(m)}/m\right)^{i}}+\frac{A}{\left(1+r^{(m)}/m\right)^{Tm}}, \quad (8)$$

where $q=(1/m)Af$ — amount of each coupon payment. If $\tilde{r}^{(m)}$ — the yield to maturity of the bond as a result of an instant change in the market interest rate at a given value, then price of the bond will become equal:

$$P\left(\tilde{r}^{m}\right)=\sum\nolimits_{i=1}^{n}\frac{q}{\left(1+\frac{\tilde{r}^{(m)}}{m}\right)^{i}}+\frac{A}{\left(1+\frac{\tilde{r}^{(m)}}{m}\right)^{Tm}}. \quad (9)$$

Formula (8) is converted to form:

$$P\left(r^{(m)}\right)=\frac{A}{\left(1+r^{(m)}/m\right)^{Tm}}\left(1-\frac{f}{r^{(m)}}\right)+A\frac{f}{r^{(m)}}.$$

Auxiliary function in this case is:

$$\varphi\left(x,y\right)=\frac{A}{\alpha\left(x,y\right)}\left(1-\frac{f}{y}\right)+A\frac{f}{y},$$

where $\alpha\left(x,y\right)=\left(1+y/x\right)^{Tx}$, $x\geq 1$, $y=r^{(m)}$. Then

$$\varphi'_{x}\left(x,y\right)=-\frac{A}{\alpha^{2}\left(x,y\right)}\alpha'_{x}\left(x,y\right)\left(1-\frac{f}{y}\right),$$

$$\frac{\varphi'_{x}(x,y)}{\varphi(x,y)}=\frac{\frac{\alpha'_{x}\left(x,y\right)}{\alpha\left(x,y\right)}\left(\frac{f}{y}-1\right)}{\frac{f}{y}\left(\alpha\left(x,y\right)-1\right)+1}.$$

We use decomposition of functions $\alpha\left(x,y\right)$, $\frac{\alpha'_{x}\left(x,y\right)}{\alpha\left(x,y\right)}$ into power series:

$$\alpha\left(x,y\right)\approx 1+Ty+\frac{1}{2}T^{2}y^{2}-\frac{Ty^{2}}{2x},$$

$$\frac{\alpha'_{x}\left(x,y\right)}{\alpha\left(x,y\right)}\approx\frac{1}{2}T\left(\frac{y}{x}\right)^{2},$$

where $0<y<1$. We get:

$$\frac{\varphi'_{x}(x,y)}{\varphi(x,y)}\approx\frac{1}{2x^{2}}T\frac{\left(fy-y^{2}\right)}{1+fT+\frac{fT}{2}\left(T-\frac{1}{x}\right)y}.$$

We get the sign of derivative $\left(\frac{\varphi'_{x}(x,y)}{\varphi(x,y)}\right)'_{y}<0$ differentiating function $\frac{\varphi'_{x}(x,y)}{\varphi(x,y)}$ by variable y. Then, $\frac{\varphi'_{x}(x,y)}{\varphi(x,y)}$ — decreasing function of variable y. If $\tilde{y}<y$, then $\frac{\varphi'_{x}(x,\tilde{y})}{\varphi(x,\tilde{y})}>\frac{\varphi'_{x}(x,y)}{\varphi(x,y)}$ and expression (6) has a sign:

$$\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_{x}=\frac{\varphi(x,\tilde{y})}{\varphi(x,y)}\left(\frac{\varphi'_{x}(x,\tilde{y})}{\varphi(x,\tilde{y})}-\frac{\varphi'_{x}(x,y)}{\varphi(x,y)}\right)>0.$$

Table1

Dependence $\left|\Delta P(r^{(m)})/P(r^{(m)})\right|$ on the Parameter '*m*'

	$\left\|\Delta P(r^{(m)})/P(r^{(m)})\right\|$	
m / $\tilde{r}^{(m)}$	5%	7%
1	0.04329	0.04100
2	0.04376	0.04158
3	0.04392	0.04178
4	0.04400	0.04188
5	0.04405	0.04194
6	0.04408	0.04198
7	0.04410	0.04201
8	0.04412	0.04203
9	0.04413	0.04205
10	0.04414	0.04206
15	0.04418	0.04211
20	0.04419	0.04213
$\lim\limits_{m\to\infty}\left\|\frac{\Delta P(r^{(m)})}{P(r^{(m)})}\right\|$	0.04424	0.04219

Source: Compiled by the author.

If $\tilde{y} > y$, then $\dfrac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})} < \dfrac{\varphi'_x(x,y)}{\varphi(x,y)}$

and expression (7) has a sign:

$$\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_x = \frac{\varphi(x,\tilde{y})}{\varphi(x,y)}\left(\frac{\varphi'_x(x,y)}{\varphi(x,y)} - \frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})}\right) > 0.$$

Thus, at any rate the derivative is $\left|\dfrac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_x > 0$. This means that the function $\left|\dfrac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|$ is increasing by variable x. If $1 \le m_1 < m_2$, then

$$\left|\Delta\varphi(m_1,y)/\varphi(m_1,y)\right| < \left|\Delta\varphi(m_2,y)/\varphi(m_2,y)\right|.$$

Given the relation (5), we get:

$$\left|\Delta P(r^{(m)})/P(r^{(m)})\right|_{m=m_1} < \left|\Delta P(r^{(m)})/P(r^{(m)})\right|_{m=m_2},$$

where $m_1 < m_2$.

The more often coupons are paid, the greater the percentage change in the price of a bond when the market rate changes by a given amount, i.e. the greater the interest rate risk of the bond. The limit value:

$$\lim_{m\to\infty}\left|\frac{\Delta P\left(r^{(m)}\right)}{P\left(r^{(m)}\right)}\right| = \left|\frac{\left(1-\dfrac{f}{\tilde{r}^{(m)}}\right)e^{-T\tilde{r}^{(m)}}+\dfrac{f}{\tilde{r}^{(m)}}}{\left(1-\dfrac{f}{r^{(m)}}\right)e^{-Tr^{(m)}}+\dfrac{f}{r^{(m)}}}-1\right|. \quad (10)$$

Theorem is proved.

Calculations. In *Table 1*, the calculations of the $\left|\Delta P(r^{(m)})/P(r^{(m)})\right|$ are given for the values of the yield $\tilde{r}^{(m)} < r^{(m)}$ or $\tilde{r}^{(m)} > r^{(m)}$ when T = 5 years, f = 6%, $r^{(m)}$ = 6%. The prices are calculated by formulas (8) and (9), the limit values are calculated by formula (10).

As we can see, the calculation results confirm the assertion of Theorem 1. The proof of Theorem 1 showed that the result of using the yield to maturity in the form of a nominal interest rate turned out to be unsatisfactory due to its inconsistency with criterion (4).

Consider another solution to the task.

Theorem 2. With a specified term to maturity, coupon rate and initial yield to maturity r, determined by the method of effective interest rate, the percentage change in the price of the bond when the market interest rate changes by a given amount decreases with an increase in the number of coupon payments per year.

A proof of the theorem 2. According to the condition, r — initial yield to maturity of the bond, determined by the method of effective interest rate. Then the price of the bond at the initial moment is calculated by the formula:

$$P(r)=\sum_{i=1}^{n}\frac{q}{(1+r)^{i/m}}+\frac{A}{(1+r)^{T}}. \qquad (11)$$

If $\tilde{r}$ — yield to maturity of the bond as a result of an instant change in the market interest rate by a given value, then the price of the bond will be equal:

$$P(\tilde{r})=\sum_{i=1}^{n}\frac{q}{(1+\tilde{r})^{\frac{i}{m}}}+\frac{A}{(1+\tilde{r})^{T}}. \qquad (12)$$

Formula (11) is converted to form:

$$P(r)=Af\left(1-\frac{1}{(1+r)^{T}}\right)\frac{1}{m\left((1+r)^{\frac{1}{m}}-1\right)}+\frac{A}{(1+r)^{T}}.$$

Auxiliary function in this case is:

$$\varphi(x,y)=Af\left(1-\frac{1}{(1+y)^{T}}\right)\beta(x,y)+\frac{A}{(1+y)^{T}},$$

where $\beta(x,y)=\dfrac{1}{x\left((1+y)^{\frac{1}{x}}-1\right)}$, $x\geq 1$, $y=r$.

Then

$$\varphi'_x(x,y)=Af\left(1-\frac{1}{(1+y)^{T}}\right)\beta'_x(x,y),$$

where $\beta'_x(x,y)=-\beta^2(x,y)\left(x\left((1+y)^{\frac{1}{x}}-1\right)\right)'_x$.

Hence

$$\frac{\varphi'_x(x,y)}{\varphi(x,y)}=\frac{f\left((1+y)^{T}-1\right)\dfrac{\beta'_x(x,y)}{\beta(x,y)}}{f\left((1+y)^{T}-1\right)+\dfrac{1}{\beta(x,y)}}.$$

We use approximate equalities:

$$\frac{1}{\beta(x,y)}=x\left((1+y)^{\frac{1}{x}}-1\right)\approx y+\frac{1}{2}\left(\frac{1}{x}-1\right)y^2,$$

Table 2

Dependence $|\Delta P(r)/P(r)|$ on the Parameter '*m*'

	$\lvert\Delta P(r)/P(r)\rvert$	
***m* / $\tilde{r}$**	**5%**	**7%**
1	0.04935	0.04100
2	0.04545	0.04035
3	0.04414	0.04014
4	0.04349	0.04003
5	0.04310	0.03996
6	0.04284	0.03992
7	0.04266	0.03989
8	0.04252	0.03986
9	0.04241	0.03985
10	0.04232	0.03983
15	0.04206	0.03979
20	0.04193	0.03977
$\lim\limits_{m\to\infty}\left\lvert\dfrac{\Delta P(r)}{P(r)}\right\rvert$	0.04191	0.03970

Source: Compiled by the author.

$$\left(x\left((1+y)^{\frac{1}{x}}-1\right)\right)'_x\approx-\frac{y^2}{2x^2}, \quad (1+y)^{T}-1\approx yT,$$

where $0<y<1$. We get:

$$\frac{\beta'_x(x,y)}{\beta(x,y)}\approx\frac{\dfrac{y}{2x^2}}{1+\dfrac{1}{2}\left(\dfrac{1}{x}-1\right)y},$$

$$\frac{\varphi'_x(x,y)}{\varphi(x,y)}\approx\frac{\dfrac{fT}{2x^2}y}{fT+1+\dfrac{y}{2}\left(\dfrac{1}{x}-1\right)(fT+2)}.$$

We get the sign of derivative $\left(\dfrac{\varphi'_x(x,y)}{\varphi(x,y)}\right)'_y>0$ differentiating function $\dfrac{\varphi'_x(x,y)}{\varphi(x,y)}$ by variable y.

Then, $\frac{\varphi'_x(x,y)}{\varphi(x,y)}$ — increasing function of variable y. If $\tilde{y} < y$, then $\frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})} < \frac{\varphi'_x(x,y)}{\varphi(x,y)}$ and expression (6) has a sign:

$$\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_x = \frac{\varphi(x,\tilde{y})}{\varphi(x,y)}\left(\frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})} - \frac{\varphi'_x(x,y)}{\varphi(x,y)}\right) < 0.$$

If $\tilde{y} > y$, then $\frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})} > \frac{\varphi'_x(x,y)}{\varphi(x,y)}$ and expression (7) has a sign:

$$\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_x = \frac{\varphi(x,\tilde{y})}{\varphi(x,y)}\left(\frac{\varphi'_x(x,y)}{\varphi(x,y)} - \frac{\varphi'_x(x,\tilde{y})}{\varphi(x,\tilde{y})}\right) < 0.$$

Thus, at any rate $\tilde{y} = \tilde{r}$ the derivative is $\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|'_x < 0$. This means that the function $\left|\frac{\Delta\varphi(x,y)}{\varphi(x,y)}\right|$ is decreasing by variable x. If $1 \le m_1 < m_2$, then

$$\left|\Delta\varphi\left(m_2,y\right)/\varphi\left(m_2,y\right)\right| < \left|\Delta\varphi\left(m_1,y\right)/\varphi\left(m_1,y\right)\right|.$$

Given the relation (5), we get:

$$\left|\Delta P(r)/P(r)\right|_{m=m_2} < \left|\Delta P(r)/P(r)\right|_{m=m_1},$$

where $m_1 < m_2$.

The more often coupons are paid, the smaller the percentage change in the price of a bond when the market interest rate changes by a given amount, i.e. the lower the interest rate risk of the bond. The limit value:

$$\lim_{m\to\infty}\left|\frac{\Delta P(r)}{P(r)}\right| = \left|\frac{f\left(1-\frac{1}{(1+\tilde{r})^T}\right)\frac{1}{\ln(1+\tilde{r})}+\frac{1}{(1+\tilde{r})^T}}{f\left(1-\frac{1}{(1+r)^T}\right)\frac{1}{\ln(1+r)}+\frac{1}{(1+r)^T}}-1\right|. \quad (13)$$

Theorem is proved.

Calculations. In *Table 2*, the calculations of the $\left|\Delta P(r)/P(r)\right|$ are given for the values of the yield $\tilde{r} < r$ и $\tilde{r} > r$ when T = 5 years, f = 6%, r = 6%. The prices are calculated by formulas (11) and (12), the limit values are calculated by formula (13).

As you can see, the results of the calculations confirm the statement of theorem 2 and correspond to criterion (4).

CONCLUSION

Dependence of the results of studies of influence of coupon payments frequency on interest risk of bonds on the type of yield to maturity indicator is established. The use of yield to maturity, determined by the method of effective interest rate, these gave the results for interest risk bonds, consistent with the dependence of the duration bond on the number of coupon payments per year. Based on these consistent dependencies on the parameter m, it is possible to formulate the dependence of interest risk of the bond on the number of coupon payments per year: with the specified term to maturity, coupon rate and initial yield to maturity, the more often coupons are paid, the lower the interest rate risk of the bond.

The use of yield to maturity, determined by the method of nominal interest rate, did not yield results that can be given an economic explanation, which is similar to the result of using this indicator in the task about the price of the bond [23]. It can be concluded that the market agreement on the yield to maturity in the form of a nominal interest rate, although it has a predominant use in the market, in researches can lead to incorrect results. This indicator, which was formally developed for the convenience of market participants, is the approximate value of the bond yield to maturity, which may be considered as the major reason for the divergence of results.

The paper's results may be useful both to the bond issuer when constructing bond parameters, and to the investor when making investment decisions.

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

The article was submitted on 20.08.2022; revised on 03.09.2022 and accepted for publication on 27.01.2023.
The author read and approved the final version of the manuscript.

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DOI: 10.26794/2587-5671-2023-27-3-139-153
JEL G21, G41

How Effective is the Banking and Financial Services Sector in the United Arab Emirates in Using Technological Innovations

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ABSTRACT

The paper's goal is to determine the current state and trends of Fintech development in the United Arab Emirates' (UAE) financial sector, customer satisfaction with financial technology implementation in the banking sector, and the impact of financial technologies on the efficiency and competitiveness of financial and banking institutions. Qualitative research conducted through a structured questionnaire is designed to collect data from 500 banking service clients in the UAE. The data was collected through email communication and WhatsApp using Google forms. The data was evaluated using the Likert scale of five-point: 1 = strongly disagree to 5 = strongly agree. According to the survey **results**, the majority of respondents are familiar with FinTech services. The most demanded FinTech service was an app for financial management. Furthermore, the majority of respondents stated that the services they supplied were innovative to them, and the same percentage stated that they were pleased with the services given by their banks. Hence, better service associated with FinTech is seen as a major incentive for them to leave their current bank to the digital one. In addition, when selecting a bank, reliability is the most important criterion, with ease of use of its services ranking in second.

Keywords: FinTech; financial services management; financial institutions; UAE banking system; digital banking; FinTech startups

For citation: **Jumaa M. How effective is the banking and financial services sector in the United Arab Emirates in using technological innovations. *Finance: Theory and Practice*. 2023;27(3):139-153. DOI: 10.26794/2587-5671-2023-27-3-139-153**

INTRODUCTION

FinTech is a term that combines finance and technology. It is developing rapidly across international markets. Although the concept of FinTech has been pioneered in developed countries, emerging markets are catching up quickly against the backdrop of global market fluidity and the boundless nature of technology adoption [1] the international financial system through the unprecedented double expansion of innovation and technology in the financial sector [2]. The shift has been observed in terms of Information and Communication Technology (ICT) adoption, product diversity, implications for cost-effective methods, and information asymmetry. The development of FinTech in the financial sector has reduced transaction costs, increased international capital flows, and increased investment opportunities both locally and internationally.

Financial institutions' interest in adopting FinTech varies across countries [3]. A recent PWC survey revealed that 45% of respondents formed partnerships with FinTech in 2017, showing a 32% increase from the previous year. Germany led the way with a 70% adoption rate, while less established markets like Indonesia and South Africa had rates of 55% and 64%, respectively. To bridge the gap between established organizations and startups, new players must grasp and incorporate the latest technologies [4]. This involves leveraging ecosystems like social media platforms, big tech companies, financial infrastructure, and e-commerce.

PROBLEM STATEMENT

The UAE financial sector is under pressure to modernize and collaborate with emerging FinTech companies [5]. This digital transformation is crucial for staying competitive and adapting to the changing landscape. Significant investments are being made in the UAE to embrace technological advancements in finance. However, integrating FinTech faces challenges, especially due to the country's reliance on dual banking systems. The UAE government needs to establish appropriate regulations to ensure the successful integration of FinTech in the banking sector. Additionally, there are risks associated with FinTech operations, including potential financial

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losses. Users in the UAE show reluctance towards adopting FinTech-based services, with only 51% accepting mobile banking, a lower percentage compared to Western countries [6]. This reluctance may be influenced by the complex nature of digital banking and inconvenient user experiences in financial service centers [7].

RESEARCH QUESTIONS

The research discussed the following questions:

a. What is the trend of financial technology in the UAE financial institutions?

b. What are the effects of financial technology on the management of financial services in the United Arab Emirates?

c. What aspects of the legal regulation of the use of financial technologies in the UAE?

d. What could be the recommendations for financial institutions in the United Arab Emirates towards the integration of financial technology?

RESEARCH OBJECTIVES

The research objectives associated with this study are:

- to analyze the pattern of financial technology adoption in the United Arab Emirates;
- to explore the various sectors of finance that have embraced financial technology;
- to assess the influence of financial technology on the performance and competitiveness of financial and banking institutions;
- to gauge the level of customer satisfaction regarding the implementation of financial technology by the banking sector;
- to examine the existing utilization of financial technology for enhancing financial services in the UAE;
- to check FinTech benefits if financial institutions use FinTech technologies.

RESEARCH IMPORTANCE

This research paper is significant for its insights into financial technology and its impact on financial service management in the UAE. It provides relevant findings for financial institutions seeking to adopt FinTech while adhering to conventional and Islamic banking principles. The paper emphasizes the government's regulatory framework to promote FinTech adoption and highlights the benefits for users of the banking system. It can also address user reluctance to embrace FinTech services, especially during the current pandemic where online services are crucial. Additionally, the paper addresses challenges faced by the banking sector in integrating with FinTech, considering its significant contribution to the UAE's GDP. It aims to fill the research gap in the FinTech industry, particularly in financial service management within the UAE.

PREVIOUS STUDIES

Based on authors H. Bao and D. Roubaud the FinTech industry is huge and is expected to expand in the coming years [7]. In this regard, CB Insights revealed that there are 41 VC-backed FinTech institutions with a combined value of $ 154.1 billion. As a result, a significant catalyst for its growth is the increasing number of traditional banks that are embracing and endorsing technology by acquiring, investing in, or forming partnerships with FinTech startups.

Furthermore, H. Zarrouk, T. El Ghak and A. Bakhouche [8] mentioned that financial technology companies are integrating technologies such as blockchain, artificial intelligence, and data science into traditional financial sectors to make them faster, safer and more efficient. Thus, a paper published by scholar M.M. Mursalov [9] reported that FinTech is one of the rapidly growing technology sectors, with organizations innovating in almost every area of finance. For example, from loans and payments to stock trading and credit scoring. However, a study by Investment Monitor revealed that the courage behind FinTech varies from application to application and from project to project [10].

However, with the rise of FinTech, there are increasing concerns about cyber security in the industry [11], for example, the explosive and rapid growth of FinTech markets and institutions at the international level has increased exposure to uncertainty in the industry infrastructure while making financial technology companies a big target for cybercriminals.

Hence, the study examined the influence of various banking regulatory instruments on the likelihood of a banking crisis [12]. The results confirmed the effectiveness of banking regulation in predicting periods of stability in banking systems.

FinTech Examples

As the FinTech industry is growing rapidly and evoking the changing technology of the industry, banks and traditional financial services companies are also looking for ways to adopt FinTech services for various purposes [13]. In this regard, here are some of the areas of finance that FinTech is increasingly adopting.

D.A. Artemenko and S.V. Zenchenko [14] considered the issues related to the study of the prospects for the development of financial technologies in global practice and the possibilities of their adaptation in the activities of Russian financial organizations using an official data source of the Central Bank (Bank of Russia). It was concluded that improving the technological effectiveness of banking processes is possible on the basis of digitalization using various financial technologies. Additionally, [15] considered mobile banking as the largest part of the FinTech industry. Examples of some new banks are: Starling Banks and Monzo in the UK, which are digital banks that rely on mobile devices only and work on advanced technology within the company. Also, in the USA, Chime and Moven are at the forefront of smartphone-dependent banks rather than physical presence. Goldman Sachs, the traditional investment bank, switched to digital retail in 2016 [16].

Another example where FinTech has developed an explosion is the investment and savings advantage of financial banking. With the development of FinTech, investment barriers were broken, and companies such as Stash, Robinhood and Acrons played a role in this regard [17]. While these applications are different in approach and each uses a combination of automated small-dollar investing and a savings method such as introducing consumers to markets and instant deposits on purchases.

Furthermore, this paper investigated the factors that influence the attitudes of economic agents towards digital currencies and the effects of financial literacy on their utilization as investment assets and payment methods. The findings of this study [18] revealed that "insufficient financial literacy results in an overestimation of participants' knowledge within the cryptocurrency market".

Although the concepts of crypto currency and block chain are inherently unique technologies that can be considered outside the realm of FinTech, they essentially create practical applications that help FinTech develop further. In this regard, examples of some large block chain companies are Spring Labs, Circle, Gemini, and examples of crypto currencies are SALT and Coin base [19].

Moreover, P. S. Koklev [20] developed a methodological toolkit for scenario forecasting of possible consequences for the national economy of the introduction of blockchain technologies into the economic sector. The authors concluded that: "the integration of blockchain technologies into the business processes of the national economy affects the change in the financial results of credit institutions, an increase in capital liquidity of economic agents, as well as the acceleration of the processes of socialization of channels of access of business entities to financial markets".

Also, A.I. Mention [21] explained that, not surprisingly, there is a strong association between FinTech, machine learning, and training. The strength of this subset of Artificial Intelligence lies in its ability to run massive amounts of data through algorithms designed to detect risks and trends, allowing businesses, consumers and banks to report purchase and investment risks early in the process

Additionally, P. Dwivedi and co-authors [22] tested the hypothesis about the applicability of machine learning methods in training models capable of accurately forecasting the market capitalization of an enterprise. Author of this paper concluded that machine learning can be applied as a more accurate, unbiased, and less costly approach to value a company. Feature importance analysis can also be used to understand and further explore the value creation process.

Furthermore, consumers face difficulty in requesting credit reports multiple times within a year without impacting their credit score. FinTech has made the entire lending world more transparent for everyone. In this regard, examples of lending companies are Petal, Tala and Credit Karma [23].

The Age of FinTech in the UAE

According to [24], it is undeniable that the public is entering the age of FinTech. Internationally, the public finds itself at a moment of increased development in the financial services industry with a record level of mobile phone ownership. Moreover, the COVID-19 pandemic has moved digital services from an episodic to an indispensable level. The expansion of FinTech

is evident in the increasing trend observed in the Middle East, indicating a flourishing and dynamic environment for innovative FinTech solutions. For example (*Fig. 1*), the number of FinTech startups has gradually increased since 2015, and reaching 51 deals in 2019 [25]. The following figure shows the total funding and the annual number of deals of FinTech startups in the Middle East.

The United Arab Emirates has prioritized the advancement of financial technology as a national agenda, positioning it as one of the leading nations in the progression of technology within the financial sector. In particular, Abu Dhabi Global Market is committed to providing the ideal development for moving financial services into the future [26].

Looking at the growth of the financial services market (*Fig. 2*), it is reported that it continued to grow with a massive number of capitals raising deals in 2021, despite the pandemic (UAE FinTech Era, 2021). The following figure shows 2021 as the peak year for capital raising deals.

Similarly, paper [27] addressed that FinTech emerges as a prominent participant in the rapidly growing global market, numerous financial institutions are enhancing their offerings and simultaneously pursuing technological advancements such as advanced big data analytics and artificial intelligence. For example, Tarabut Gateway, the leading open banking platform in the Middle East, is revolutionizing the relationship between banks and financial technology.

Payment companies currently dominate the UAE FinTech market, accounting for a quarter of all FinTech companies. They are vastly outperforming their competitors, like InsurTech and Blockchain. Although there are relatively few FinTech companies in emerging industries such as artificial intelligence and open banking, significant development is expected in the coming years. The following (*Fig. 3*) shows the payment companies that make up the largest percentage in the United Arab Emirates [28].

Looking at the emerging trend above, it is estimated that 465 FinTech companies in the UAE will generate $ 2 billion in revenue from venture capital funding by 2022, compared to $ 80 million in 2017 [30]. In this aspect, the country shows a significant opportunity for companies and investors alike to take advantage of a world-class environment for innovation and to become part of the transformation of the traditional financial services sector towards a more modern one.

Impact of FinTech on Financial Services Sector in the UAE

According to [31], the UAE has one of the highest levels of Information and Communication Technology adoption internationally, ranking sixth out of 140 countries. Internet users make up more than 91% of the population, while mobile broadband and mobile cellular subscriptions have increased by 243% and 211%, respectively. Looking at these achievements, it was noted that the UAE government has applied its decentralized approach in the field of financial technology by introducing 40 free zones among its seven emirates, while there are specific and separate regulatory and governance structures under which each free zone operates. They are largely independent of the mainland authorities.

Therefore, [32] revealed that the tendency toward mobile-based financial payment services helped the Financial Services Department to provide better and secure payments.

Similarly, [33] identified the impact of FinTech in the context of the payment industry in the UAE while examining the developmental capacity of FinTech in retail, wholesale and corporate consumer payment procedures.

Challenges Being Faced by UAE Financial Management in the Adoption of Fintech

As per authors AlMomani and K. Alomari [10], the integration and development of financial technology conduit ecosystems in the United Arab Emirates (UAE) encounter various challenges, including a deficiency in essential skills. However, this challenge is not unique to the UAE, but the emergence of FinTech ecosystems at the international level has led to a growing demand for special expertise and skills. The increasing speed with which financial services, educational institutions, and government organizations are adapting.

One of the primary hurdles faced by financial institutions in the development of FinTech solutions is the cost associated with conducting business. These costs encompass both time and resources, which can significantly increase when integrating the new system into the FinTech ecosystem. Hence, over the past two

	Disclosed fintech funding ($m)	MAGNiTT undisclosed funding estimate ($m)	Deals
2015	18	0	18
2016	18	5	28
2017	109	12	38
2018	42	2	46
2019	25	5	51

Fig. 1. **Annual Number of Deals and Total Funding in MENA-Based FINTech Startups, 2015–2019**
Source: Based on J. Jagtiani et al. [24].

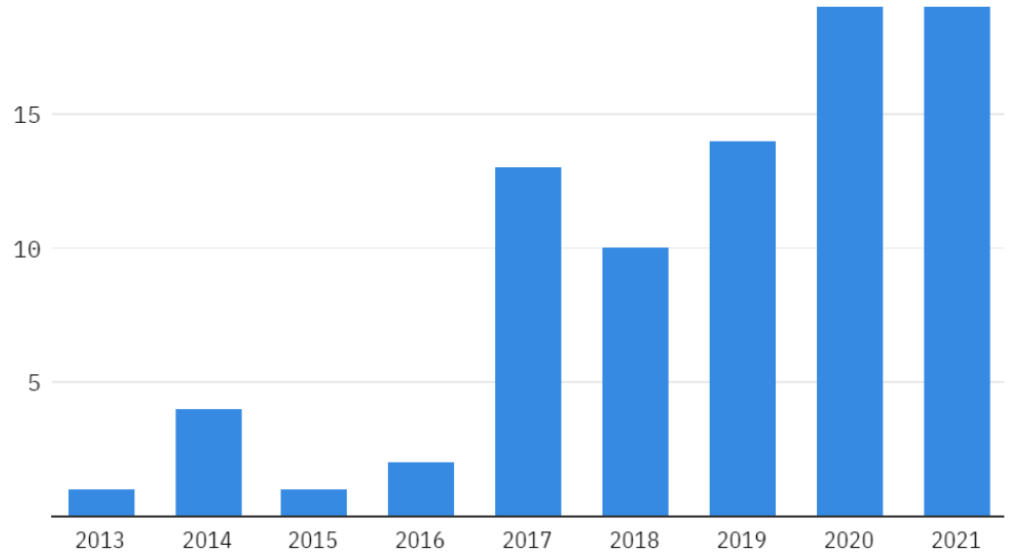

Fig. 2. **Number of Capitals Raising Deals in the Financial Services Sector, 2013–2021**
Source: Based on J. Jagtiani et al. [24].

years, Dubai International Financial Center (DIFC) and Abu Dhabi Global Market (ADGM) have demonstrated a high level of activity in promoting a flexible regulatory framework that enables financial services centers to manage the expenses associated with conducting business.

Regulation Laws in the UAE

The UAE has a strong legal system aimed at bolstering Anti Money Laundry efforts while supporting the widespread integration of crypto assets into commercial and government operations. The author noted that "a review of the UAE legislative framework reveals critical issues. First, current regulations do not cover decentralized finance (DeFi) or non-fungible tokens (NFT). Therefore, the absence of clear regulations for DeFi and NFT protocols has created room for money laundering and related criminal activities. Second, there is a high level of

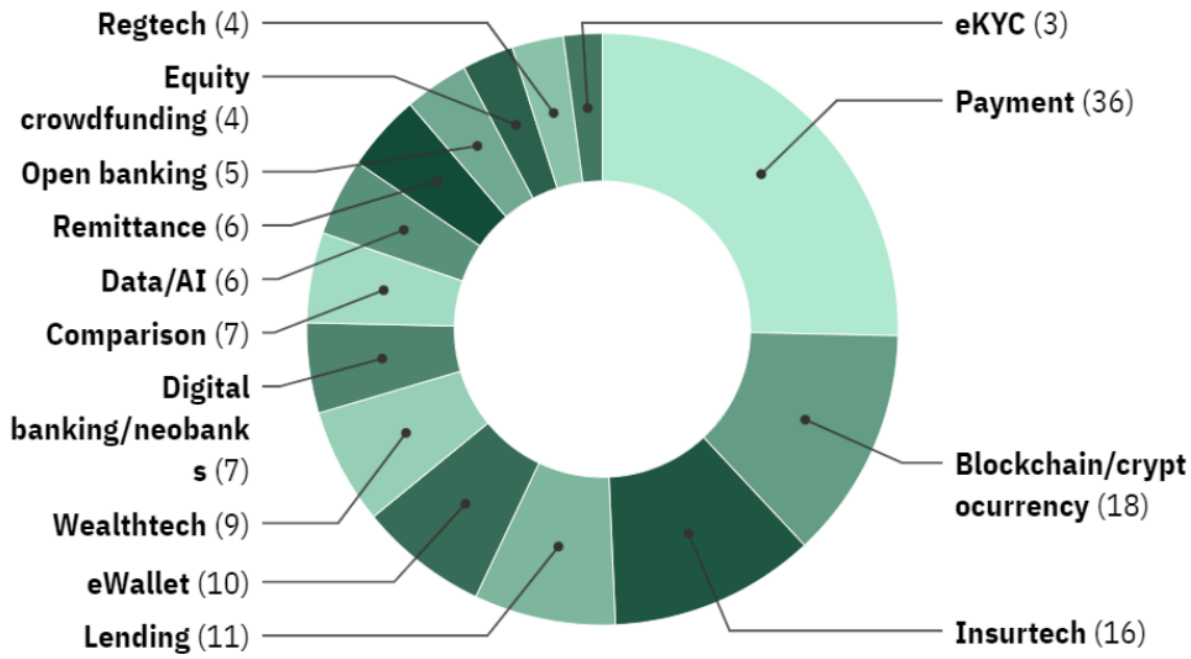

Fig. 3. **Payments Company Makes up Biggest Proportion of Fintech Companies in UAE Breakdown of Fintech Companies by Subsector, 2021**

Source: Based on A. AlMomani and K. Alomari [10].

fragmentation in the UAE's legislative landscape" in the paper [30].

The UAE does not have uniform national laws that apply to all Emirates. Fragmentation is not unique to the UAE, but a major global problem affecting the United States and the EU. Therefore, the Financial Action Task Force (FATF) should develop a global standard that supports a unified/harmonized application, laws and regulations related to cryptocurrencies and blockchain technology.

RESEARCH METHODOLOGY

Qualitative research was carried out through online surveys with the primary objective of gathering data on FinTech and its influence on financial service management in the UAE. The survey was conducted among a targeted population of 500 banking service clients, as they were deemed the most suitable group for the research focus.

The survey questionnaire was designed to be closed-ended, allowing respondents to complete it easily and with flexibility. Participants were required to select the most suitable option from various choices provided. However, a Likert scale was utilized to gather the data [32], as it is commonly employed in constructing survey questions that yield more precise insights into the opinions of respondents. The questionnaire consisted of two sections: the first section aimed to collect demographic information, while the second section focused on obtaining data through an Agree and Disagree format using the Likert Scale The purpose of gathering demographic details was to acquire more relevant information about the users of financial institution services and their level of engagement with FinTech applications. The questionnaire comprised a total of 15 questions derived from the existing literature.

Likewise, a wide range of secondary sources have been used to collect indirect data.

DATA ANALYSIS

This section presents the findings of the survey through the use of tables and graphs, with percentage analysis being employed for analysis purposes. As previously mentioned, the questionnaire was divided into two parts. The first part focuses on capturing the demographic information of the respondents, while the second part delves into examining the influence of FinTech on the management of financial services in the UAE.

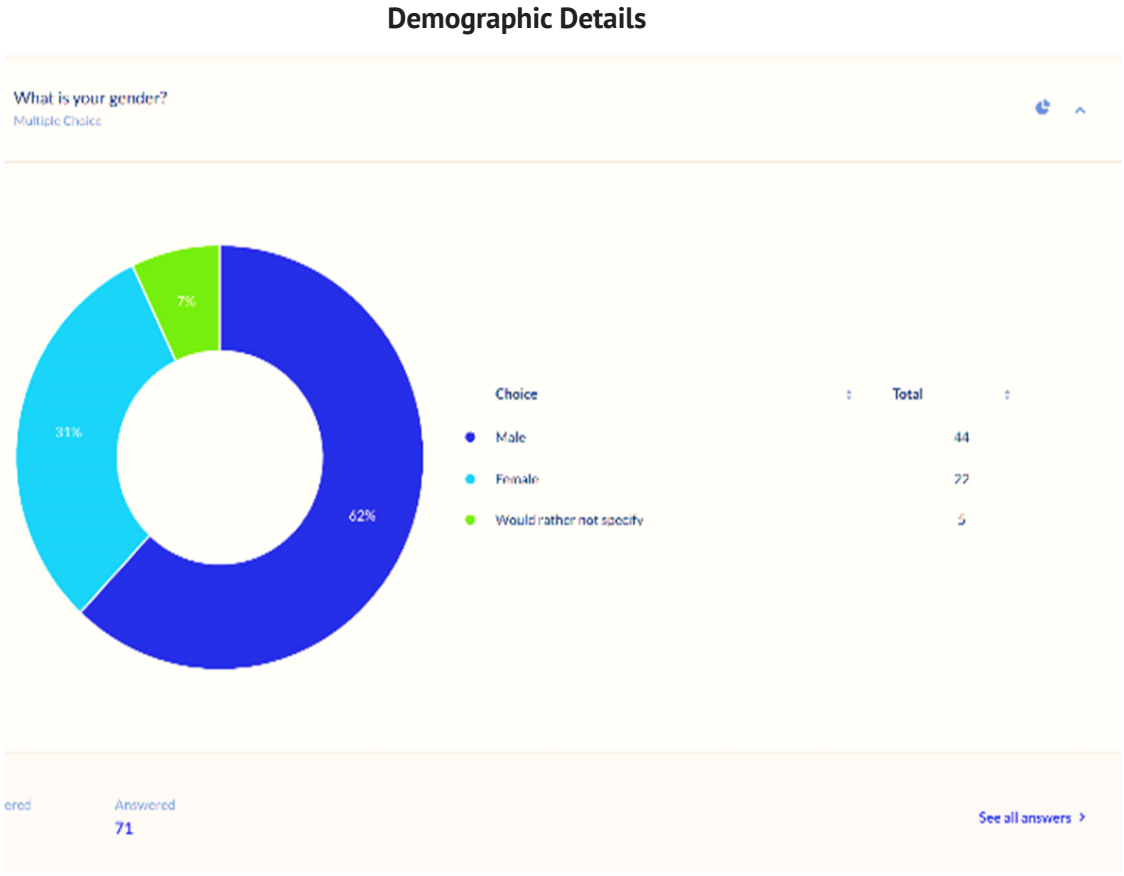

Fig. 4. **Question 1. What is Your Gender?**

Source: Researcher google survey analysis.

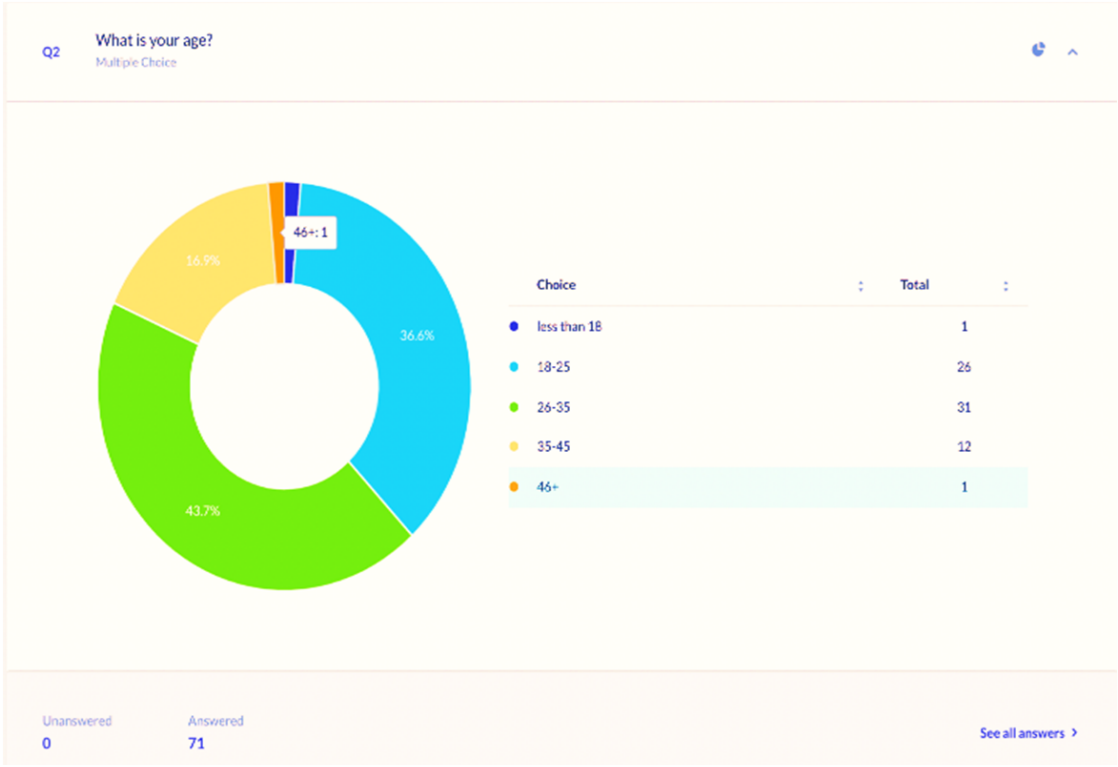

Fig. 5. **Question 2. What is Your Age?**

Source: Researcher google survey analysis.

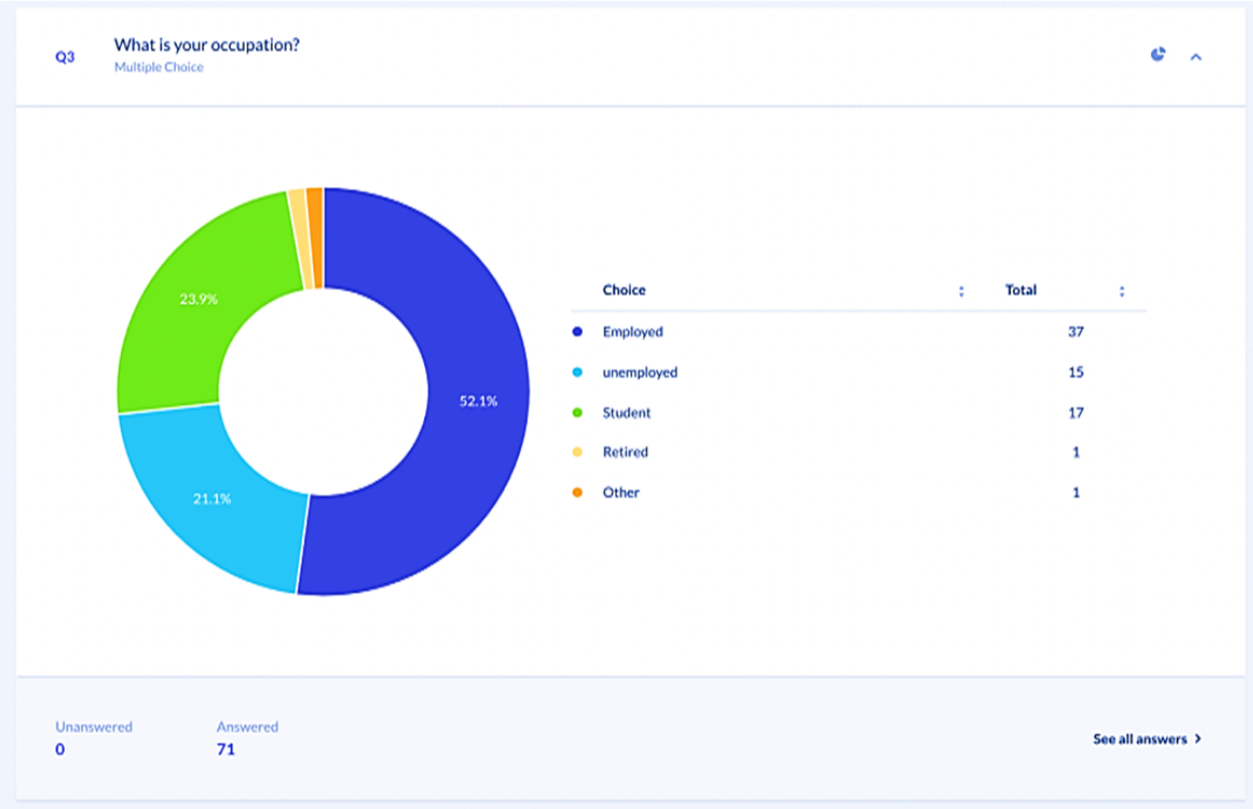

Fig. 6. **Question 3. What is Your Occupation Statue?**

Source: Researcher google survey analysis.

Figure 4 revealed that the male respondents dominated in the survey with a majority of 62%.

Figure 5 showed that different individuals from different age groups contributed to the survey. Around 47% of the respondents were between 26–35 years old.

According to *Fig. 6*, the majority of respondents were employed (52.1%), followed by 21% who were unemployed, and the remaining participants were students or retired individuals.

FinTech Questions: Below are the Questions that Connected with Fintech

Figure 7 concluded that people are not very aware of the term FinTech — since only 117 out of 450 respondents replied "yes", accounting for 26% compared to 44% who said "no".

Figure 8 demonstrates the preferences of respondents for various FinTech services. According to the data, 29% of participants found the Wealth Management App to be the most intriguing, followed by 26% who favored the Virtual Currency Platform. Additionally, 24% selected Peer to Peer Lending App, while AI/Robot Advisor was chosen by 24% of respondents. Only 3% of participants expressed interest in other FinTech services.

The examination of the pie chart in *Fig. 9* reveals that 65% of respondents expressed satisfaction with the innovative services offered by their current bank. In contrast, 25% of participants expressed dissatisfaction with the level of service improvement.

According to *Fig. 10*, the findings show that 65% of the respondents expressed their satisfaction with the services provided by their respective banks. On the other hand, 25% of the participants indicated dissatisfaction with the services offered by their bank.

The bar chart presented in *Fig. 11* displayed the reasons for customers switching their accounts to FinTech banks. It revealed that 46% of respondents left their traditional banks in favor of better financial technology. Furthermore, 19.7% switched their accounts to access a more user-friendly service, 11.3% cited the need for faster services, and another 11.3% were enticed by financial incentives. Additionally, a portion of the respondents transferred their accounts due to the lower transaction fees offered by FinTech banks.

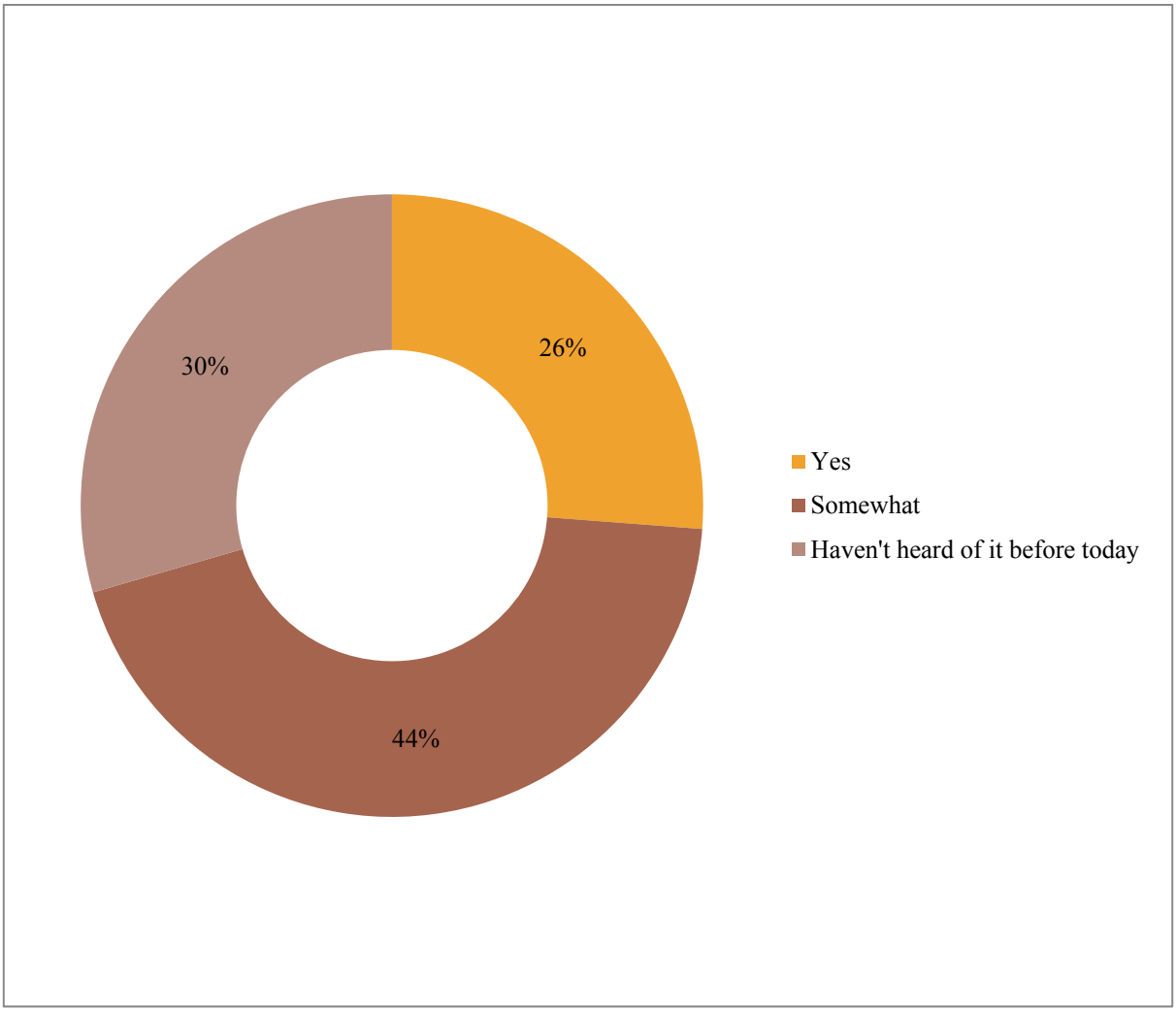

Fig. 7. **Q4. Are you Familiar with the Term FinTech?**

Source: Researcher google survey analysis.

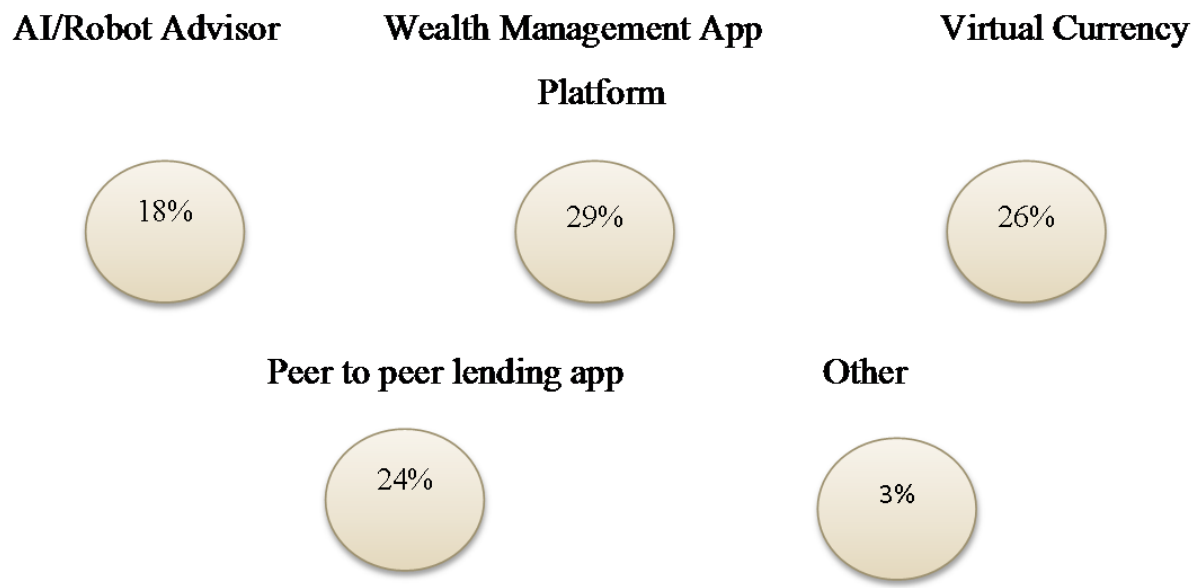

Fig. 8. **Q5. What Types of FinTech Services Would you be Interested in?**

Source: Researcher google survey analysis.

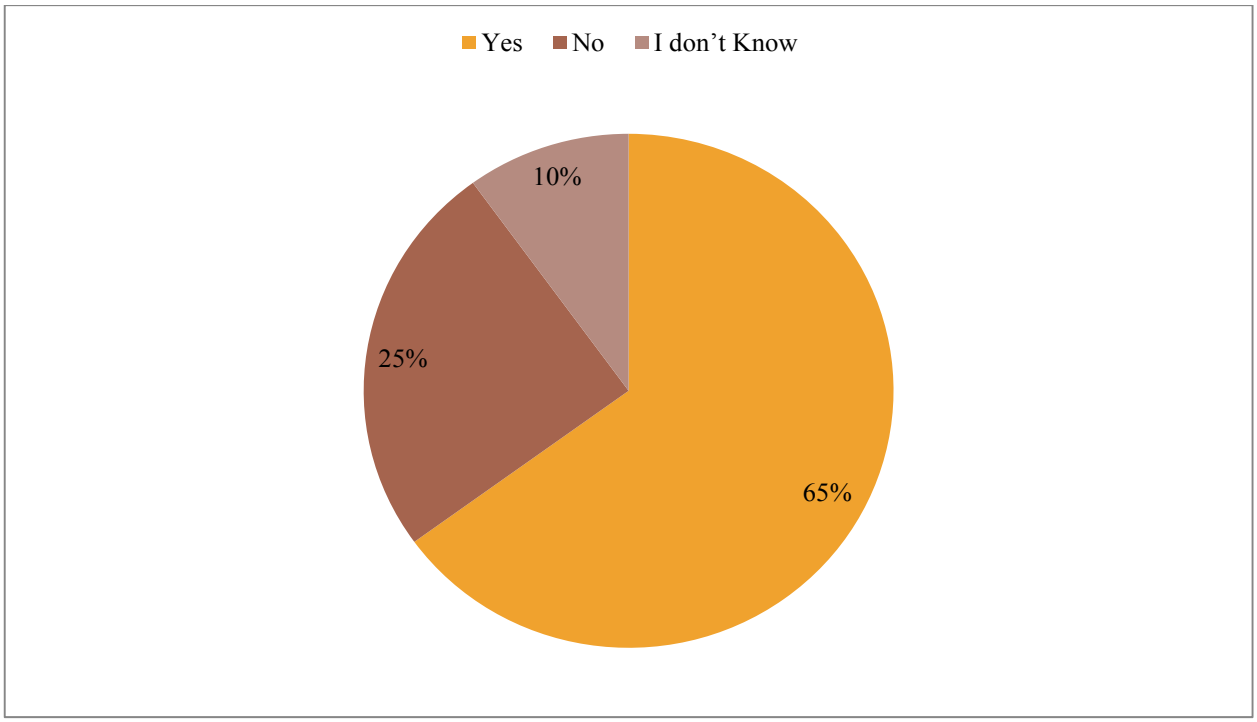

Fig. 9. **Q6. Are the Services of Your Current Bank Innovative?**

Source: Researcher google survey analysis.

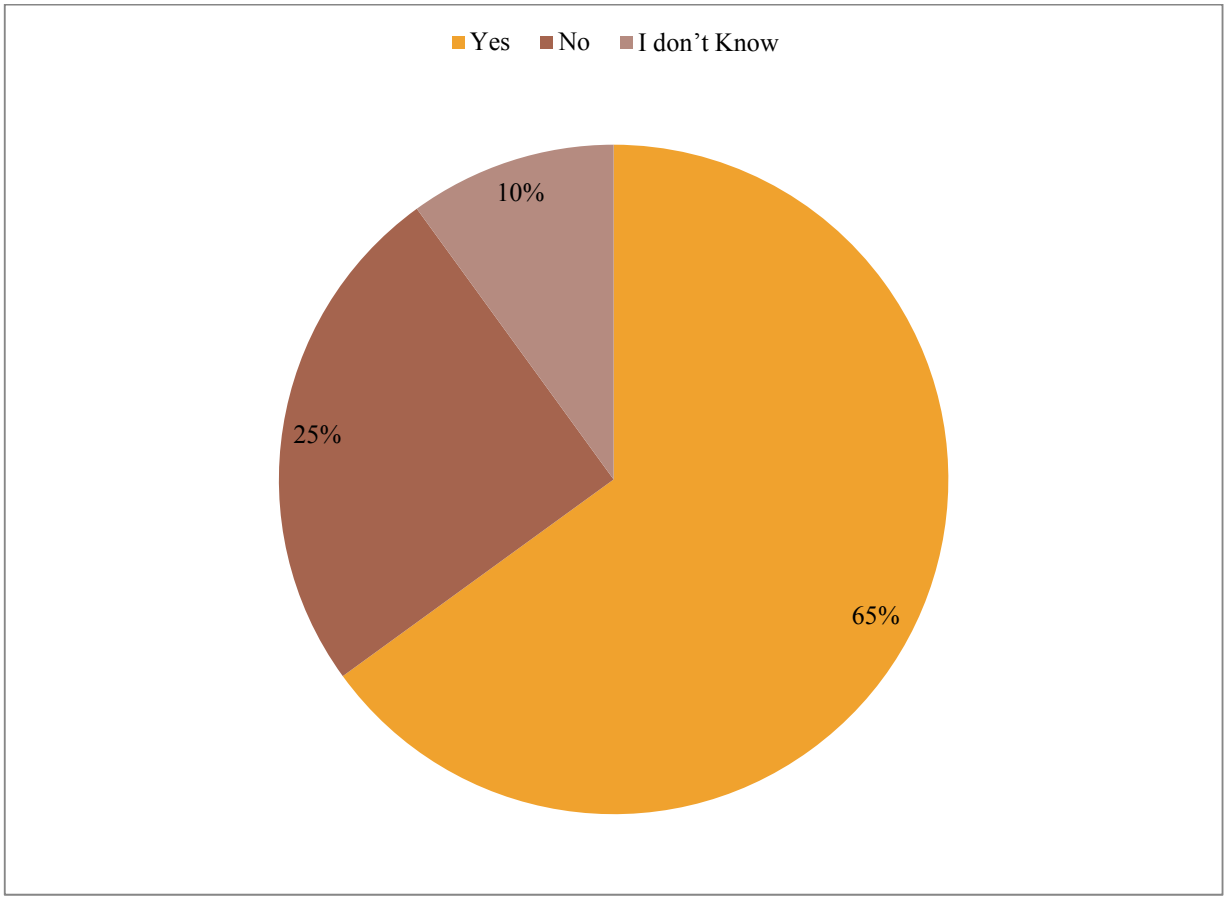

Fig. 10. **Q7. Are you Overall Satisfied with the Services at your Bank?**

Source: Researcher google survey analysis.

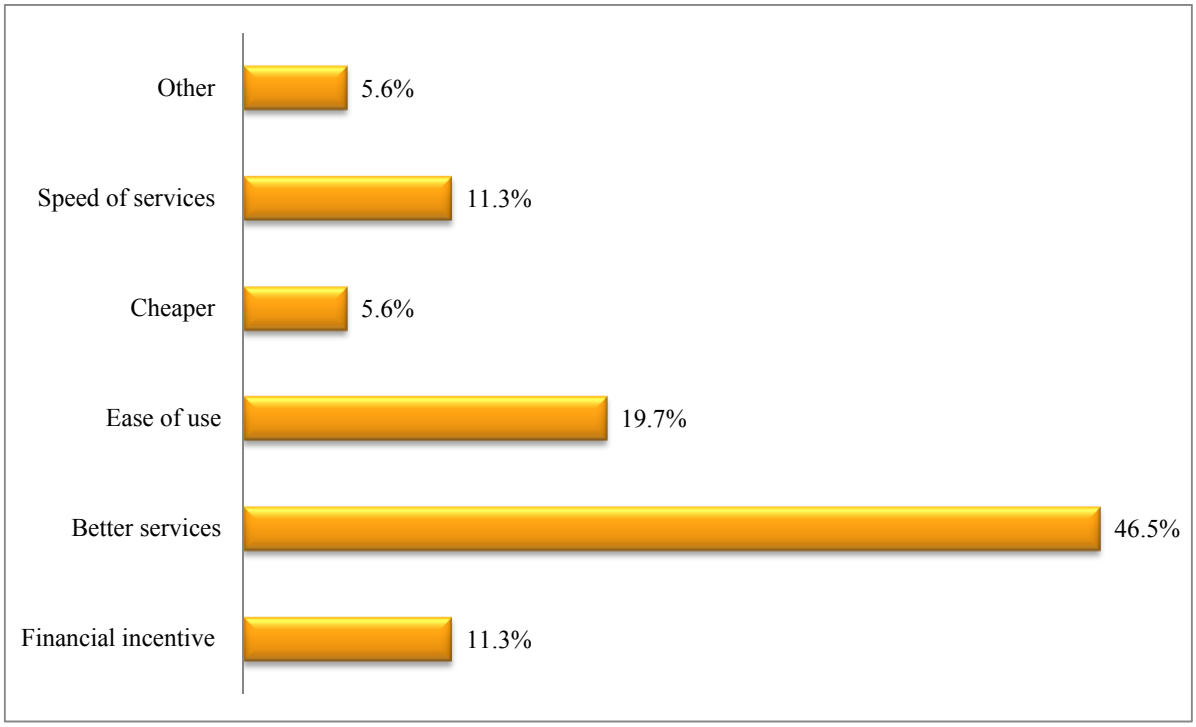

Fig. 11. **Q8. What Services or Incentives Would Persuade You to Leave Your Current Bank to Join a Fintech Bank?**

Source: Researcher google survey analysis.

The *Fig. 12* pie chart indicated that 36% choose their banks in terms of reliability, while 35% support ease of use of services, 12% because of diversification and quality of services, and 9% for financial incentives. The rest choose the bank because of prestige and other issues.

The stacked bar chart in *Fig. 12* indicates that the most commonly used payment method among respondents is debit/credit cards, with 70% of participants using them on a daily basis. In comparison, 40% of respondents reported using contactless payment methods, while 35% preferred cash transactions.

Participants using credit/debit cards weekly were given 37%, followed by cash by 35.4% of respondents.

Customers do not pay by check frequently, as 58.3% of respondents report that they do not currently use them.

DISCUSSION AND ANALYSIS

The results revealed that 62% of the respondents were male and 31% were female. The remaining 7% of respondents did not intend to specify their gender. Based on the findings, it can be observed that 36.6% of the participants fall within the age range of 18 to 25 years. Additionally, 43.7% of the respondents are between 26 and 35 years old, while 16.9% are between 35 and 45 years.

Demographic details showed that there were more males in the population as the majority of respondents were young. Regarding the respondents' profession, it was found that 52.1% of the respondents are employed, 21% of the respondents are unemployed, 23% of the respondents are students, and the rest are either retired or others. The results showed that the majority of the respondents who participated in the survey were employees.

Furthermore, based on the findings, it was concluded that FinTech is a new concept in financial services management and that the majority of people in the UAE are not yet familiar with it. However, the people of the UAE are open to accepting all FinTech services based on their perceived usefulness.

Moreover, respondents found the services of their current bank are innovative, and they are satisfied with the services in their bank. The majority of respondents answered reliability and financial incentives as the most important factors in financial services.

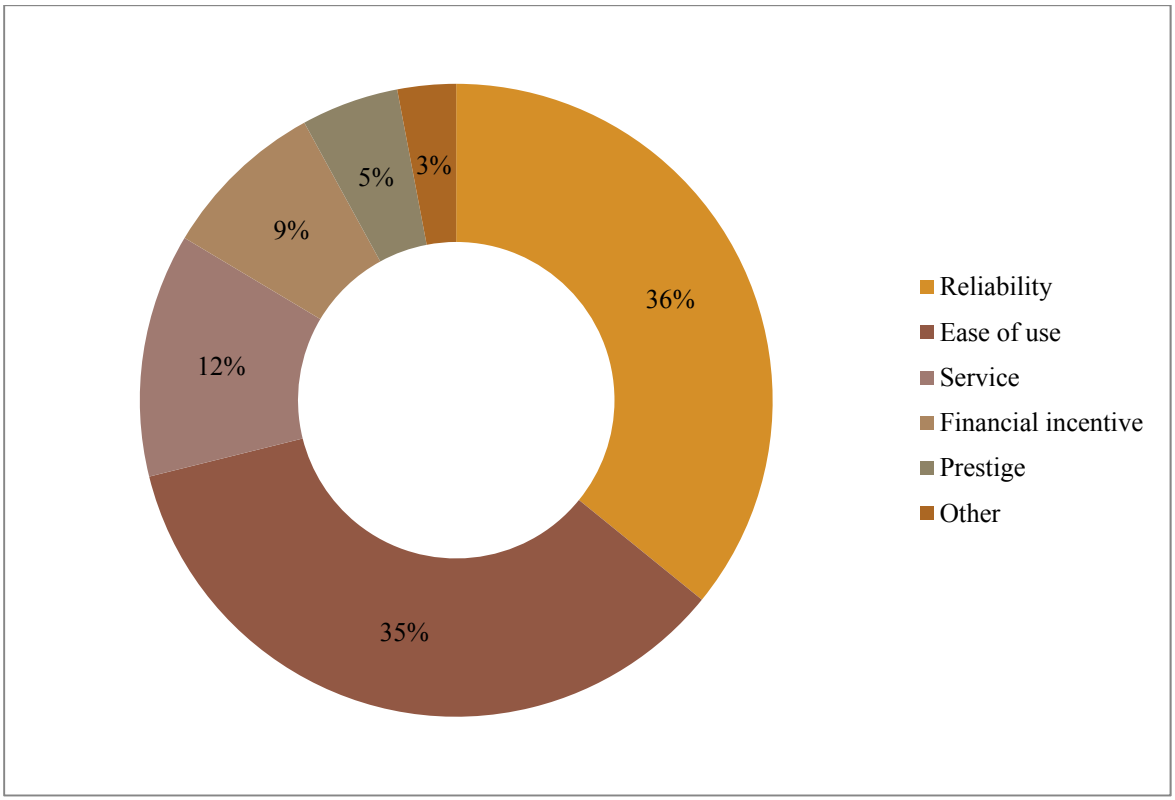

Fig. 12. **Q9. What are Most Important Factors in Selecting a Banking Institutions?**

Source: Researcher google survey analysis.

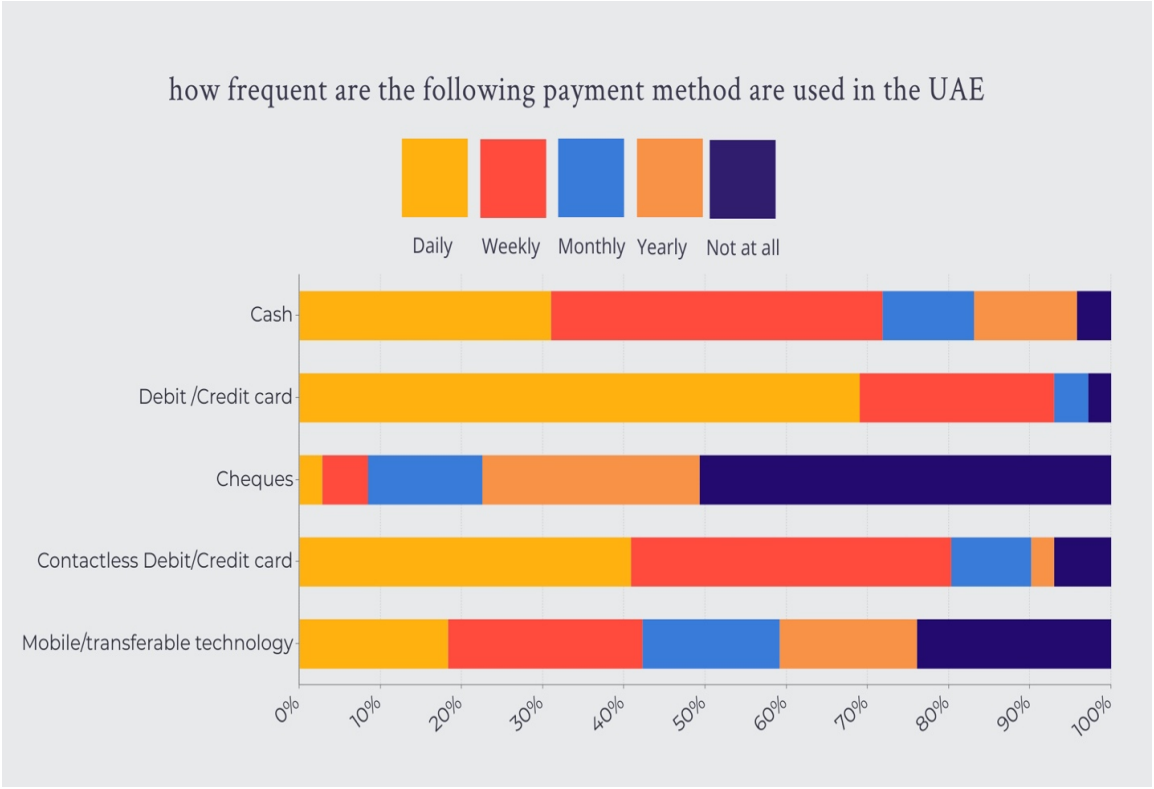

Fig. 13. **Question 10 to Question 15. How Frequently do you use the Following Payment Method?**

Source: Researcher google survey analysis.

LIMITATIONS OF THE RESEARCH

The primary constraint of this study is the sample size, given that FinTech is being embraced by numerous financial services centers and banking systems in the UAE, with millions of users. Consequently, the sampling of 450 respondents may not be fully representative of the entire population utilizing FinTech services. This limitation could potentially impact the outcomes, and results obtained may differ with a larger sample size.

The second limitation relates to the number of questions included in the questionnaire. Given the extensive scope of FinTech's impact on various aspects of financial services and the banking sector, encompassing these aspects in only 15 questions might create a gap. It would have been ideal to have a larger number of questions to cover all domains comprehensively. However, a specific number of questions were included in the questionnaire to prevent respondents from losing interest or becoming fatigued while completing it.

The last limitation is that the responses obtained from the survey rely entirely on the subjectivity of the individuals surveyed. Consequently, different respondents may have interpreted and answered the survey questions in varying ways, and some may have exhibited reluctance to complete the survey. As a result, the responses provided in such circumstances may not accurately reflect their true understanding of financial technology and its impact on financial institutions.

CONCLUSION

The subsequent findings present notable conclusions:

- The initial observation pertains to the comprehension of financial technology, which amalgamates finance and technology. Internet-based technologies are utilized in financial and banking institutions as FinTech. This concept is not only rapidly advancing in banking and financial management centers, but it is also recognized as a convenient approach for conducting financial transactions.
- Fintech companies are integrating technologies like blockchain, artificial intelligence, and data science into traditional financial sectors to enhance speed, security, and efficiency. FinTech finds applications in various financial domains, with mobile banking occupying a significant portion of the FinTech industry. FinTech has revolutionized investment and savings options within the financial sector.
- Despite the rapid technological advancements and easy access to advanced solutions in the banking sector, many financial institutions in the UAE still lag behind in adopting FinTech services. Therefore, there is a need to raise awareness about the benefits of FinTech among consumers who are more inclined towards traditional services and show hesitation in embracing FinTech.
- The impact of FinTech on financial service management in the UAE is evident in the growing preference for mobile financial payment services and transactions. These advancements have facilitated better and secure payments, improved performance, and enabled high-value creations for companies adopting FinTech in the UAE.
- When examining the challenges faced in integrating and developing FinTech ecosystems within the UAE banking system, it is evident that the international emergence of FinTech ecosystems has created a demand for specialized expertise and skills. The UAE should focus on bridging this skills gap by regulating the development of financial technology and attracting the required talent to the country.

FUTURE DIRECTION

Further research is warranted to address the limitations identified in this study and expand our understanding in this area. For instance, in a study conducted with a larger sample size and a larger number of questions, the researcher can determine the best location for the impact of financial technology on the management of financial services. Future research could identify other aspects not mentioned in this study that could have an impact on the management of financial services in the UAE in relation to the development of financial technology and its implications.

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

The article was submitted on 20.08.2022; revised on 03.09.2022 and accepted for publication on 27.01.2023. The author read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-154-175
UDC 336.647.64(045)
JEL G30, G32, G34

Peculiar Properties of the Financial State of Companies with Falling Income

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[d] Deutsche Bank Ltd, Moscow, Russia

ABSTRACT

The recent rise in inflation in Europe, caused by the pandemic, the increase in prices for energy resources and the violation of the logistics of energy supplies, has led to a decrease in company income. This makes it relevant to study the financial condition of companies with falling revenues. The **purpose** of this study is the development of tools for quantifying the impact of falling company incomes is becoming essential for making adequate management decisions. Until recently, such tools in capital structure theory did not exist. Two main theories of the capital cost and capital structure — Brusov — Filatova — Orekhova (BFO) theory and Modigliani — Miller (MM) theory — described companies with constant revenue: the first — for arbitrary age company, the second — for perpetuity companies. Within last couple years both these theories have been generalized for the case of variable revenue. In this paper the peculiar properties of the financial state of companies with falling income are studied within the modern capital cost and capital structure theory — Brusov–Filatova–Orekhova (BFO) theory, generalized for the case of variable revenue. As part of the goal, the **tasks** are solved to study the behavior of the main financial indicators (the cost of raising capital, the discount rate, the company's capitalization, the cost of equity, and others), their dependence on debt financing, the age of the company in the face of declining income, which will make it possible to make adequate management decisions and reduce risks for companies.

Keywords: Generalized Brusov–Filatova–Orekhova (BFO) theory; the companies with falling income; equity cost; the weighted average cost of capital; company capitalization

For citation: **Brusov P.N., Filatova T.V, Kashirin A.D., Kulik V.L. Peculiar properties of the financial state of companies with falling income.** ***Finance: Theory and Practice.*** **2023;27(3):154-175. DOI: 10.26794/2587-5671-2023-27-3-154-175**

INTRODUCTION

The capital structure affects all of a company's financial performance, including capitalization and the cost of raising capital. Until recently, two main theories of the capital cost and capital structure — Brusov–Filatova–Orekhova (BFO) theory and Modigliani — Miller (MM) theory — described companies with constant income: the first — for arbitrary age company, the second — for perpetuity companies. Within last couple years, both these theories have been generalized to the case of variable revenue. This allows study the financial state of companies with falling revenue, with growth revenue and with alternating periods of falling and rising revenue.

The recent rise in inflation in Europe, caused by the pandemic, the military conflict, the increase in prices for energy resources and the violation of the logistics of energy supplies, has led to a decrease in company income. This makes it relevant to study the financial condition of companies with falling revenues. The purpose of this study is the development of tools for quantifying the impact of falling company incomes is becoming essential for making adequate management decisions. The article develops and applies an approach that allows to investigate the financial state of companies with falling revenues.

From a historical point of view, the theory of Modigliani and Miller was the first quantitative theory of the cost of capital and the structure of capital [1–3]. The authors, under a variety of assumptions, including the absence of corporate and individual taxes, the perpetuity of all companies and all cash flows, etc., obtained results that are completely different from the results of the traditional approach that existed before: the capital structure does not affect the financial performance of companies. Over the decades, many attempts have been made to modify the Modigliani–Miller theory [4–14].

Recently, Brusov et al. adapted two main theories of capital structure (Brusov–Filatova–Orekhova and Modigliani–Miller) to establish the practice of the function of companies [15–17]. This generalization

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takes into account the real conditions of the work of the companies. The Brusov–Filatova–Orekhova (BFO) theory, its methodology, and results are widely known (see, for example, [14, 19–26]). A lot of authors of [21–23] use the BFO theory in practice.

THEORETICAL BACKGROUND

One of the generalization of two main theories of capital structure (Brusov–Filatova–Orekhova and Modigliani — Miller) was coupled to account a variable revenue.

In case of Brusov–Filatova–Orekhova theory the following formula has been derived [16].

$$\frac{1-\left(\frac{1+g}{1+\mathrm{WACC}}\right)^n}{\mathrm{WACC}-g}=\frac{1-\left(\frac{1+g}{1+k_0}\right)^n}{(k_0-g)\cdot\left(1-w_d t\left[1-(1+k_d)^{-n}\right]\right)}. \quad (1)$$

Here, 'n' is company age; WACC is the weighted average cost of capital; 'k0' is equity cost at L = 0; 'wd' is debt share; 'kd' is debt cost; 'g' is revenue growth rate; 't' is tax on profit rate; 'L' is the leverage level.

For perpetuity (Modigliani–Miller) limit ($n \to \infty$) we arrive at the following equation for WACC in case of variable revenue [15].

$$\mathrm{WACC}=(k_0-g)\cdot(1-w_d t)+g\,. \quad (2)$$

Formulas (1) and (2) allow study the financial state of companies with falling revenue, with growth revenue and with alternating periods of falling and rising revenue.

RESULTS AND DISCUSSIONS

Using formulas (1) and (2), the dependences of the main financial parameters of the financial state of the company: weighted average cost of capital, WACC, discount rate, WACC –g, company value 'V', and the cost of equity 'ke' on the leverage level 'L' at different values of income falling rate 'g', different debt cost 'kd', different company ages are studied, as well as the dependence of WACC on company age 'n'. The results of calculations within Microsoft are presented below for the following financial parameters of the company: WACC, WACC –g, V, ke. Calculations are made for debt costs kd = 0.03; 0.04; 0.05 and for three company ages n = 3; 6; 9. The study was carried out for the parameters of the "Gazprom Ltd" company calculated by the authors.

CALCULATIONS FOR DEBT COST KD = 0.03

Calculations of weighted average cost of capital, WACC

Below we present the results of calculations at debt cost kd = 0.03.

From *Fig. 1* it is seen that all WACC(L) curves decrease with level of leverage 'L' at all 'g' values and all company ages n = 3; 6; 9. WACC values decrease with company age, but increase with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed age is ordered as follows (from bottom to top): g = –0.05; –0.04; 0. **The distance between the curves corresponding to different fall rates increases with the age of the company.** An increase in WACC as the rate of fall of 'g' increases indicates that WACC is no longer a discount rate, since it is intuitively clear that the discount rate must decrease as the rate of fall of g increases in order for the value of the company to rise as 'g' increases. As will be seen in the next paragraph, the role of the discount rate is transferred to WACC–g.

Calculations of discount rate, WACC–g

From *Fig. 2* it is seen that all (WACC–g)(L) curves decrease with level of leverage L at all g values and all company ages n = 3; 6; 9. WACC–g values decreases with company age 'n', as well as with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed falling rate 'g' is ordered as follows (from bottom to top): n = 9; 6; 3. **The distance between the curves corresponding to different company ages decreases with** falling rate 'g'. A decrease in WACC–g as the rate of fall of 'g' increases indicates that WACC–g is a discount rate, because in this case the value of the company rises as 'g' increases. Thus, the role of the discount rate is transferred from WACC to WACC–g. This could be seen as well from the BFO — formula (1).

Calculations of company value, V

As it could be seen from *Fig. 3* the company value 'V' increases with level of leverage L at all g values and all company ages n = 3; 6; 9. The company value 'V' increases with company age, as well as

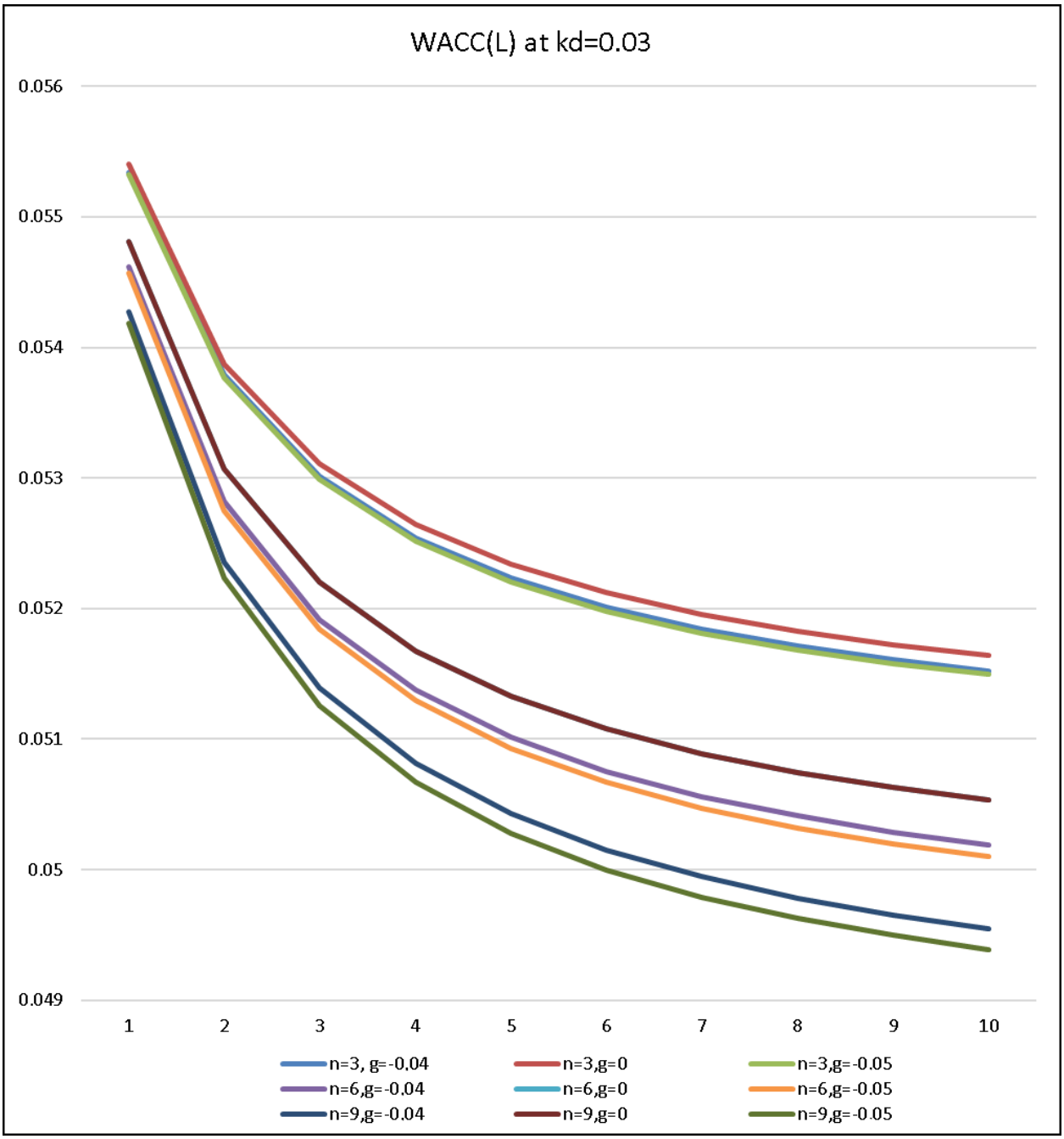

Fig. 1. **The WACC Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed age 'n', is ordered as follows (from bottom to top): g = –0.05; –0.04; 0. **The distance between the curves corresponding to different fall rates increases with the age of the company.** This means that influence of falling rate 'g' increases with company age 'n'. For example, under decrease 'g 'on 5% (g = –0.05): for nine-year company (n = 9) company value 'V', decreases by 12.3%, while for six-year company (n = 6) company value 'V', decreases by 10.9%, and for three-year company (n = 3) company value 'V', decreases by 4.7% only. An important conclusion is that the impact of the rate of decline in revenue 'g' on the value of company 'V' increases significantly with the age of company 'n'.

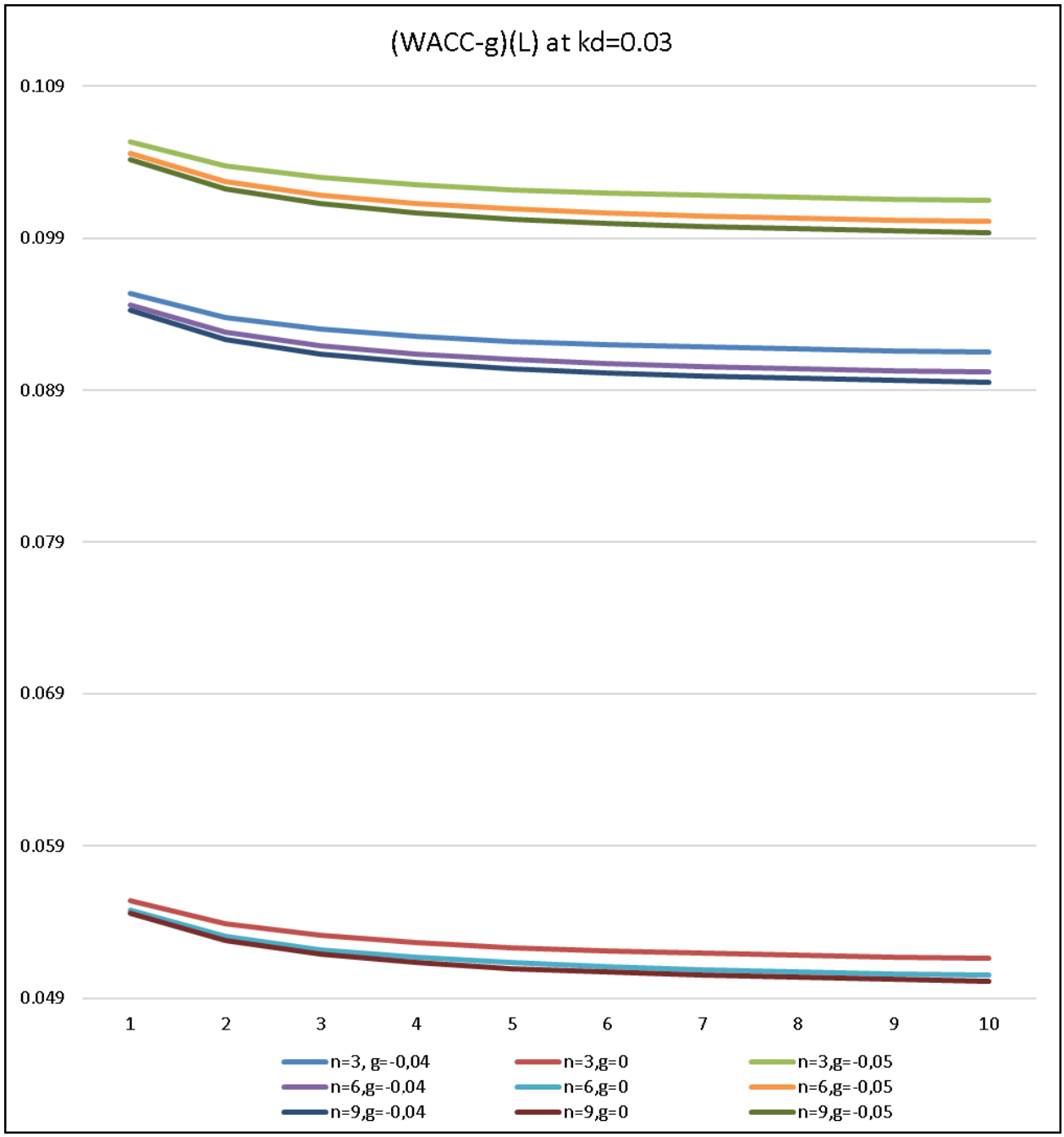

Fig. 2. **The Discount Rate, WACC–g, Depending on the Level of Leverage L at Different Fall Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

Calculations of equity cost, ke

The equity cost 'ke', as it is seen from *Fig. 4 and Fig. 5*, linearly grow with level of leverage 'L' at all falling rate 'g' and all company age 'n'. The tilt angle of the curve ke (L) grows with 'g', but decrease with company age 'n'. There is intermixture of the lines ke (L), corresponding to company ages six and nine years at different falling rate 'g'. It could lead to some interesting effects, because the cost of equity, being an economically justified amount of dividends, determines the company's dividend policy.

CALCULATIONS FOR DEBT COST KD = 0.04

Calculations of weighted average cost of capital, WACC

Below we present the results of calculations at debt cost kd = 0.04.

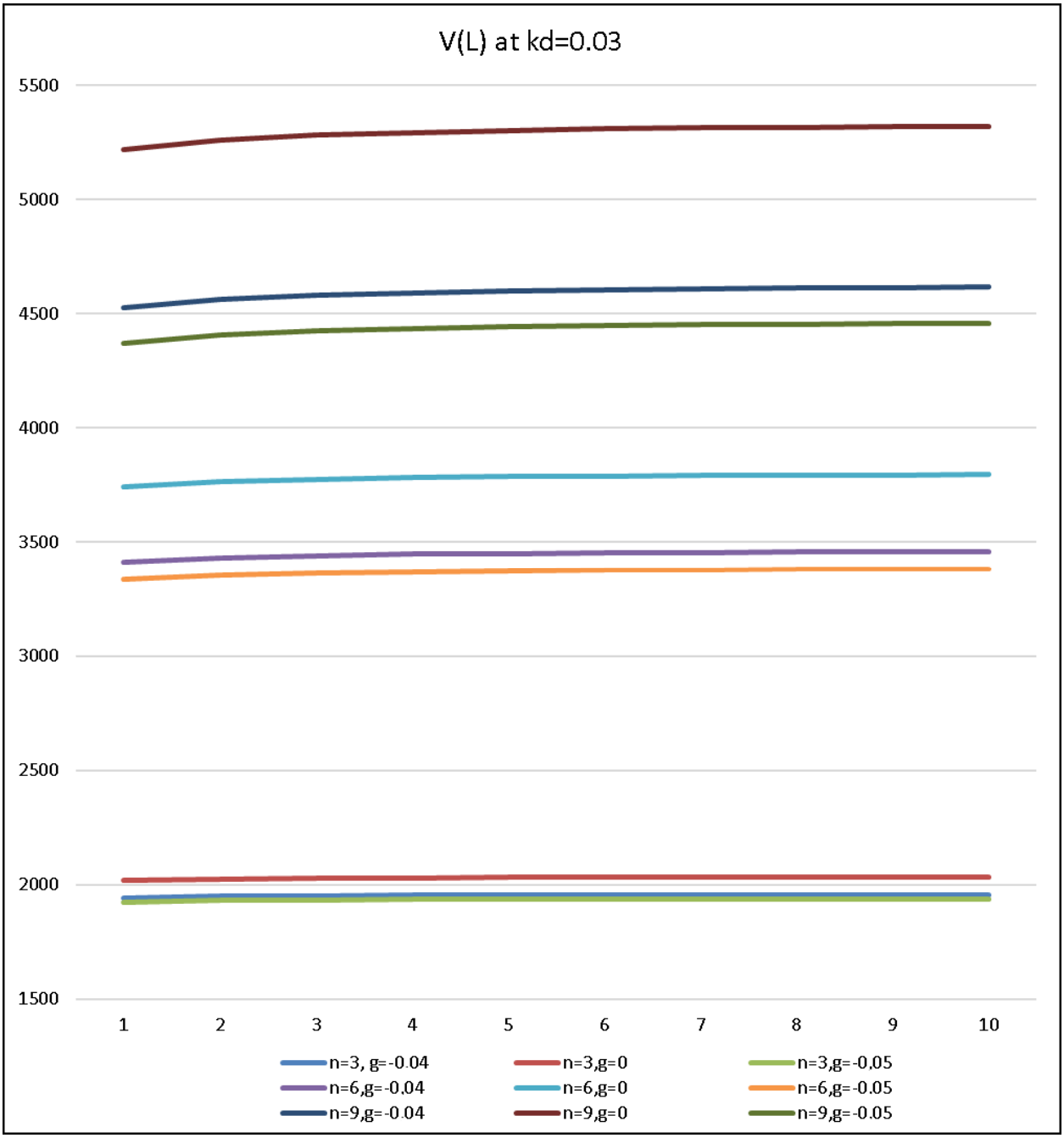

Fig. 3. **The Company Value, V, Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and different company age n = 3; 6; 9**

Source: Compiled by the authors.

From *Fig. 6* it is seen that all WACC(L) curves decrease with level of leverage 'L' at all 'g' values and all company ages n = 3; 6; 9. WACC values decrease with company age, but increase with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed age is ordered as follows (from bottom to top): g = –0.05; –0.04; 0. **The distance between the curves corresponding to different fall rates increases with the age of the company.** An increase in WACC as the rate of fall of 'g' increases indicates that WACC is no longer a discount rate, since it is intuitively clear that the discount rate must decrease as the rate of fall of 'g' increases in order for the value of the company to rise as 'g' increases. As will be seen in the next paragraph, the role of the discount rate is transferred to WACC–g.

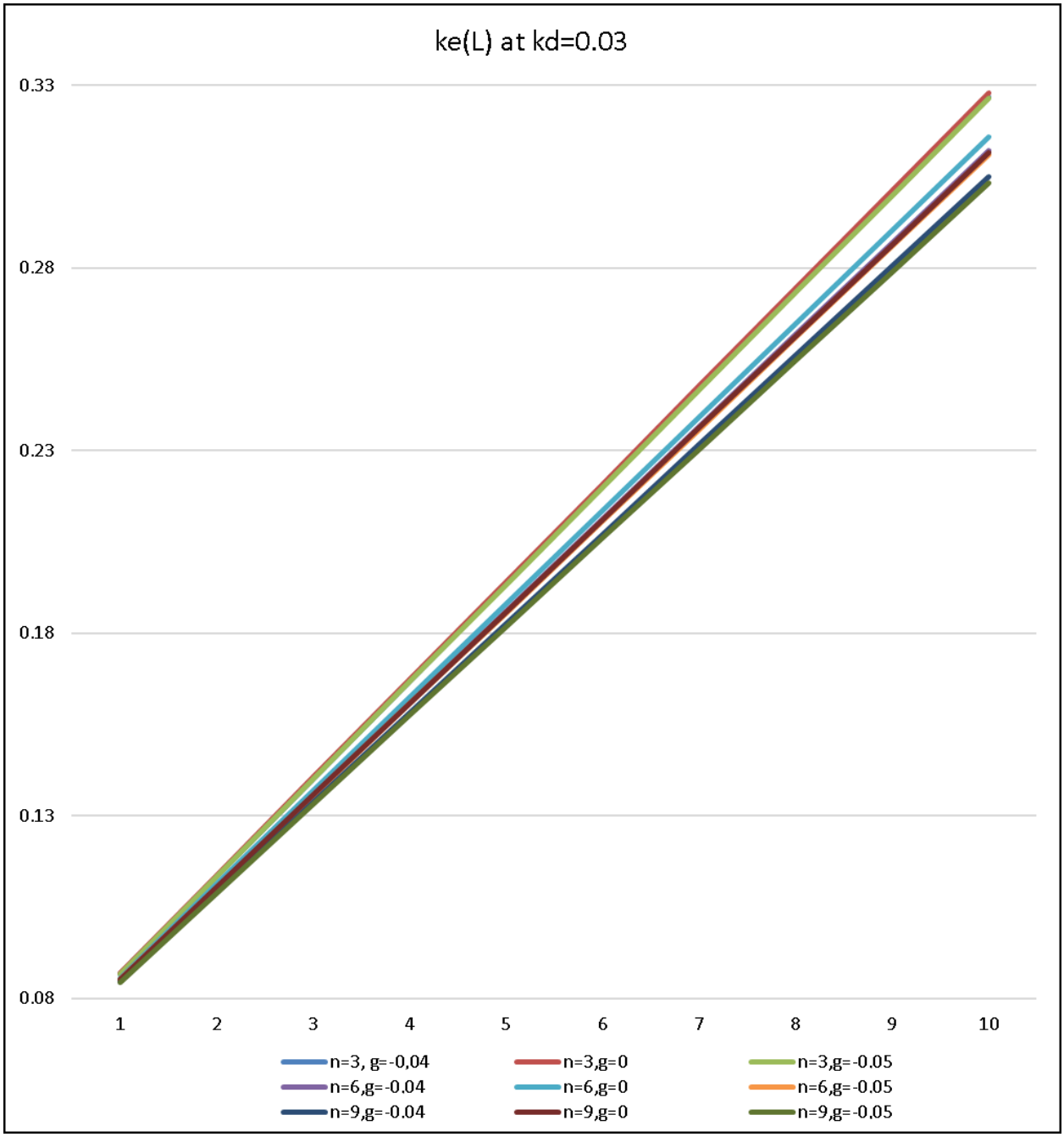

Fig. 4. **The Equity Cost, ke, Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

Calculations of discount rate, WACC–g

From *Fig. 7* it is seen that all (WACC–g) (L) curves decrease with level of leverage L at all 'g' values and all company ages n = 3; 6; 9. WACC–g values decrease with company age 'n', as well as with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed falling rate 'g' is ordered as follows (from bottom to top): n = 9; 6; 3. **The distance between the curves corresponding to different company ages decreases with** falling rate 'g'. A decrease in WACC–g as the rate of fall of g increases indicates that WACC–g is a discount rate, because in this case the value of the company rises as 'g' increases. Thus, the role of the discount rate is transferred from WACC to WACC–g. This could be seen as well from the BFO–formula (1).

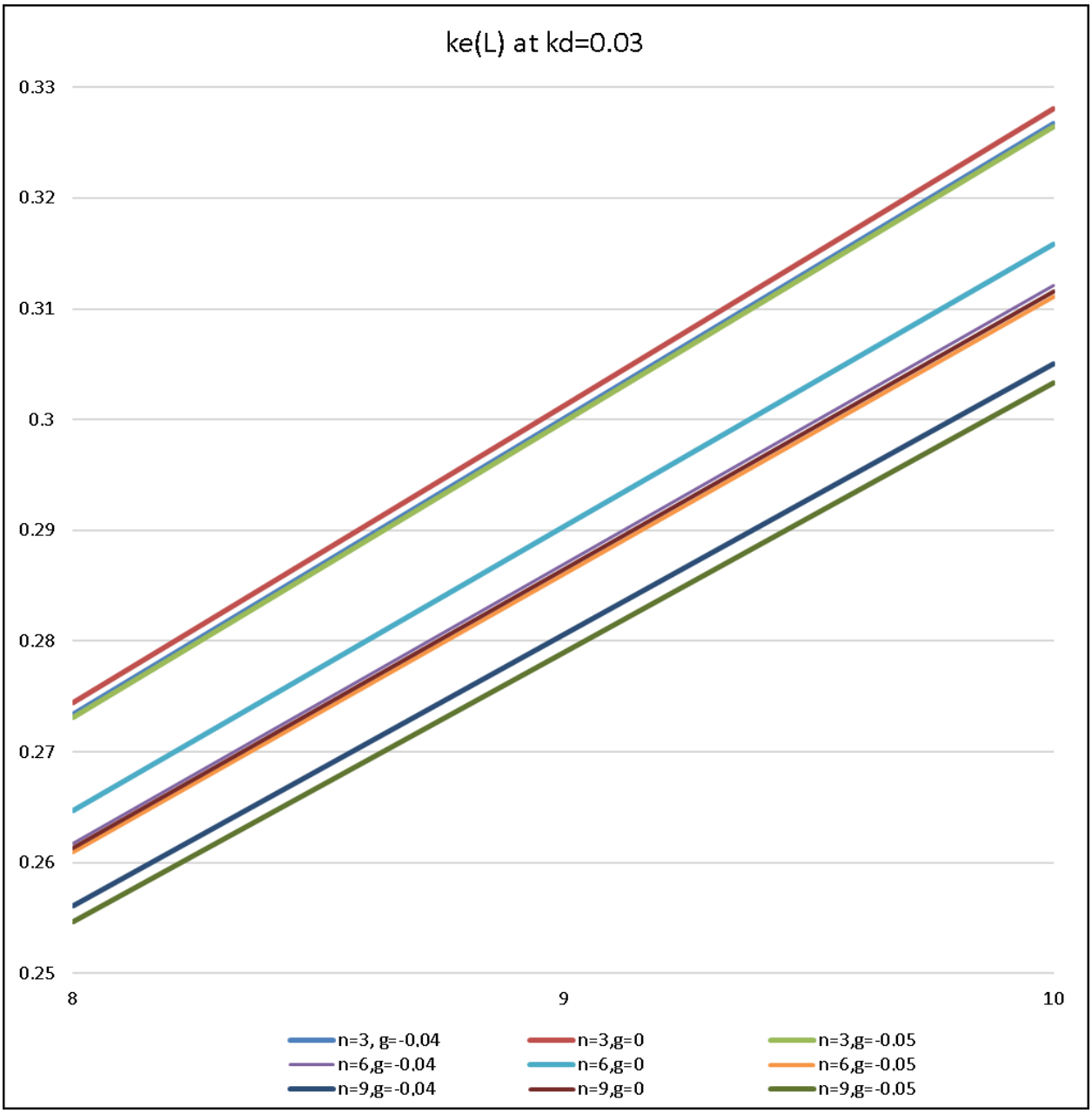

Fig. 5. **The Equity Cost, ke, Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9 (Bigger Scale)**

Source: Compiled by the authors.

Calculations of company value, V

As it could be seen from *Fig. 8* the company value 'V', increase with level of leverage L at all 'g' values and all company ages n = 3; 6; 9. The company value 'V' increases with company age, as well as with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed age 'n' is ordered as follows (from bottom to top): g = –0.05; –0.04; 0. **The distance between the curves corresponding to different fall rates increases with the age of the company.** This means that influence of falling rate 'g' increases with company age 'n'. For example, under decrease 'g' on 5% (g = –0.05): for nine-year company (n = 9) company value 'V' decreases by 12.3%, while for six-year company (n = 6) company value 'V' decreases by 10.9%, and for three-year company (n = 3) company value 'V' decreases by 4.7% only. An important conclusion is that the impact of the rate of decline in revenue g on the value of company 'V' increases significantly with the age of company 'n'.

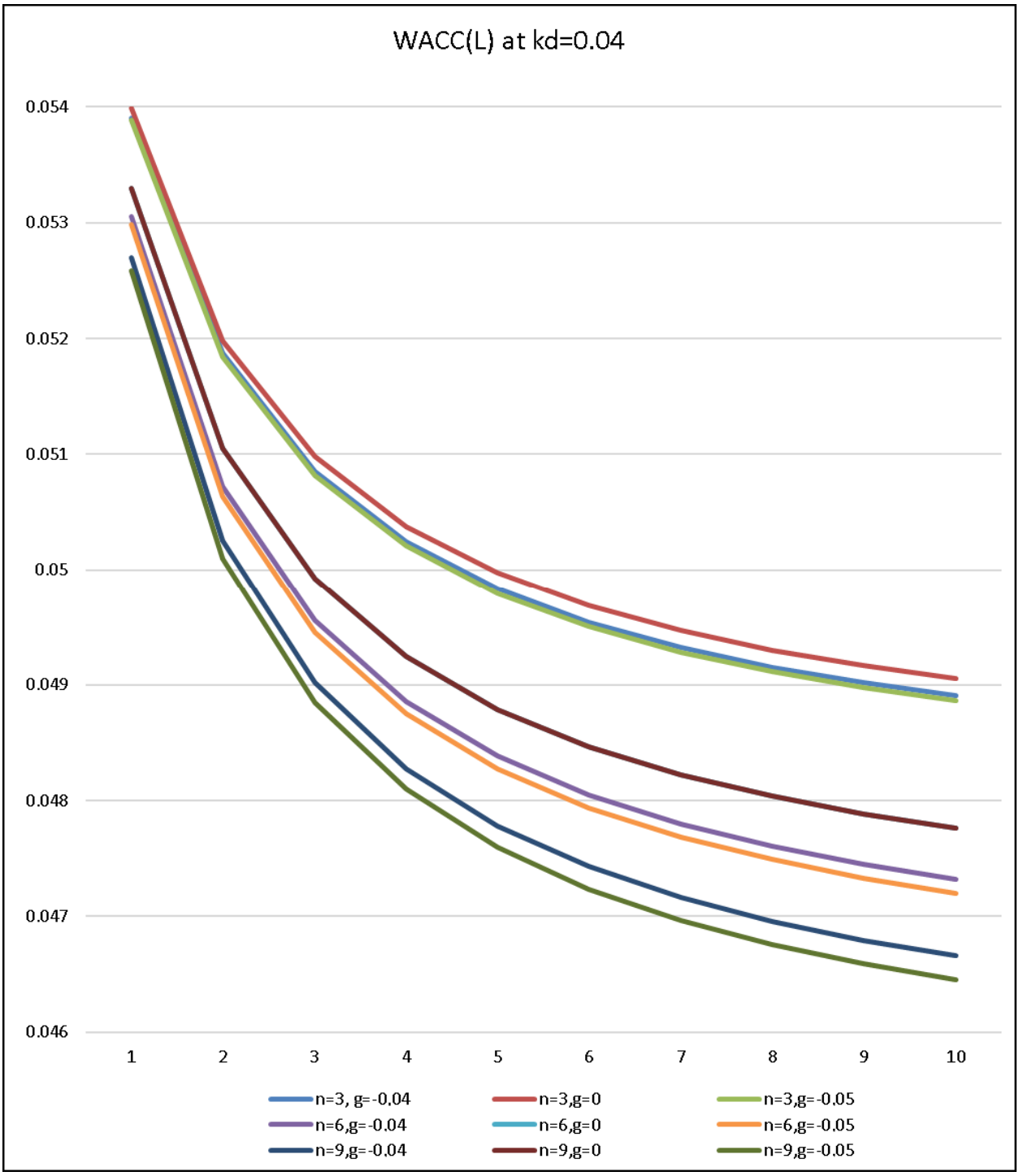

Fig. 6. **The WACC Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

Calculations of equity cost, ke

The equity cost, ke, as it is seen from *Fig. 9* and *Fig. 10*, linearly grow with level of leverage L at all falling rate 'g' and all company age 'n'. The tilt angle of the curve ke (L) grows with 'g', but decrease with company age 'n'. There is intermixture of the lines ke (L), corresponding to company ages six and nine years at different falling rate 'g'. It could lead to some interesting effects, because the cost of equity, being an economically justified amount of dividends, determines the company's dividend policy.

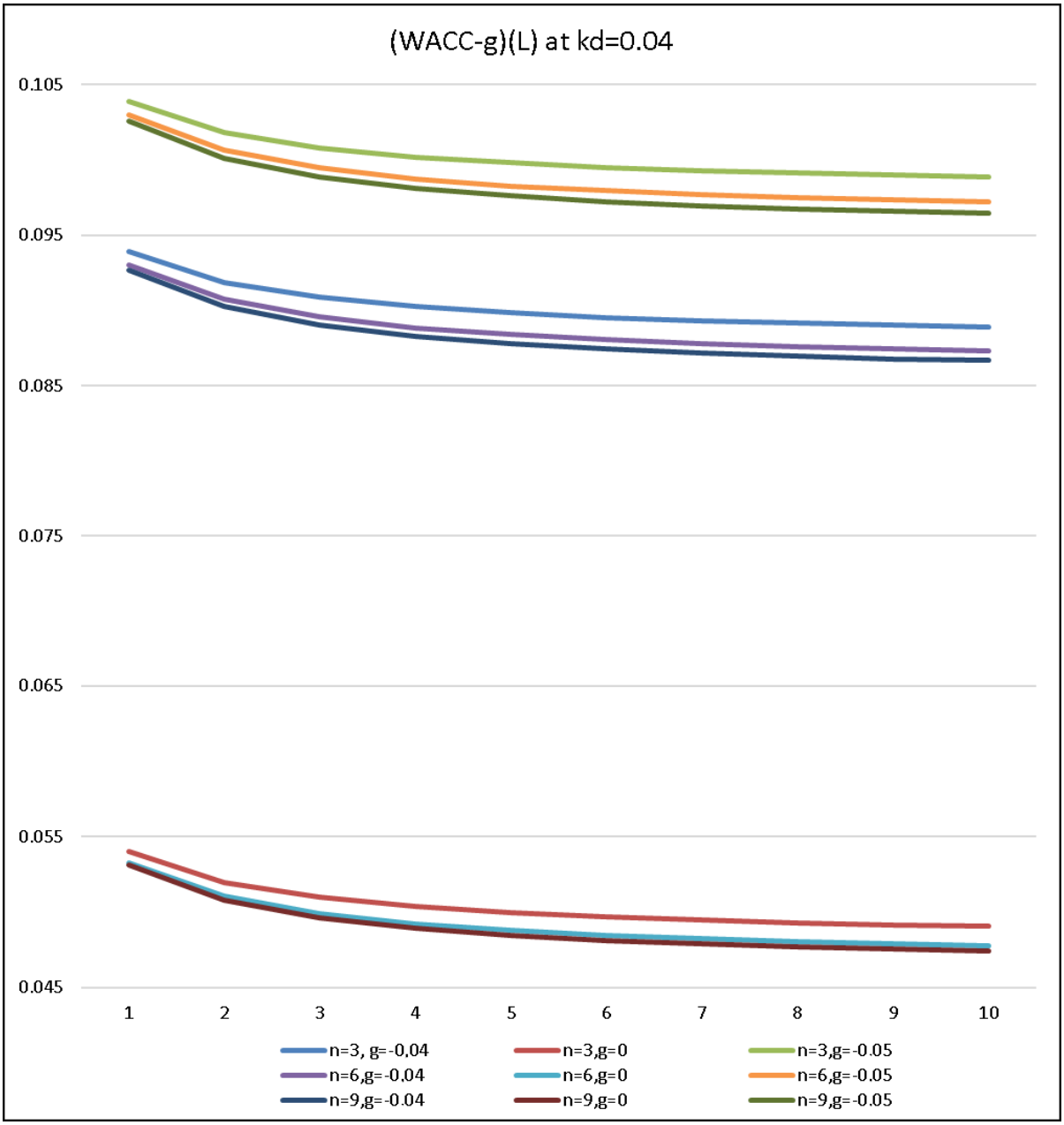

Fig. 7. **The Discount Rate, WACC–g, Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

CALCULATIONS FOR DEBT COST KD = 0.05

Calculations of weighted average cost of capital, WACC

Below we present the results of calculations at debt cost kd = 0.05.

From *Fig. 11* it is seen that all WACC(L) curves decrease with level **of** leverage L at all 'g' values and all company ages n = 3; 6; 9. WACC values decrease with company age, but increase with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed age is ordered as follows (from bottom to top): g = –0.05; –0.04; 0. **The distance between the curves corresponding to different fall rates increases with the age of the company.** An increase in WACC as the rate of fall of 'g' increases indicates that WACC is no longer a discount rate, since it is intuitively clear that the discount rate must decrease as the rate of fall of 'g' increases in order for the value of the company to rise as 'g' increases. As will be seen in the next paragraph, the role of the discount rate is transferred to WACC–g.

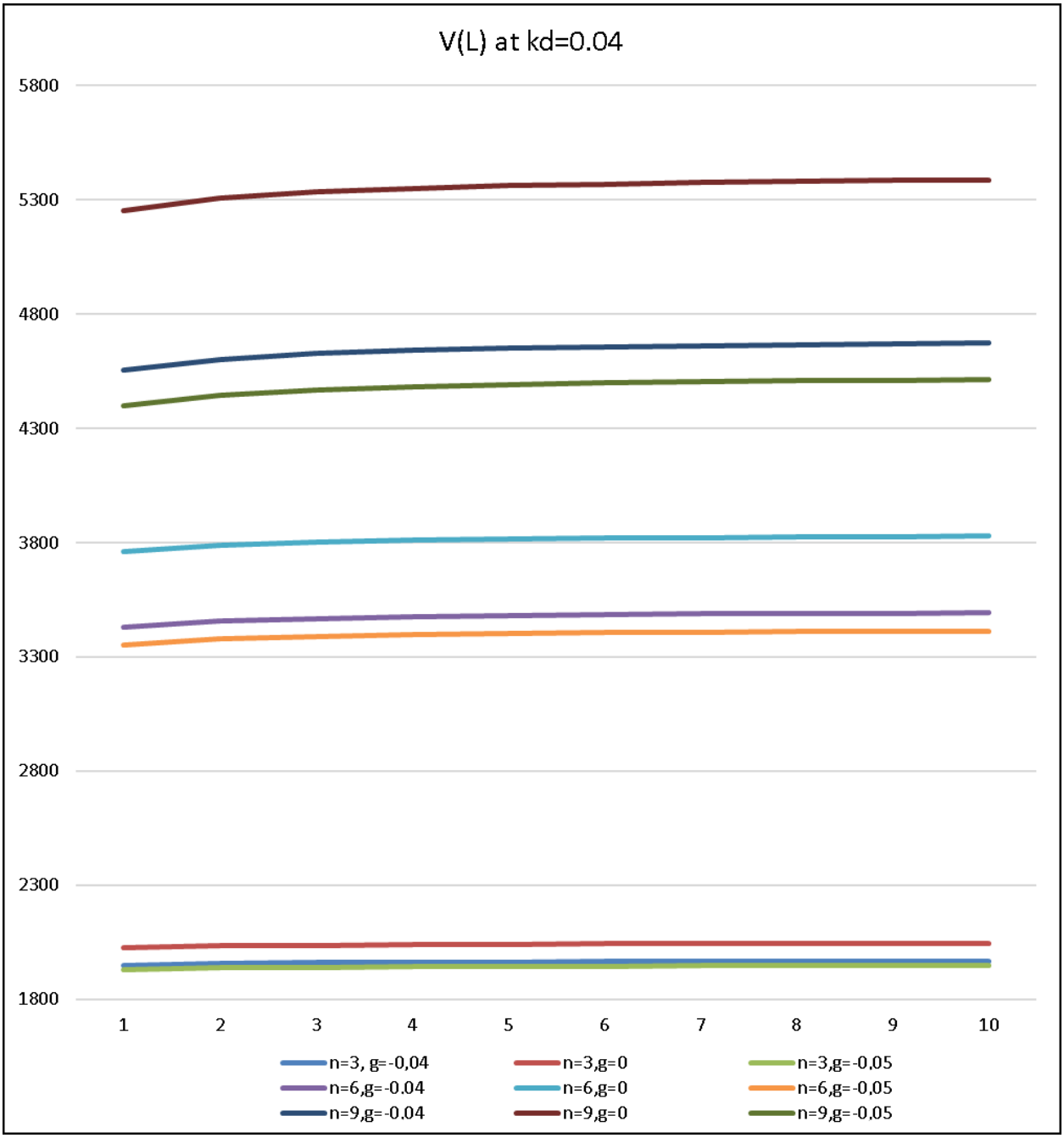

Fig. 8. **The Company Value, V, Depending on the Level of Leverage L at Different Growth Rates g = 0;–0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

Calculations of discount rate, WACC–g

From *Fig. 12* it is seen that all (WACC–g) (L) curves decrease with level **of** leverage L at all 'g' values and all company ages n = 3; 6; 9. WACC–g values decrease with company age 'n', as well as with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed falling rate g is ordered as follows (from bottom to top): n = 9; 6; 3. **The distance between the curves corresponding to different company ages decreases with** falling rate 'g'. A decrease in WACC–g as the rate of fall of 'g' increases indicates that WACC–g is a discount rate, because in this case the value of the company rises as 'g' increases. Thus, the role of the discount rate is transferred from WACC to WACC–g. This could be seen as well from the BFO–formula (1).

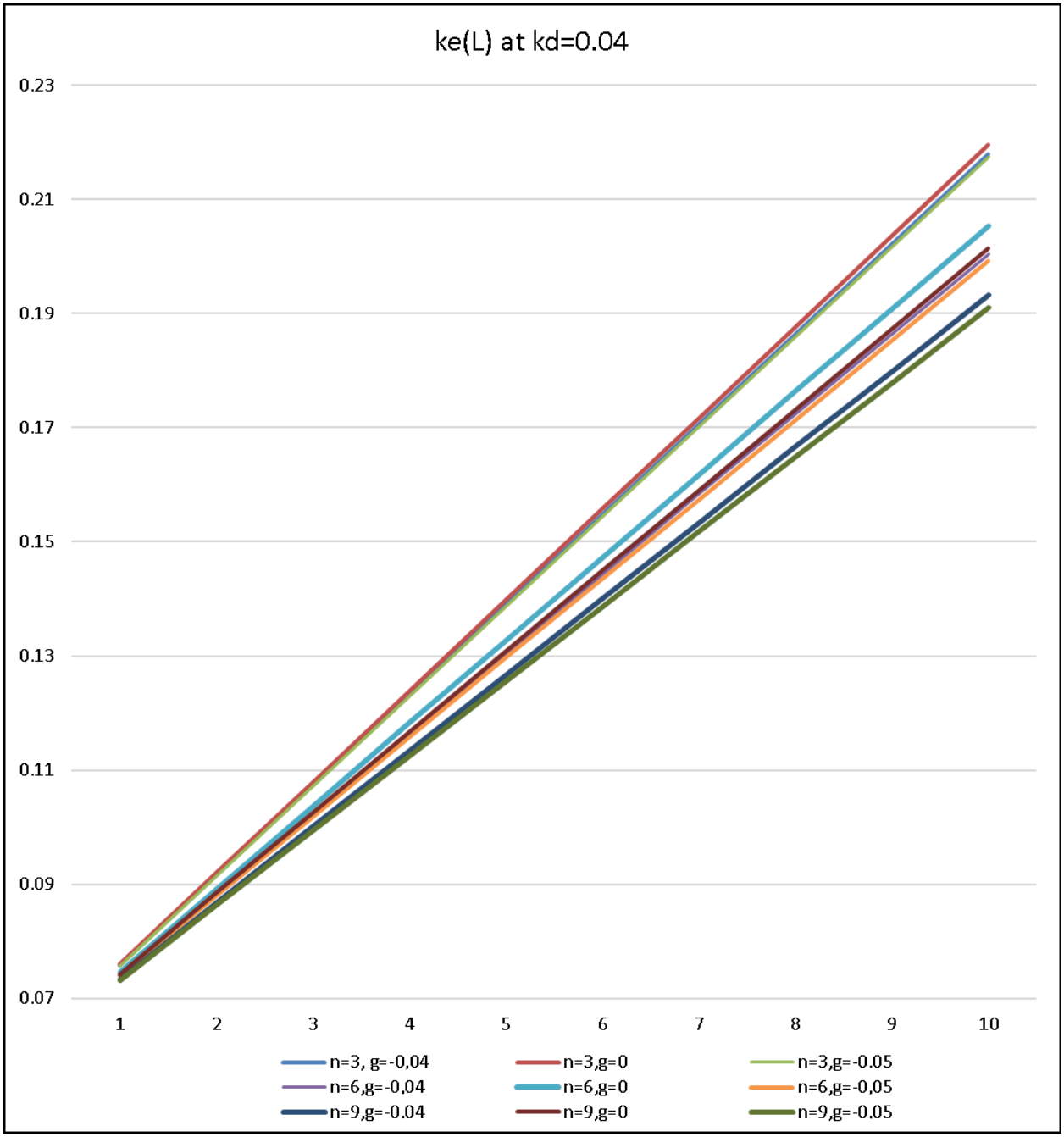

Fig. 9. **The Equity Cost, Ke, Depending on the Level of Leverage L at Different Growth Rates g = 0;–0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

Calculations of company value, V

As it could be seen from *Fig. 13* the company value, V, increase with level of leverage L at all 'g' values and all company ages n = 3; 6; 9. The company value 'V' increases with company age, as well as with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed age 'n', is ordered as follows (from bottom to top): g = –0.05; –0.04;0. **The distance between the curves corresponding to different fall rates increases with the age of the company.** This means that influence of falling rate 'g' increases with company age 'n'. For example, under decrease g on 5% (g = –0.05): for nine-year company (n = 9) company value 'V' decreases by 16.2%, while for six-year company (n = 6) company value 'V' decreases by 10.8%, and for three-year company (n = 3) company value 'V'

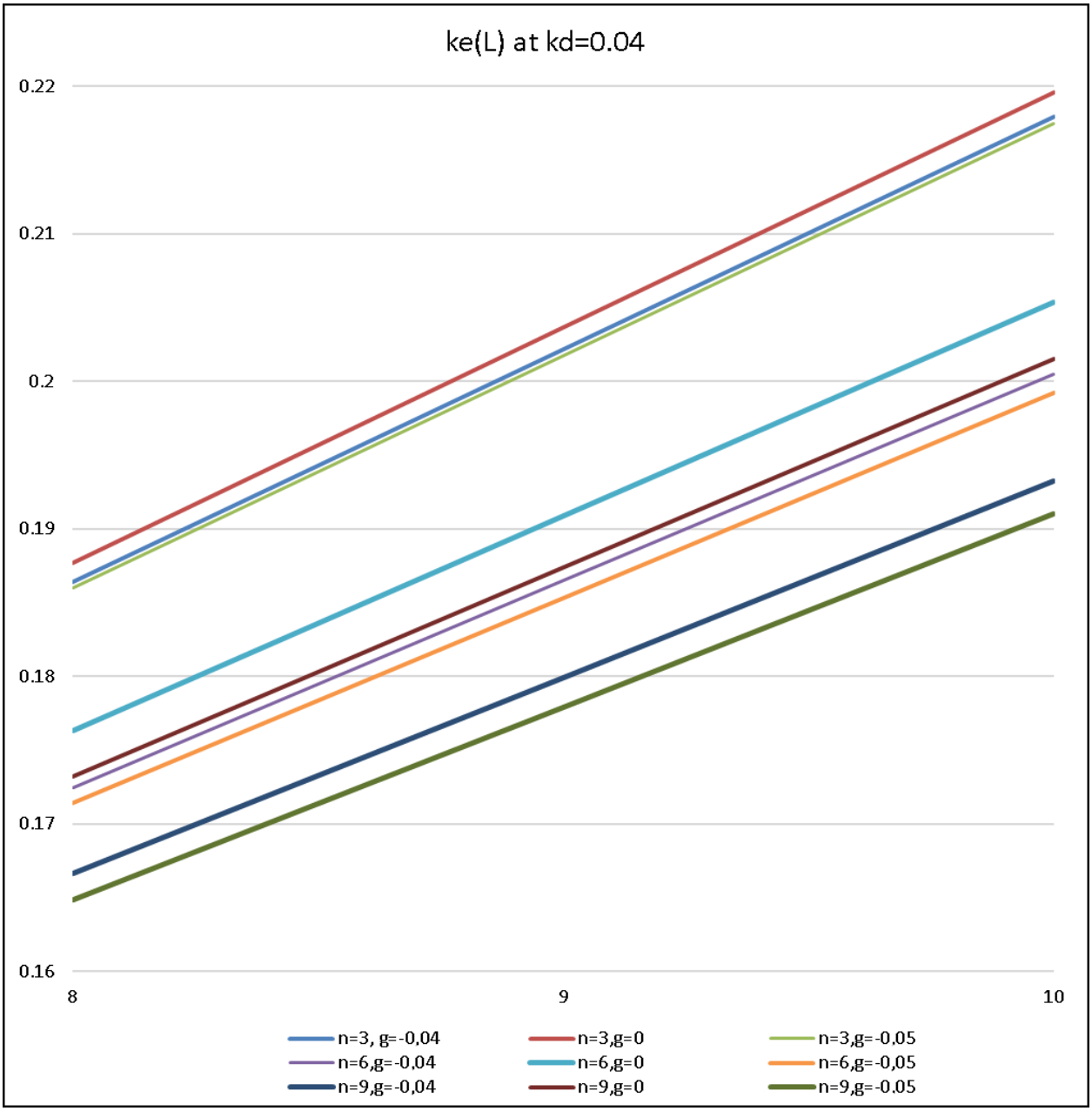

Fig. 10. **The Equity Cost, Ke, Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9 (Bigger Scale)**

Source: Compiled by the authors.

decreases by 4.7% only. An important conclusion is that the impact of the rate of decline in revenue 'g' on the value of company 'V' increases significantly with the age of company 'n'.

Below we compare the results for company value V at kd = 0.03; 0.04 and 0.05 under decrease 'g' on 5% (g = –0.05).

At kd = 0.03; 0.04 and 0.05 under decrease 'g' on 5% (g = –0.05) decrease of **nine-year** company value is equal to 16.2%; 16.2%; 12.3%;

At kd = 0.03; 0.04 and 0.05 under decrease 'g' on 5% (g = –0.05) decrease of **six-year** company value is equal to 10.9%; 10.9%; 10,8%;

At kd = 0.03; 0.04 and 0.05 under decrease 'g' on 5% (g = –0.05) decrease of three-year company value is equal to 4.7%; 3.8%; 4.7%.

Calculations of equity cost, ke

The equity cost, ke, as it is seen from *Fig. 14* and *Fig. 15*, linearly grows with level of leverage L at all falling rate

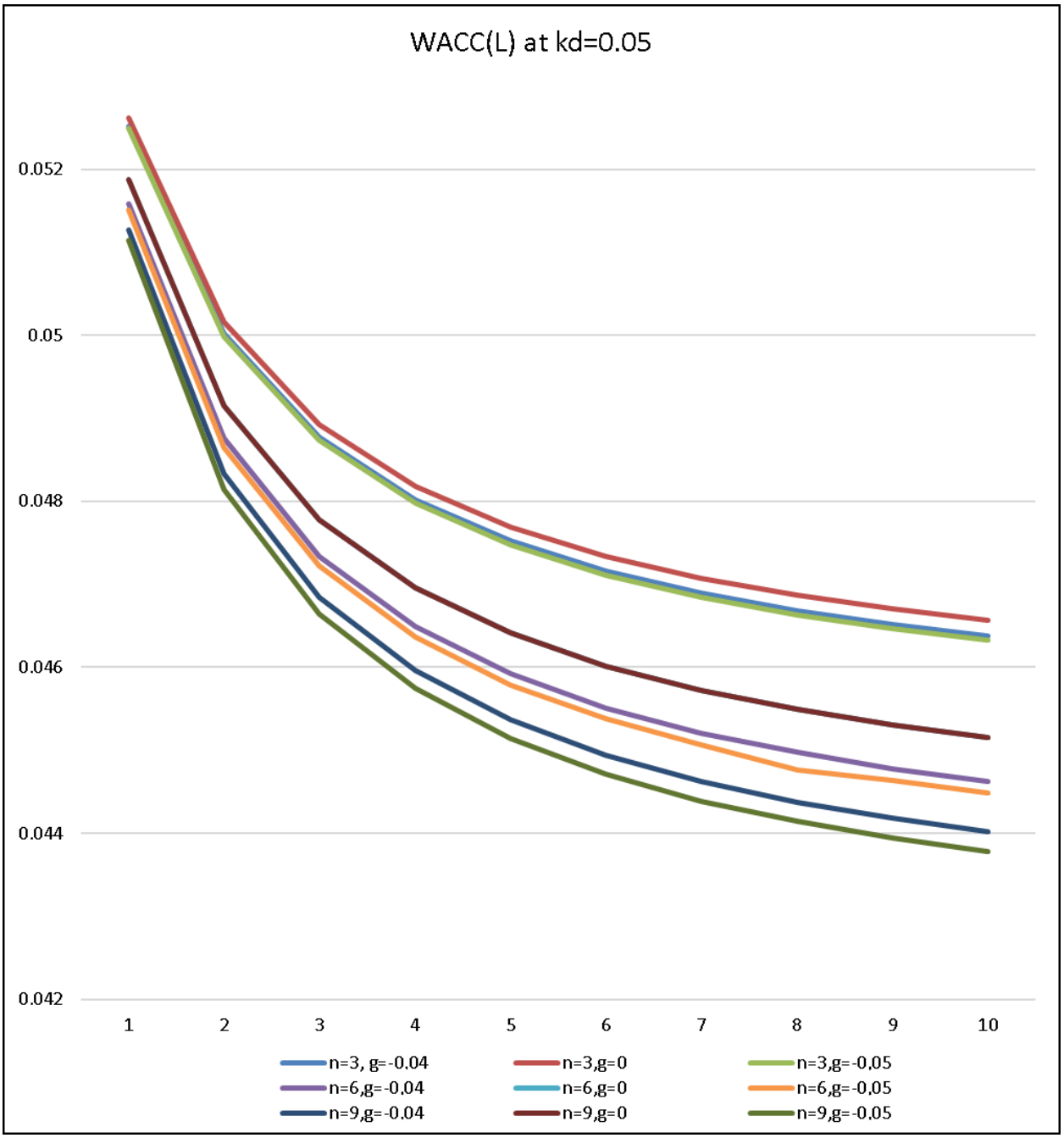

Fig. 11. **The WACC Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

g and all company age 'n'. The tilt angle of the curve ke(L) grows with 'g', but decrease with company age 'n'. There is intermixture of the lines ke(L), corresponding to company ages six and nine years at different falling rate 'g'. It could lead to some interesting effects, because the cost of equity, being an economically justified amount of dividends, determines the company's dividend policy.

Dependence of Weighted Average Cost of Capital, WACC, on Company Age, n

Below we study the dependence of weighted average cost of capital, WACC, on company age 'n' at two values of falling rate, g = –0.04 and g = –0.05, at three values of kd (0.03; 0.04; 0.05) and two values of leverage level L = 0.5 and 0.1. We try to clarify whether the golden age effect takes place at these

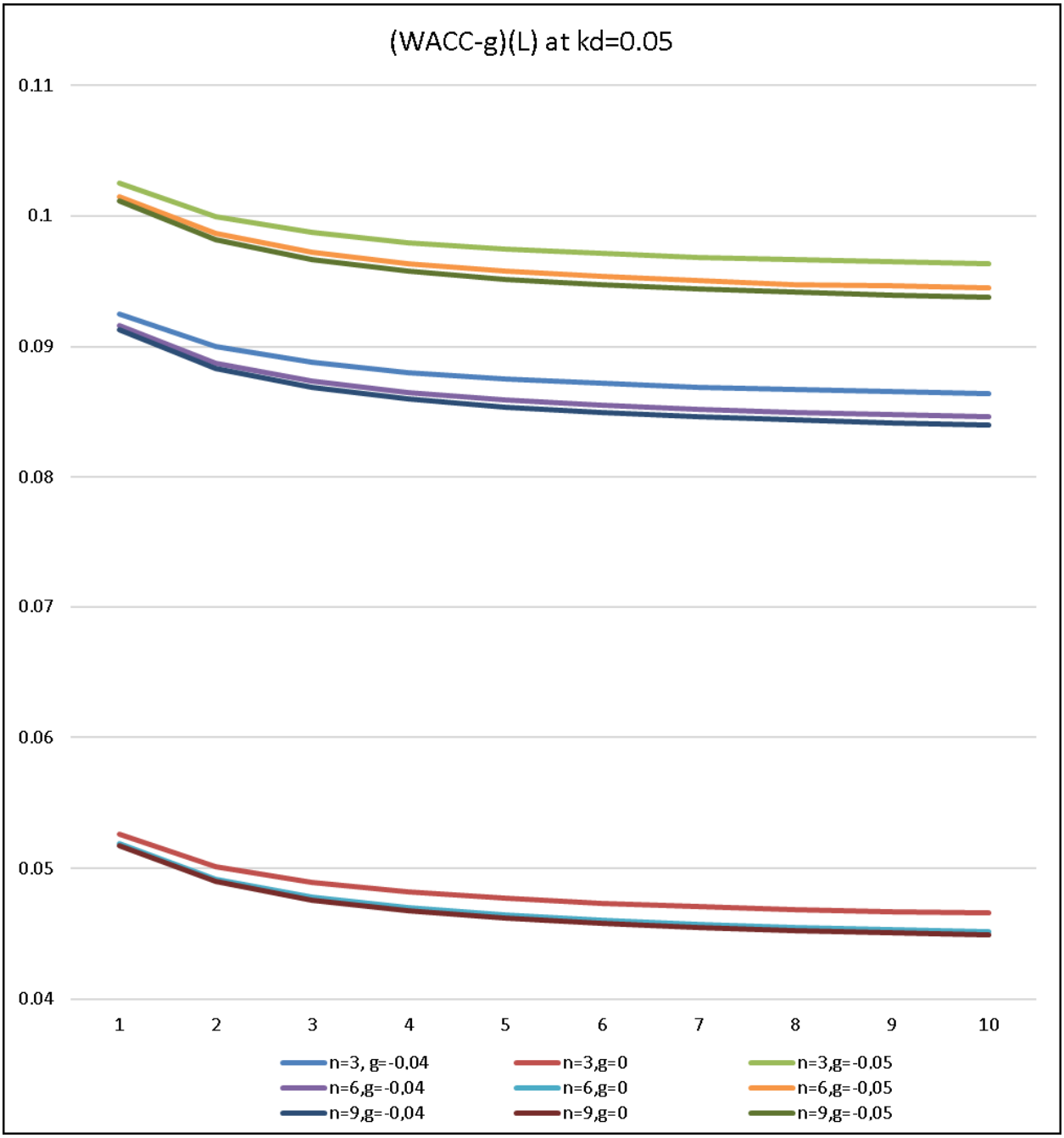

Fig. 12. **The discount rate, WACC–g, B=Depending on the Level of Leverage L at Different Growth Rates g = 0;–0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

particular values of equity and debt costs (k0 = 6%; kd = 3%).

It was shown for the first time [17] that the value of WACC in the Modigliani — Miller theory is not minimal, and the value of the company is not maximal, contrary to the opinion of all financiers: it turned out that at a certain age of the company, the value of WACC is lower than in the eternal Modigliani — Miller theory, and the value of company 'V' is greater than the value of company 'V' in the Modigliani — Miller theory.

From *Fig. 16* it is seen that WACC decreases with n monotonically at all three values of kd (0.03; 0.04; 0.05) and tends to perpetuity (Modigliani — Mille) limit, which could be calculated by the use of Modigliani — Miller formula for WACC, generalized by us to the case of variable income:

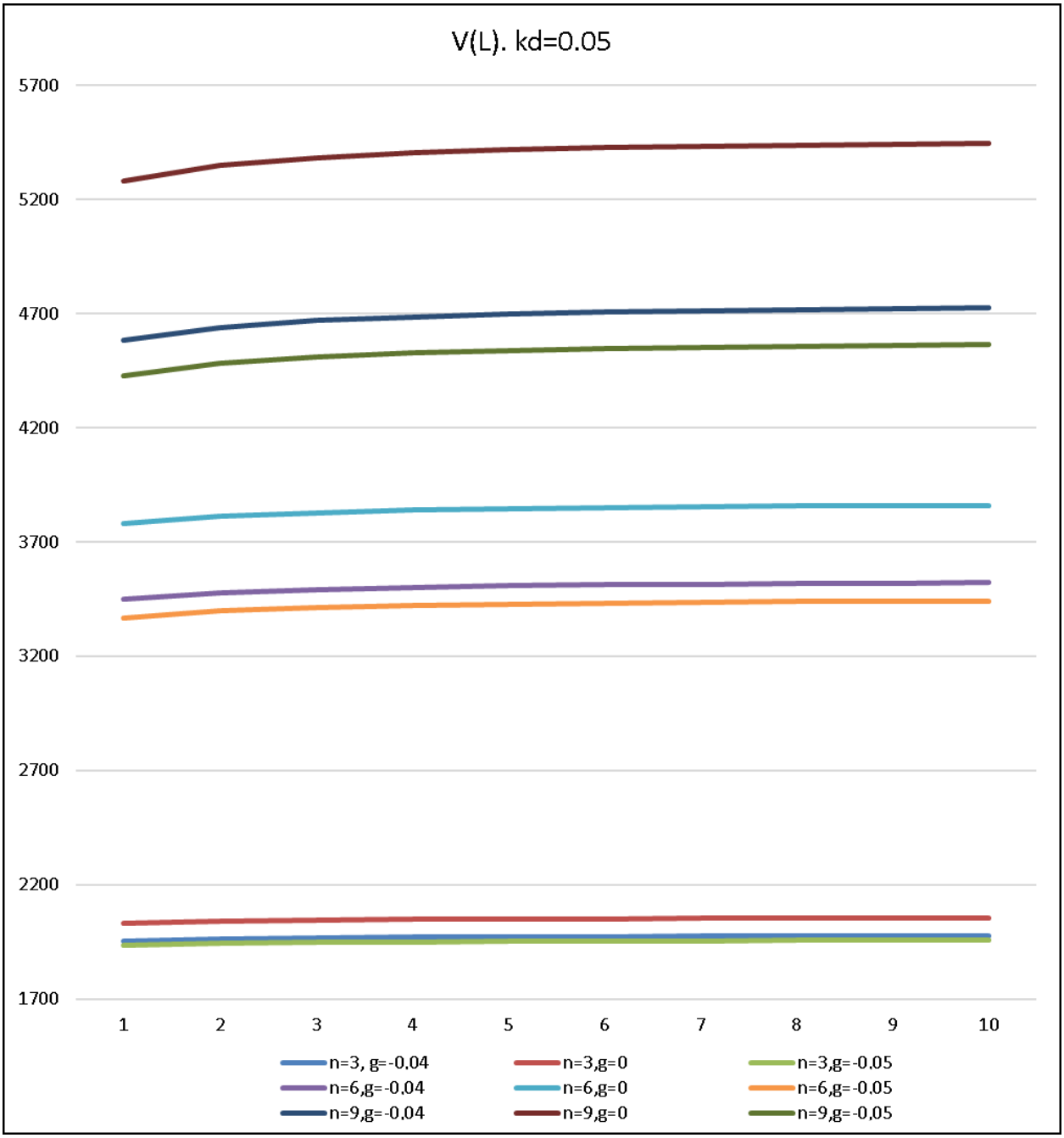

Fig. 13. **The Company Value, V, Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

$$WACC = (k_0 - g)\cdot(1 - w_d t) + g \qquad (3)$$

WACC = 5.33% at L = 0.5.

Note, that WACC decreases in debt value, kd (0.03; 0.04; 0.05). All three curves WACC(n) tends to the same limit WACC = 5.33%, because, as it is seen from the formula (3) WACC in perpetuity (Modigliani — Mille) limit does not depend on debt cost, kd.

From *Fig. 17* it is seen that WACC decreases with n monotonically at all three values of kd (0.03; 0.04; 0.05) and tends to perpetuity (Modigliani — Mille) limit, which could be calculated by the use of Modigliani — Miller formula (3) for WACC, generalized by us to the case of variable income:

WACC = 5% at L = 1.

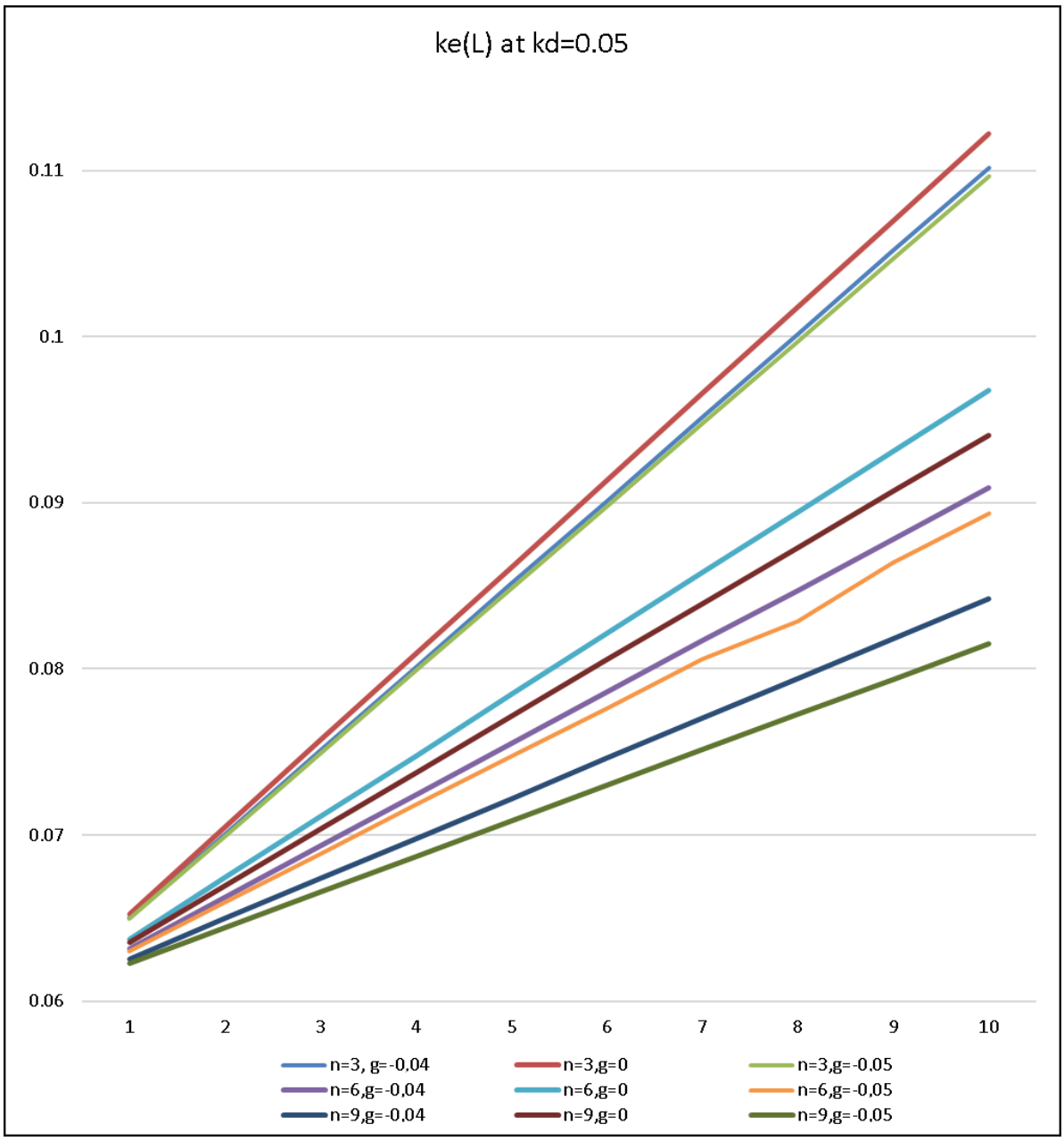

Fig. 14. **The Equity Cost, ke, Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9**

Source: Compiled by the authors.

Note, that WACC decreases in debt value, kd (0.03; 0.04; 0.05). All three curves WACC(n) tends to the same limit WACC = 5%, because, as it is seen from the formula (3) WACC in perpetuity (Modigliani — Mille) limit does not depend on debt cost, kd.

From *Fig. 19* it is seen that WACC decreases with n monotonically at all three values of kd (0.03; 0.04; 0.05) and tends to perpetuity (Modigliani — Mille) limit, which could be calculated by the use of Modigliani — Miller formula (3) for WACC, generalized by us to the case of variable income:

WACC = 4.9% at L = 0.5.

Note, that WACC decreases with debt value, kd (0.03; 0.04; 0.05). All three curves WACC(n) tends to the same limit WACC = 4.9%, because, as it is seen from the formula (3) WACC in perpetuity (Modigliani — Mille) limit does not depend on debt cost, kd.

We conclude, that the "Golden age" effect is absent at these particular values of equity and debt costs

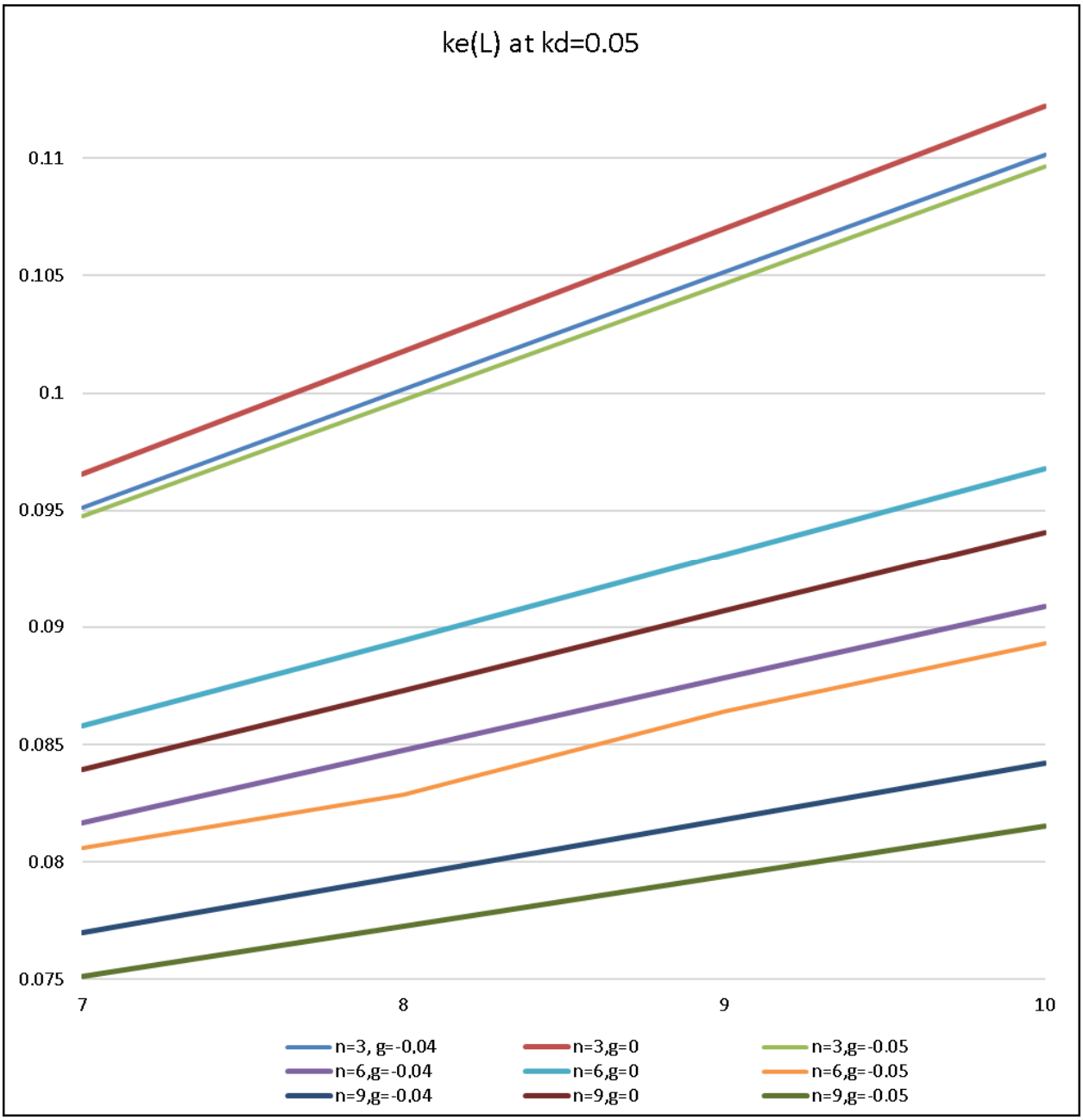

Fig. 15. **The Equity Cost, ke, Depending on the Level of Leverage L at Different Growth Rates g = 0; –0.04; –0.05 and Different Company Age n = 3; 6; 9 (Bigger Scale)**

Source: Compiled by the authors.

(k0 = 6%; kd = 3%), because WACC decreases with 'n' monotonically at all three values of kd (0.03; 0.04; 0.05) at all leverage level values (0.5 and 1) and both falling rates 'g' (–0.04 and –0.05).

CONCLUSIONS

The article develops and applies an approach that allows to investigate the financial state of companies with falling revenues.

From *Fig. 1, 5, 9* it is seen that all WACC(L) curves decrease with level **of** leverage L at all 'g' values and all company ages n = 3; 6; 9. WACC values decrease with company age, but increase with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed age is ordered as follows (from bottom to top): g = –0.05; –0.04; 0. **The distance between the curves corresponding to different fall rates increases with the age of the company.** An increase in WACC as the

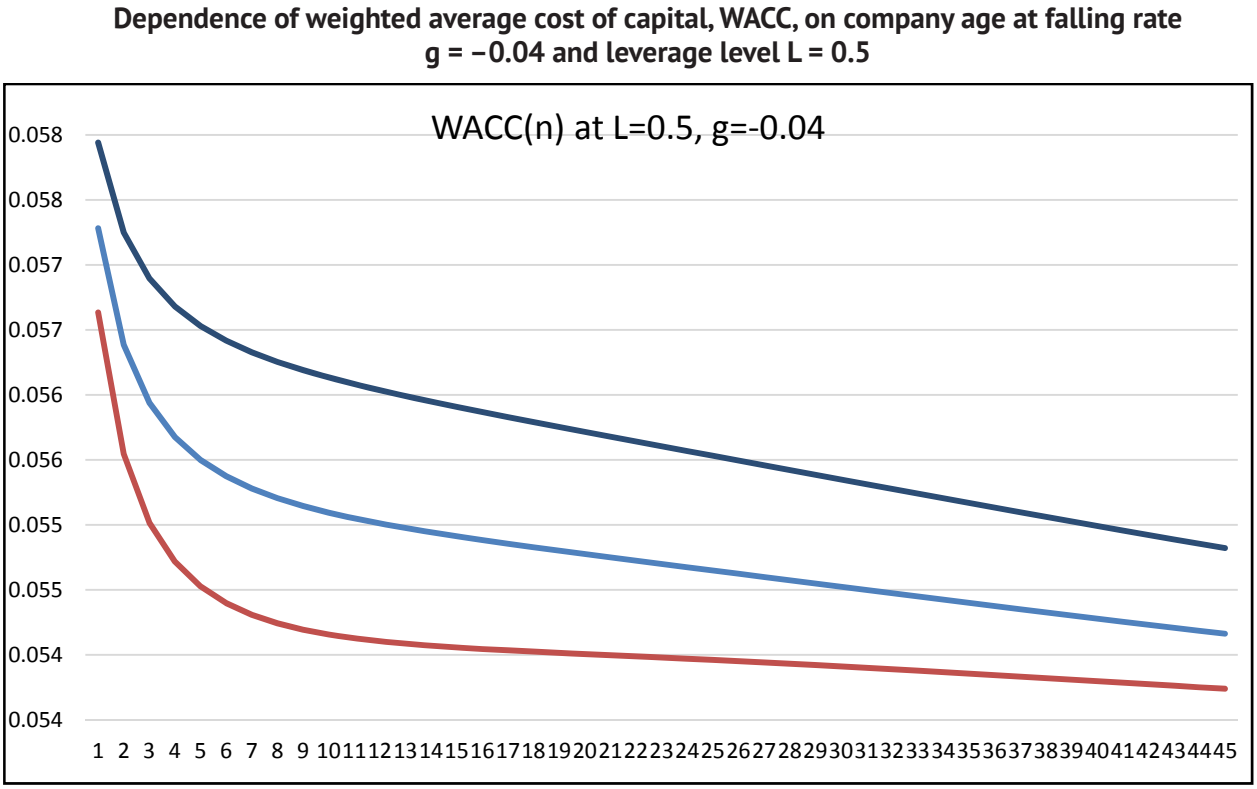

Fig. 16. **The WACC Depending on Company Age n at Different Debt Cost kd = 0.05; 0.04; 0.03 (from Bottom to Top); at Leverage Level L = 0.5 and g = –0.04**

Source: Compiled by the authors.

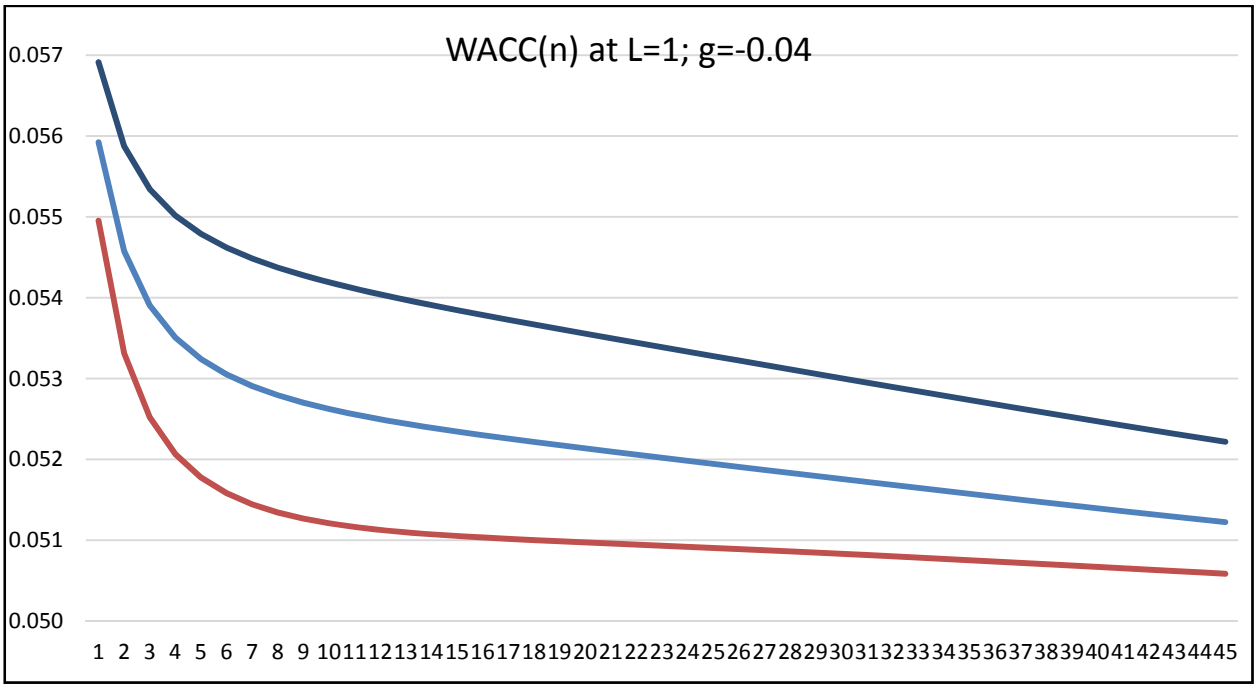

Fig. 17. **The WACC Depending on Company Age n at Different Debt Cost kd = 0.05;0.04; 0.03 (From Bottom to Top); at Leverage Level L = 1 and g = –0.04**

Source: Compiled by the authors.

Dependence of weighted average cost of capital, WACC, on company age at falling rate g = –0.05 and leverage level L = 0.5

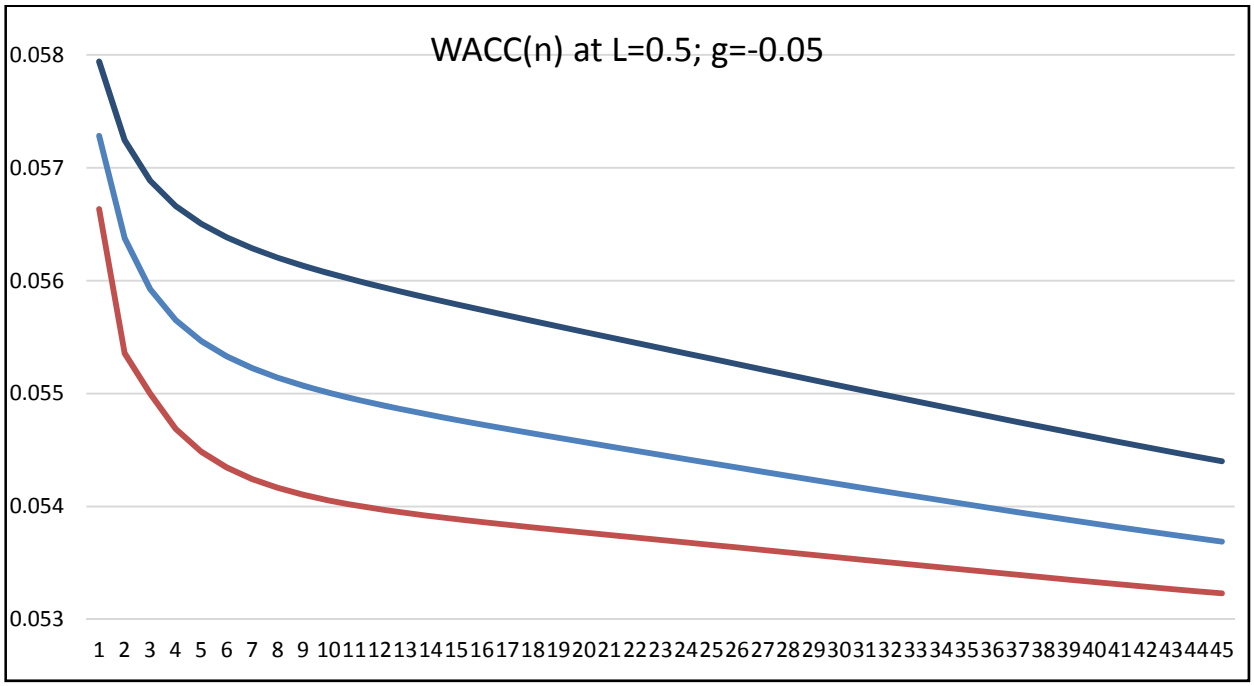

Fig. 18. **The WACC Depending on Company Age n at Different Debt Cost kd = 0.05; 0.04; 0.03 (from Bottom to Top); at Leverage Level L = 0.5 and g = –0.05**

Source: Compiled by the authors.

Dependence of weighted average cost of capital, WACC, on company age at falling rate g = –0.05 and leverage level L = 1

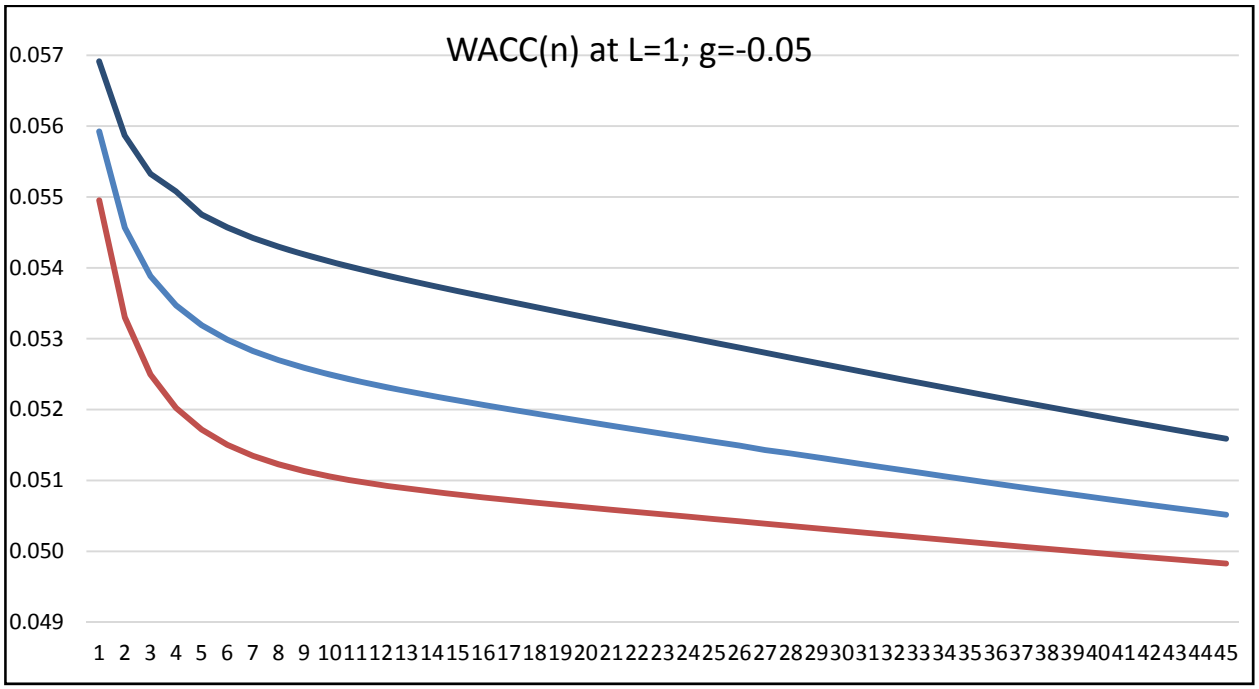

Fig. 19. **The WACC Depending on Company Age n at Different Debt Cost kd = 0.05; 0.04; 0.03 (from Bottom to Top); at Leverage Level L = 1 and g = –0.05**

Source: Compiled by the authors.

rate of fall of 'g' increases indicates that WACC is no longer a discount rate, since it is intuitively clear that the discount rate must decrease as the rate of fall of 'g' increases in order for the value of the company to rise as 'g' increases. As will be seen in the next paragraph, the role of the discount rate is transferred to WACC–g.

From *Fig. 2, 6, 10* it is seen that all (WACC–g)(L) curves decrease with level of leverage 'L' at all g values and all company ages n = 3; 6; 9. WACC–g values decreases with company age 'n', as well as with increase of falling rate 'g'. Each triple of curves formed for a company of a fixed falling rate 'g' is ordered as follows (from bottom to top): n = 9; 6; 3. **The distance between the curves corresponding to different company ages decreases with** falling rate 'g'. A decrease in WACC–g as the rate of fall of g increases indicates that WACC–g is a discount rate, because in this case the value of the company rises as 'g' increases. Thus, the role of the discount rate is transferred from WACC to WACC–g. This could be seen as well from the BFO–formula (1).

As it could be seen from *Fig. 3, 7, 11* the company value 'V' increase with level of leverage 'L' at all 'g' values and all company ages n = 3; 6; 9. The company value 'V' increase with company age, as well as with increase of falling rate g. Each triple of curves formed for a company of a fixed age 'n', is ordered as follows (from bottom to top): g = –0.05; –0.04; 0. **The distance between the curves corresponding to different fall rates increases with the age of the company.** This means that influence of falling rate g increases with company age 'n'. For example, under decrease g on 5% (g = –0.05): for nine-year company (n = 9) company value, V, decreases by 12.3%, while for six-year company (n = 6) company value, V, decreases by 10.9%, and for three-year company (n = 3) company value 'V' decreases by 4.7% only. An important conclusion is that the impact of the rate of decline in revenue g on the value of company 'V' increases significantly with the age of company 'n'.

The equity cost, ke, as it is seen from *Fig. 4, 5, 8, 9, 12, 13* linearly grows with level of leverage L at all falling rate g and all company age 'n'. The tilt angle of the curve ke (L) grows with g, but decrease with company age 'n'. There is intermixture of the lines ke (L), corresponding to company ages six and nine years at different falling rate 'g'. It could lead to some interesting effects, because the cost of equity, being an economically justified amount of dividends, determines the company's dividend policy.

We study the dependence of weighted average cost of capital, WACC, on company age 'n' at two values of falling rate, g = –0.04 and g = –0.05, at three values of kd (0.03; 0.04; 0.05) and two values of leverage level L = 0.5 and 0.1. We try to clarify whether "the Golden age" effect [17] takes place at these particular values of equity and debt costs (k0 = 6%; kd = 3%).

We conclude, that the "Golden age" effect is absent at these particular values of equity and debt costs (k0 = 6%; kd = 3%), because WACC decreases with company age, n, monotonically at all three values of kd (0.03; 0.04; 0.05) at all leverage level values (0.5 and 1) and both falling rates g (–0.04 and –0.05).

It was found, that WACC decreases in debt value, kd (0.03; 0.04; 0.05). All three curves WACC(n) tends to the same limit because, as it is seen from the formula (3) WACC does not depends on debt cost value 'kd' in the eternal Modigliani — Miller limit.

The study will allow companies to take into account the behavior of the main financial indicators in the face of declining revenues and will allow reduce risks for companies.

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

The article was submitted on 06.03.2023; revised on 06.04.2023 and accepted for publication on 06.04.2023.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-176-188
UDC 336.6(045)
JEL G3

Reorganization of the System of Intra-Holding Settlements: Methodological Tools, Efficiency Assessment

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ABSTRACT

In the context of growth trends in the scale and diversification of business, the internal costs of companies with a complex holding structure are also increasing. Solutions that improve the efficiency of settlement systems are particularly relevant and significant. Therefore, the paper is devoted to the problems of building settlement systems that minimize the negative impact of certain factors reducing the economic efficiency of calculations. The **purpose** of the study is to develop methodological foundations for rationalization the holding's settlement system based on clearing obligations. The **tasks** of this paper are set as follows: to propose methodological tools for the reorganization of the system of intra-holding settlements; to test the proposed recommendations for the rationalization of the settlement system in holding structures. According to the **results** of the study, the authors systematized a set of factors that determine the effectiveness of the system of intra-group settlements. It is proposed to attribute the number of payment transactions and the volume of payment turnover to the quantitative factors of the settlement system efficiency. Qualitative factors of the settlement system efficiency are associated with the consolidation of financial information, the degree of automation of settlement processes, and the flexibility of the settlement system. The authors used the Ward **method** to build a cluster structure of the holding based on the analysis of payment turnover of pairs of companies, statistical methods of quantitative and qualitative assessment of the effectiveness of the holding's settlement system. The **scientific novelty** is expressed by the fact that the paper offers methodological tools for reorganization the system of intra-holding settlements. A methodology for rationalization the holding's settlement system based on clearing obligations, universal in use by holding-type companies, has been developed and its approbation has been carried out. The conclusions based on the **results** of the study form recommendations for changing some aspects of the holding's activities in accordance with the results of the modernization of the holding's settlement system. The method of rationalization of the system of intra-holding settlements proposed by the authors has versatility in application and can be used in solving management tasks within any holding.

Keywords: holding; intra-group settlement system; efficiency of the settlement system; effect; two-way clearing; multilateral clearing

For citation: **Nemtseva Yu.V., Bekker A.V. Reorganization of the system of intra-holding settlements: Methodological tools, efficiency assessment. *Finance: Theory and Practice*. 2023;27(3):176-188. DOI: 10.26794/2587-5671-2023-27-3-176-188**

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INTRODUCTION

It is common knowledge that intra-group operations are involved in the economic activities of holding companies. The need to establish intra-group economic relations of a financial nature in holding structures with legal entities generates the value of transaction costs, which include the reduction of solvency of individual group companies, labour and financial costs of intra-group payments.

Scale and diversification of business in the context of pandemics and turbulence of economic processes, solutions that ensure the efficiency of settlement systems should be recognized as particularly relevant and significant. In this case, the efficiency of the settlement system of holding will be understood as the ratio of the benefits and functions it performs to the amount of direct and indirect losses associated with the device of such system. In the scientific literature, the main focus in the consideration of efficiency is shifted to costs (negative effect) of inter-group settlements in the form of transaction costs [1–8].

LITERATURE REVIEW AND RESEARCH METHODS

Many works of domestic and foreign experts in the field of corporate financial flows management are devoted to the search for ways to reduce transaction costs: K. Asai [9], A. P. Kirsanov [1], A. N. Kulemin [10], A. Z. Piramatov [11], A. Sinkevich [12], D. O. Chukhlantsev [6], A. A. Shishakin [7], K. Spremann [13] etc. Dynamics of intra-group payments and maintenance of liquidity paid attention in the works of D. A. Endovitskii, I. V. Polukhina [14], S. A. Mkhitaryan [15], D. E. Okladnikov [16], V. A. Makarova [17], P. Atrill [18], N. Petit [19]. Efficiency tools for calculation in the domestic market of the group of companies are considered in the works of V. A. Buzanov [3], A. S. Volkov [4], A. S. Pleshchinskii [8].

Despite sufficient theoretical material accumulated by experts and available for study on the subject, the review of the literature revealed a lack of a harmonized approach to addressing the economic losses from internal operations.

To obtain the result, the paper uses general scientific research methods, such as theoretical analysis and synthesis, abstraction and concretization, deduction and induction. The authors apply methods of cluster analysis for building cluster structure of holding on the basis of analysis of payment turnover of pairs of companies, statistical methods of quantitative and qualitative assessment of efficiency of holding's settlements system, method of expert estimation.

PROBLEM STATEMENT

In their papers, the authors consider ways to construct settlement systems that minimize the negative impact of individual factors reducing the economic efficiency of settlements. Some researchers suggest specific methodologies for performance management, the scope of which is limited to a separate branch of economic activity or to the regulation of a particular State; other work is limited to a theoretical review of practices in the construction of intra-group settlement systems; the third results have mathematical models of settlement and payment operations in order to reduce the negative influence of one of the factors of transaction costs.

It is obvious that the lack of theoretical and methodical support on the issue is compensated by the efforts of top management and staff "on the ground" in the process of studying the causes and solutions of affordable ways to curb the growth of transaction costs. This issue is resolved in private, taking into account the specifics of the business, and as a rule, the results of the decision are closed from the study of commercial secrets by third parties.

The purpose of the study — development of methodical bases of rationalization of settlement system of holding on the basis of clearing obligations. The goal is achieved by solving the following tasks:

- to propose methodical tools of reorganization of the system of intra-holding settlements;
- to carry out approbation of the proposed recommendations on rationalization of the settlements system in holding structures.

RESULTS AND DISCUSSION OF THE STUDY

Clearing of liabilities is a tool to improve the group's settlement system. Different types of clearing are distinguish depending on the features of intra-group settlement system, and improving by clearing.

Popular belief that multilateral clearing has a more beneficial effect than two-way clearing, but has a more complex implementation procedure and more risks generated by clearing activities (*Fig. 1*) [17, 20, 21].

The use of netting allows not only to reduce the risk of a shortage of funds, but also to accumulate funds that can be used to finance capital-intensive projects of the holding company. Money is not taken out of circulation for a long time, which allows to use it not only for operational but also for investment purposes.

The reduction in the number of payments, the degree of process automation will lead to the release of labor, which will also improve the efficiency of the holding.

The amount of savings will be achieved by reducing the number of payment orders — the cost of the bank's commission on settlement servicing will be reduced.

Under multilateral clearing, financial information on a group of companies is also centralized in a single center, which facilitates its collection for the parent company. However, it has to be noted the possibility of reducing the document management between the settlement participants.

Thus, the positive effect of clearing for large systems of companies bound by mutual monetary obligations is significant. At the same time, it is necessary to calculate the economic feasibility of creating and maintaining a clearing system. The authors proposed an algorithm for increasing the efficiency of intra-group settlements, including a number of steps or stages (*Fig. 2*). Each phase consists of a group of methods to achieve the objectives. Clearing of intra-group liabilities is a tool for increasing the efficiency of intra-holding settlements.

The authors consider the stage of primary analysis and collect information in the form of two blocks:

1) initial state — constant factors determining the structure of the settlement system of holding;

2) efficiency factors — quantitative and qualitative characteristics of the system, the values of which can be changed by modification of the settlement system, thereby increasing or reducing its overall efficiency (*Fig. 3*).

As a result of the initial analysis of the system of intra-group settlements the researcher gets a number of quantitative and qualitative indicators, the values of which can be changed in favor of a group of companies by adopting appropriate adjustments in the system. Limitations and influence of conditions needs to be taken into account.

As quantitative indicators of the need to improve the system of payments, the authors propose to use indicators of the potential of system improvement — the potential to reduce the number and volume of intra-group payments transactions.

The main positive effect is the possibility of releasing financial resources from the payment chain, so the value of the potential is determined by the ratio of the aggregate value of intra-group payment operations

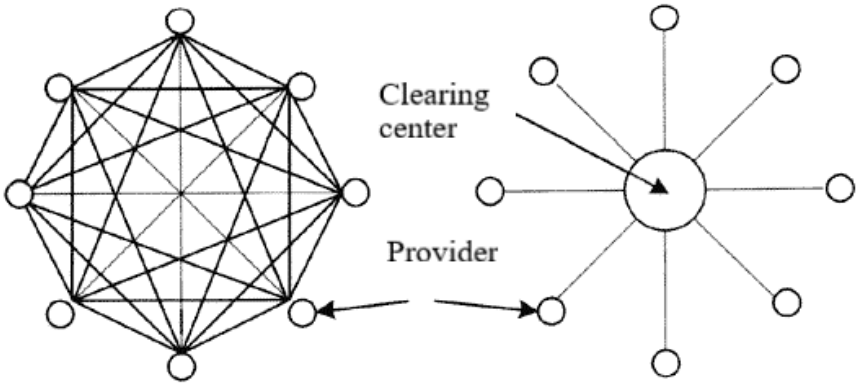


Fig. 1. **The Scheme of Interaction of Participants of Multilateral Clearing**
Source: Compiled by the authors.

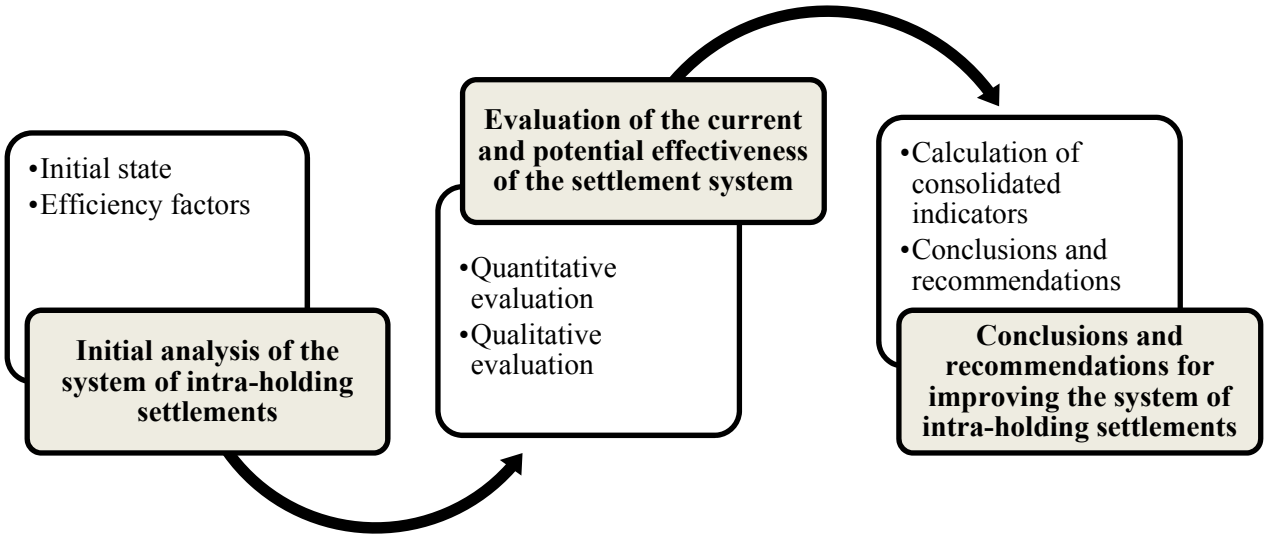


Fig. 2. **Methodology for Improving the Efficiency of the System of Intra-Holding Settlements**
Source: Compiled by the authors.

(internal turnover) to the total value of payment operations (turnover) of group companies. The higher the value of the indicator, the more theoretically possible clearing effect can be obtained for the holding. Savings of the holding on payment operations and turnover due to transition from gross settlements between companies to multilateral clearing [22].

According to the authors, the method of expert estimation should be used to evaluate the quality indicators of the system of intra-group settlements (level of information support for management, the presence of levers of influence on the settlement system, the degree of process automation, etc.) (*Fig. 4*).

In this way, the settlement system efficiency factors that need management impact can be evaluated in their current and potential state in a digitized form, allowing for a comparison of alternative options for this system.

The third phase of the rationalization of the intra-holding settlement system is related to the integrated evaluation of the system reform project. The net present NPV effect should be used to assess the

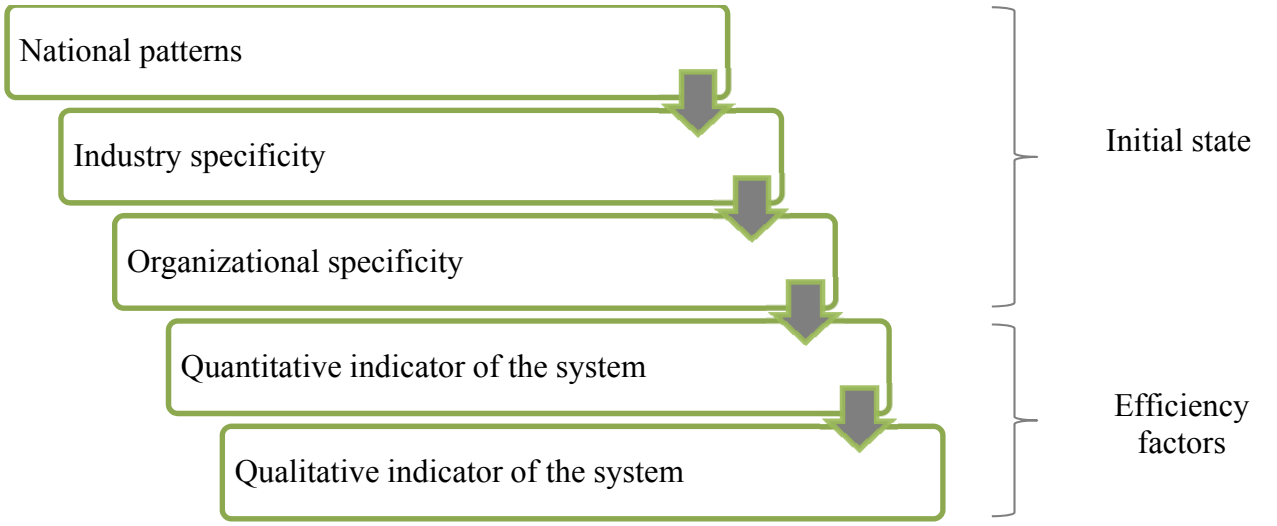


Fig. 3. **Elements of the Primary Analysis of the System of Intra-Holding Settlements**

Source: Compiled by the authors.

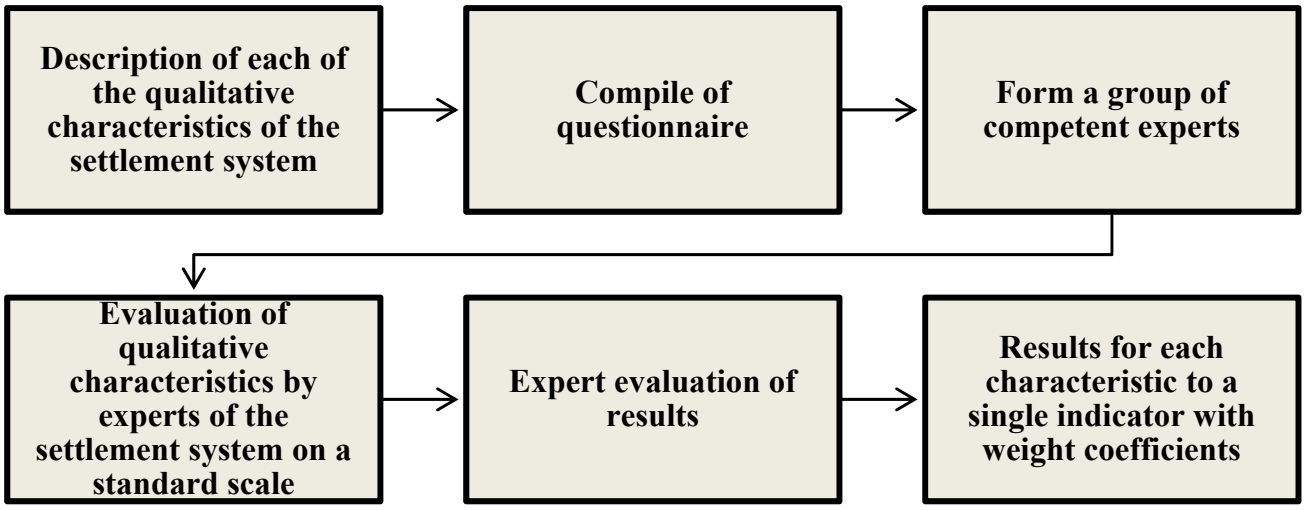


Fig. 4. **Algorithm to Evaluate the Qualitative Factors of the Settlement System Efficiency**

Source: Compiled by the authors.

effectiveness of the project. The positive value of the net present value will allow us to speak about the effectiveness of the introduction of clearing in the practice of intra-holding settlements, while the negative value will show the impracticality of such a project.

When assessing the NPV, the project costs should be included:

- cost of work on collection, systematization and analysis of primary information on settlement system in the holding;
- cost of work on the project development clearing system;
- cost of work on reconciliation of obligations, calculation of net positions, processing of accounting documents, recording of transactions in the accounting system;
- value of other overhead costs (management, transaction, security, reserve formation, etc.).

The economic impact of the introduction of clearing in the calculation practice in value terms can be defined as:

Table 1

Format of Comparison of Alternatives of the Settlement System Device

	Initial state	Option 1	Option 2	...	Option n
NPV project, where *n* — number of considered alternatives for settlement system; *i* — value of the indicator that characterizes the effectiveness of the settlement system	–	i_{12}	i_{13}	...	i_{1n+1}
Qualitative indicator	i_{21}	i_{22}	i_{23}	...	i_{2n+1}

Source: Compiled by the authors.

- cost of bank payment services, which were reduced as a result of clearing;
- cost of employees' work on formation and support of payment operations, the number of which was reduced as a result of clearing;
- amount of savings on the withdrawal of short-term credit funds from clearing;
- income from accommodation in financial instruments released as a result of clearing.

It should be noted that the key issue in assessing the effectiveness of the formation or modification of the clearing system is the value of its revenue — clearing effect for the holding. Effect of reduction of payment operations and payment turnover in the holding can be called the main positive factor of introduction of clearing in the system of settlements. Most of other indicators that form savings for the holding are derived from the above indicators. For example, information on the quantitative reduction in the volume of payments transactions, together with data on the cost of bank services and the value of other costs of companies for the formation and maintenance of transactions, will allow evaluate the savings in the conduct of counterclaims. Using rate of return on potentially released financial resources from clearing will reveal the amount of additional income from project implementation.

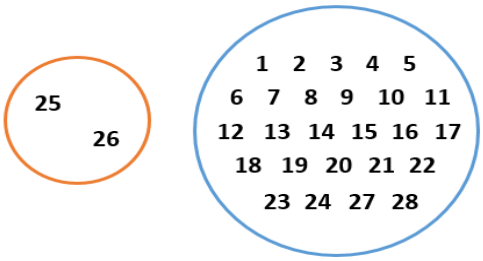
Previously noted that the impact on the aggregate result of changes in settlement system are qualitative, difficult to quantify. In this case, we propose to aggregate qualitative characteristics with the application of weight coefficients to a single indicator of the level of qualitative factors. Weight coefficients range from 0 to 1 and are detected by the expert assessment method based on a questionnaire. To assess the significance of qualitative factors (degree of consolidation of financial information, degree of process automation, possibilities for adjustment of settlement system of holding) key specialists of holding (experts), those with competence in the various stages of the payment chain in companies use a score of 10. Individual expert assessments averaged.

The final consolidation of results and management decisions remain with the manager. The recommended form for comparing the results on the various options of settlement system is presented in the *Table 1*.

The method of rationalization of settlement system of holding on the basis of clearing of liabilities is demonstrated in practice for holding, using historical data of group activity (reporting data). 28 Russian companies of the holding, the main type of economic activity of which is the provision of passenger air transport services (the article uses the names in the form of sequence

Table 2

Results of the Initial Analysis Stage of the Intra-Holding Settlement System

<table>
<tr><th rowspan="2">Initial analysis of the system of intra-holding settlements</th><th rowspan="2">Conditions</th><th colspan="2">Factors of efficiency</th></tr>
<tr><th>Quantitative factors of settlement system efficiency</th><th>Qualitative factors of settlement system efficiency</th></tr>
<tr><td rowspan="2">Actual cluster structure of holding on the basis of analysis of payment turnover of pairs of companies (Ward method)</td><td> 
</td><td rowspan="2">– number of payment transactions (more than 772 thous. payment transactions, including more than 55 thous. transactions – on intra-group settlement);
– amount of payment turnover (819.5 bln rubles of payment turnover on ruble bank accounts, of which 324.5 bln rubles are intra-group payment turnover)</td><td rowspan="2">– degree of consolidation of financial information;
– flexibility of the settlement system and possibilities for its adjustment;
– degree of process automation</td></tr>
<tr><td>Solvency problem companies: 1725</td></tr>
<tr><td colspan="4">Clearing frequency: 1 month</td></tr>
</table>

Source: Compiled by the authors.

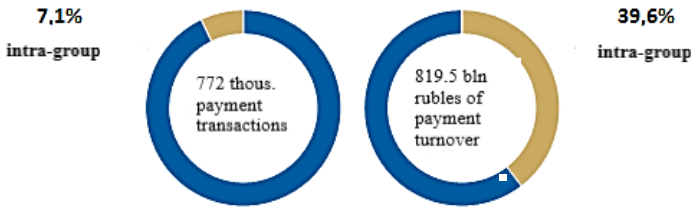
numbers from 1 to 28). The holding has a single center for the consolidation and processing of payment information (Shared Services Centre — SSC).

Initial analysis of the system of intra-holding settlements showed the following results. One of the main negative aspects of intra-group payments may be the shortage of liquidity for settlement with counterparties. Analysis of daily dynamics of financial flows and cash balances on the accounts of the holding showed that the problems of short-term loss of solvency of companies are not excluded from operational activities. More than 10 companies of the holding receive from 70 to 100% of revenues from provision of intra-group services from year to year. However, for at least three of these companies, there has been a systematic significant decline in liquidity balances in sub-average accounts unrelated to their investment or financial activities. Accordingly, the method of reducing the negative effects of conducting payment operations within the holding can be a periodic clearing of mutual obligations. Given the frequency of intra-holding payments, it is reasonable, in the authors' view, to perform monthly clearance of obligations prior to the next payment cycle in each month. This will further improve the solvency of some companies and release excess financial resources from others (*Table 2*).

The second stage of the algorithm for increasing the efficiency of intra-group settlements involves an assessment of the current and potential efficiency of the settlement system. Based on the results of the initial analysis of the system of settlements in the holding, the indicators of the potential of system improvement were evaluated. The potential for improving

Table 3

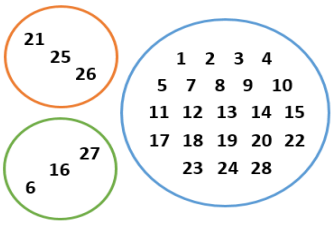
The Evaluation Results of the Current State of Factors of Efficiency the Settlement System of the Holding

Step of algorithm of improve of efficiency of intra-group settlements	Evaluation of current and potential settlement system efficiency
Evaluation of current and potential settlement system efficiency	
Quantitative evaluation	
Qualitative evaluation (score)	– degree of consolidation of financial information – 6.2; – flexibility of the settlement system, possibilities for its adjustment – 8.1; – degree of process automation – 6.3

Source: Compiled by the authors.

Table 4

Results of the Implementation of The Two-Way Clearing Scheme

Evaluation of current and potential settlement system efficiency	Quantitative evaluation	Qualitative evaluation (score)
Option 1 (introduction of a two-way clearing scheme)	– reduction in the number of payment transactions by 50 thous. pcs. (6.6%); – reduction of payment turnover by 19.1 bln rubles (2.3%)	degree of consolidation of financial information – 5.8; flexibility of the settlement system, possibilities for its adjustment – 6.5; degree of process automation – 7.6
The greatest potential clearing effect for pairs of companies	25 and 26–6.7 bln rubles; 21 and 26–4.4 bln rubles; 12 and 26–1.3 bln rubles; 6 and 16–1.2 bln rubles; 16 and 27–1.1 bln rubles	
Optimal cluster structure for clearing holding (Ward method)		

Source: Compiled by the authors.

Table 5

Results of the Implementation of the Multilateral Clearing Scheme

Evaluation of current and potential settlement system efficiency	Quantitative evaluation	Qualitative evaluation (score)
Option 2 (introduction of the multilateral clearing scheme)	– reduction in the number of payment operations by 53 thous. pcs. (7.0%); – reduction of payment turnover by 143.5 bln rubles (17.5%)	– degree of consolidation of financial information – 8.7; – flexibility of the settlement system, possibilities for its adjustment – 8.2; – degree of process automation – 7.9
Key donor-companies	25, 12, 18, 5, 6	
Key recipient- companies	3, 26, 4, 16, 27	

Source: Compiled by the authors.

the efficiency of the settlement system through transaction netting is 7.1%. In terms of turnover, 39.6% of resources could be released (*Table 3*).

Such potential is considered essential for the group of companies, then it is necessary to consider options for increasing the efficiency of the intra-group settlements system.

As alternative options for rationalization of intra-group settlements system is the formation of two-way or multilateral clearing of obligations.

Two-way clearing in the holding companies involves calculation of a net payment position of each holding company in relation to another company, which is a potential domestic recipient or payer of funds on a month basis and shows the following results (*Table 4*).

Corporate structures that have a single center for management of financial flows, predisposed to the implementation of multilateral clearing in economic activities. This option implies the calculation of a net payment position of each holding company in relation to all holding companies considered as a whole. When implementing a multilateral clearing with a central payment counterparty, the potential volume of funds transferred within the holding (at monthly clearance of obligations) is reduced by 143.5 bln rubles. Payment savings will amount to 17.5% of total actual money transfers for 2018–2020. Useful effect of multilateral clearing of obligations above the effect of bilateral clearing both on reduction of number of payment operations and on reduction of volume of transfers (*Table 5*).

In order to decide in favor of an option of a settlement and payment system, a net present value is calculated in the third step of the intra-group calculation algorithm. Taking into account the need for preparatory measures, as a start of the project of transformation of the settlement system through the introduction of clearing the beginning of 2021. The forecast period of the project implementation is defined in 5 years, which is due to the economic cycles of the company, strategic vision of the management regarding the future development of the

Table 6

Discount Rates Used to Calculate the Net Present Value of Project Implementation

Year	2021	2022	2023	2024	2025
r	8.17%	11.24%	13.62%	16.28%	19.31%

Source: Compiled by the authors.

Table 7

Forecast Cash Flow from Savings on the Payment Transactions Volume, mln rub.

Год / Year	2021	2022	2023	2024	2025
Option 1	1.38	1.41	1.47	1.47	1.50
Option 2	1.41	1.41	1.50	1.53	1.59

Source: Compiled by the authors.

Table 8

Forecast Cash Flow from Savings on the Payment Turnover Volume, mln rub.

Год / Year	2020	2021	2022	2023	2024
Option 1	18.54	29.66	37.08	44.49	48.20
Option 2	139.47	223.15	278.94	334.73	362.62

Source: Compiled by the authors.

Table 9

Comparison of Alternatives to the Design of the Settlement System

Conclusions and recommendations to improve the system of intra-holding settlements	Initial state	Option 1	Option 2
NPV project, mln rubles	–	51.55	834.53
Qualitative indicator	7.00	6.71	8.22

Source: Compiled by the authors.

holding and market conditions. To estimate the discount rate, a cumulative method was used, according to which the risk-free rate is adjusted for country, industry, management risks and inflation (*Table 6*).

In calculating the efficiency of the project, the initial investment costs for its launch were estimated in the form of work on the collection, systematization and analysis of primary information on the system of settlements in the holding, work on the development of the clearing system, purchase of equipment, training of staff and other direct and overhead costs (management,

transaction, security, reserve formation). To predict the amount of cash flows generated by the project, a cost estimate of savings from changes in the values of quantitative efficiency factors was used.

To assess the effect of reducing the number of payment transactions, the cost of sending a payment order in accordance with the average tariff of the banks servicing operations of the holding is used (the forecast of clearing effect on the reduction of the volume of payment operations in 2021–2025 is obtained by extrapolation of the results of 2018–2020 evaluation, with adjustment for the strategic plans of the group of companies (*Table 7*).

To estimate the volume effect of the payment turnover, the estimated cost of placement of funds in low-risk financial instruments (bank deposits) was used. The calculation schedule of cash flows in the form of savings on the volume of payment turnover is presented in the *Table 8*.

The results of the calculations of the indicators of economic efficiency of the projects justify the choice of the second option and indicate the feasibility of introducing a monthly multilateral clearing of intra-holding obligations with a central counterpart (*Table 9*).

CONCLUSION

The article systematizes a complex of factors that determine the efficiency of the system of intra-group settlements, develops a method of rationalization of the settlement system of holding on the basis of clearing obligations, universal in the application of holding companies. The research results generate a number of conclusions.

Firstly, the existing fragmentation of the holding into separate legal entities creates transaction costs. On individual companies of the holding there is a small payment turnover. The group of companies should consider merging individual companies to benefit the holding economy and without seriously harming business managers and owners.

Secondly, maximizing the benefits of the clearing system requires changes in the current structure of the holding organization. The results of cluster analysis based on the volume of payment turnover and the effect of two-way clearing differ from the actual structural device in the holding.

Thirdly, the presence of the SSC, which has already centralized the functions of formation and maintenance of payment operations of all participants of the holding, is the basis for building a single clearing center and transfer of authority of the central counterparty to multilateral clearing.

Fourthly, based on the analysis of options to improve the quality of the settlement system, it can be concluded that the clearing of mutual requirements will have a significant positive effect on the settlement system in the holding, will reduce the economic costs of the companies involved in the settlement, increase their financial reliability to external parties.

In general, it should be noted that the proposed method of rationalization of the system of intra-holding settlements has universality in application and can be used in solving managerial tasks within any holding.

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

The article was submitted on 08.04.2022; revised on 22.04.2022 and accepted for publication on 27.12.2022.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-189-198
UDC 336.67(045)
JEL G21, G30, D61, C25

Impact of the Board of Directors' Structure on the Company's Financial Results

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ABSTRACT

Subject of study — role of corporate governance practices in managing the largest Russian banks. The **relevance** of the study is due to the fact that decisions affecting financial results of companies depend on socio-demographic characteristics of their decision-makers and technology of these decisions. The Board of Directors is the body that controls the activities of management, and the efficiency of management decisions depends on its structure. The **aim** of the study is to estimate the influence of socio-demographic characteristics of directors on financial results of banks. In this research the authors use such **method** as panel regression analysis to estimate the significance of the obtained results. The sample captures the data on 6 largest Russian banks by total assets for the period 2011–2020. As the **result**, gender board diversity has a positive and statistically significant impact both on ROA and ROE. Meanwhile, the influence of national diversity on ROE is insignificant whereas the effect of this variable on ROA is significant and negative. In addition to board diversity features, business size is also an important determinant of profitability. The negative influence of this indicator should not be understood literally. The largest Russian banks are examined in this article, so the growth in the volume of their assets is associated with a decline in profitability in relative terms. The analysis also reveals that board independence and leverage do not affect profitability. **Conclusion** confirm a positive influence of board gender diversity on financial performance of Russian banks. Along with that, a negative impact of national diversity and an insignificant impact of board independence refute the results reported by both foreign and Russian authors. Further research on the influence of corporate governance practices on financial performance of Russian companies is required.

Keywords: corporate governance; financial results; board structure; gender diversity; national diversity; profitability; regression analysis; agency theory

For citation: **Krasnov A.N., Balynin I.V., Shmeleva L.A. Impact of the board of directors' structure on the company's financial results. *Finance: Theory and Practice*. 2023;27(3):189-198. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-189-198**

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INTRODUCTION

Corporate governance has a direct impact on the success of the company as a whole. It is the board of directors (further — BD) that determines and takes decisions that will lead to either positive or negative results for the company. The search for the optimal BD structure of the company has become the subject of research for both management practitioners and the academic community [1].

Among the parameters of the BD structure that influence the performance of management, among others, socio-demographic characteristics, CEO duality, the level of competence of directors about the salaries in the company, educational level and professional experience of directors were identified [2]. This paper is focused to the examination of the effect of the socio-demographic characteristics of the BD members on the financial results of top Russian banks.

Statistics on BD structures in Russian enterprises indicate the following. The share of independent directors increased significantly from 36.7% to 42.2% in 2020. Based at the six-year retrospective, the growth was 3.2% (in 2014, independent directors accounted for 39% of the total BD membership). The representation of women in the Russian BD is still one of the lowest compared to international practice despite the fact that the share of women on boards of directors increased from 8.4 to 10.5% in 2020. The percentage of companies that do not include women on their boards has more than halved — from 37% in 2019 to 23% in 2020. The share of foreign directors was 29.2% in 2020 and thus remained almost unchanged compared to 2019 (29.7%).[1]

The purpose of the paper is to examine the influence of the BD structure on the financial results of the main Russian banks. Specifically, the following criteria are assessed: board independence, the share of female directors and the share of foreign directors.

REVIEW OF THE LITERATURE

The theory that had the largest influence on corporate governance practices may appropriately be called an agency theory. It explores the problem of the separation ownership and control. This theory describes the relationships between hired directors and shareholders as a contract in which owners (principals) hire managers (agents) under certain conditions. And while managers are expected to conduct their work in a professional manner and act in the best interest of the company, in fact, this is not always the case [3].

Managers who obtain enormous resources of the company at their disposal begin to use them not for the development of a company, but for their own purposes or to achieve the target indicators of their activities [4]. This situation is referred to as an agency problem or agency conflict in the literature [5].

In the practice of corporate management, a huge amount of paper is devoted to the issue of the resolution of agency conflicts [6–9]. One of the most effective practices is the creation of a board of directors and the invitation of so-called independent directors [10]. Moreover, the composition and structure of the BD, namely the total number of directors, the share of independent directors and the proportion of female and foreign directors, also influence the financial performance of the business.

In Russia, agency theory has not been widely adopted. This is partly due to the less developed practices of corporate governance in general. Also, a factor reducing the effectiveness of corporate governance procedures is the fact that enterprises in Russia often use tools beyond the legal framework which puts into question the development of this model in domestic

[1] SpencerStuart. Russia Board Index; 2020. URL: https://www.spencerstuart.com/-/media/2021/june/russiabi2020/russiabi_2020.pdf (accessed on 07.01.2023).

enterprises [11]. On the other hand, with the development of the stock market, the need for improving the legal field and corporate governance practices for regulating business will grow.

METHODOLOGY OF ANALYSIS

Data

The explored sample comprises the six largest Russian banks as the management practices in such financial institutions and the management methods employed may differ considerably from those implemented in banks with smaller assets. It should also be taken into consideration that reporting in financial companies has a number of aspects contrasted to non-financial companies, therefore it would be methodologically irrelevant to include in the sample both financial and non-financial companies. The analysis period is 2011–2020. This period is selected in view of the fact that in 2010–2011, the global markets began to recover after the catastrophic 2007–2009 recession, and starting from 2020, the financial performance of enterprises were heavily damaged by the COVID-19 pandemic. The data is derived from the annual reports of the relevant banks, taken from their official websites.

Methods of analysis

The following methods are used for analysis: descriptive statistical analysis, correlation analysis of independent variables, panel regression analysis, and the Hausman test.

The degree of correlation is measured using the Pearson coefficient. For the interval variables that are used in the work, this coefficient is preferred over other similar indicators, such as the Spearman and Kendall factors [12].

Correlation analysis is performed to detect potential multicollinearity. This phenomenon reflects ~~a~~ strong correlation between independent variables. In the event of a strong correlation in the sample, the regression results may show that one of the variables affects the dependent variable while the other does not, but this may not be the case [13].

The least squares method is one of the methods of mathematical regression analysis used to determine parameters in which the modeled relationship between factors is closest to the real observed values of variables [14]. Thus, the least squares method estimates the size of the deviation of real values from the modeled values and seeks to minimize it [15].

When conducting panel analysis, another task arises: choosing the optimal model specification from two options, namely models with either fixed or random effects. The Hausman test is performed to determine whether the results of a random effect model are stable and can be used for analysis [16].

Model and hypotheses

The analytical model for panel regression analysis is as follows:

$$ROA(ROE)=Size+Leverage+Gender+ + Board\ Independence+Foreign,$$

where ROA (Return on Assets) — profit before deduction of taxes and interest payments / total assets (profitability of total capital);

ROE (Return on Equity) — net profit / equity (profit of own capital);

Gender (gender diversity) — number of women in the BD / total number of directors;

Board Independence — number of independent directors / total number of directors;

Foreign (national diversity) — number of foreign directors / total number of directors.

Size — natural logarithm of assets;

Leverage — liabilities / assets.

The last two variables are control variables. They are included in the model in order to exclude the possible undetected influence of these factors. Thus, two models that reflect different types of profitability are analyzed: total capital and equity.

Table 1

Descriptive Statistics

Variable	Observations	Average	Standard deviation	Min	Max
ROE	60	12.87%	0.133	–25.16%	43.90%
ROA	60	7.89%	0.096	–1.31%	39.42%
Size	60	8.090	1.648	3.440	10.492
Leverage	60	89.29%	7.39%	64.49%	130.77%
Board independence	33	35.76%	12.32%	11.11%	54.55%
Foreign	40	30.79%	23.74%	5.88%	90.91%
Gender	38	14.84%	7.69%	0.00%	28.57%

Source: Developed by the authors.

These models test the following hypotheses:

Hypothesis 1: the share of independent directors has a significant impact on the profitability of banks;

Hypothesis 2: the share of female directors has a statistically significant impact on bank profitability;

Hypothesis 3: the share of foreign directors has a significant impact on the profitability of banks.

It is expected that the explored factors will have a statistically significant relationship with the profitability of banks. Similarly, the hypotheses are formulated in the form of the rejection of this relationship according to the logic of the statistical tests that will be conducted in the research process.

ANALYSIS

Statistical analysis is performed in four steps. In the first stage, the descriptive statistics of the sample are analysed; then the correlation coefficients between independent variables are assessed; the next step is the panel regression analysis; and, the final stage is the Hausman specification test.

Descriptive statistics analysis

To begin with, we describe the sample statistics. The analysis considered 5 independent variables (company size, leverage, percentage of independent directors in the BD, percentage of foreigners in the BD and percentage of women in the BD) and 2 dependent variables (return on equity and return on assets). Descriptive statistics are presented in *Table 1*.

Descriptive statistics analysis reflects the importance of leverage as its mean value was. Almost 90% indicate leverage growth in the banking sector over the past 10 years. Obviously, the banking sector requires free financial resources that remain after all current costs are executed. However, it is worth noting that the growth in leverage has negative implications for the industry, as the stock of own funds of companies with high leverage is limited. A high level of leverage also has a negative impact on the efficiency of the company which in combination can become one of the causes of bankruptcy.

Average profitability was 12.87% for ROE and 7.89% for ROA, respectively. However, the minimum values for both dependent variables are negative, indicating that banks in the sample recorded losses in certain years.

With regard to the BD structure, the average share of female directors was 15% while there were also boards of directors with no women. The highest level of presence of

Table 2

Correlation Matrix

Variable	Size	Leverage	Board Ind.	Foreign	Gender
Size	1				
Leverage	–0.083	1			
Board independent	0.128	–0.070	1		
Foreign	–0.662	–0.259	0.146	1	
Gender	0.071	–0.218	0.588	0.192	1

Source: Developed by the authors.

female directors was 28.57%, i.e. just under a third. The average percentage of foreigners was higher, namely 31%, while the maximum presence of foreign directors was 90% (9 out of 10 directors were foreigners). The average board independence ratio is 36%, i.e. on average two executive directors per one independent director on the board of directors of Russian banks. There were also banks where the share of independent directors exceeded 50%.

The next step was to determine the correlation between the independent variables. At this stage, the Pearson coefficient was used to examine the correlation between variables such as company size, leverage, percentage of board independence in BD, percent of foreigners in BD and percent of women in BD. In this image, the Pearson coefficient, as mentioned above, reflects the relationship of independent variables between themselves. The correlation analysis results are presented in *Table 2*.

The analysis using the Pearson coefficient identified two pairs with the highest correlation rates: between the percentage of foreigners in BD and the size of the organization (–0.662), as well as between the proportion of women in BD, and the percent of independent directors in BD (0.588).

Regarding the first correlation between the percentage of foreigners in BD and the size of the company, it can be seen that the larger the company's size, the more it tends to invite to its board of directors' managers with a foreign passport. Foreign specialists in BD are needed to expand business relationships, diversity in management approach and to make independent decisions that allow a sober assessment of the company's activities, to analyze the negative sides and to develop positive aspects.

The second pair of variables with a strong correlation is the relationship between the proportion of women in BD and the percentage of independent directors in BD. In the world economy of the 21st century, the trend to gender equality is taken, which allows women to hold high positions in the management of large companies. Numerous studies show that firms with women on their boards of directors operate more efficiently [17, 18]. This enables us to confidently state the requirement for a proper selection of the BD composition. When developing the BD, the company's management must consider the number of independent directors, women, and foreigners on the board.

As a consequence of summarizing the correlation matrix study, we can infer that organizations with women in BD function more effectively and have greater financial results. According to Pearson's coefficient analysis, the optimum number of women on the board of directors is 15–20%, or

Table 3

Regression Analysis Results

Variable	Coefficient (Standard Deviation)			
	ROA		ROE	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Size	−0.055 (0.024) **	−0.068 (0.006) **	−0,072 (0,091)	−0,051 (0,021) **
Leverage	−0.072 (0.151)	−0.066 (0.150)	0,655 (0,568)	0,780 (0,520)
Gender	0.104 (0.142)	0.275 (0.099) ***	0,773 (0,532)	0,971 (0,343) ***
Foreign	−0.153 (0.100)	−0.177 (0.050) ***	0,190 (0,373)	−0,036 (0,172)
Board independent	−0.003 (0.068)	0.025 (0.066)	−0,0704 (0,258)	0,039 (0,230)
R^2	0.942	0.958	0,445	0,563
F-statistics (p-value)	10.570 (0.000) ***	389.89 (0.000) ***	0,67 (0,649)	21,90 (0,001) ***
$\chi 2$ (p-value)	4.7 (0.452)		1.41 (0.923)	

Source: Developed by the authors.

Note: значимость: significance at the: *** – 1%, ** – 5%, * – 10%.

approximately 1 woman per every 6 males. Women in BD allow for independent assessment of solution effectiveness, analyze problem situations, and carefully plan the future of the company.

Regression analysis using the least squares method

Since the paper uses panel sampling (data varies in two dimensions — by year and by company), it is necessary to assess which of the models (with constant or random effects) gives more accurate results. This assessment was made using the Hausman test. The test revealed that the random effect model was more appropriate for both ROA and ROE models. It was when choosing the random model that the indicators were most objective and true.

The following results were obtained after conducting regression research for ROA and ROE variables: the ROE indicator is influenced by the size of the company and gender, and the ROA indicator is also strongly influenced by the company size and gender, but the presence of foreigners on the board of directors also affects ROA (*Table 3*).

The result of the analysis shows that ROE is statistically influenced by the size of the company and gender, i.e. the number of women on the board of directors. The size of the company has a negative impact on ROE. In other words, as the size of the assets increases, this indicator decreases. ROE measures the return on equity capital, or the profitability of a company. When a company is among the largest in its industry, it is extremely difficult for it to grow at the rate that young and growing companies do. Thus, the relative return on capital of a large company increases steadily over time. This result is logical as the largest banks of the country which already occupy a significant market share were included in the sample. Therefore, they do not grow extensively. It should be noted that a negative correlation between return on equity and asset growth will be found in major banks, but the

Table 4

Research hypotheses results

Hypotheses	ROA	ROE
Board independent (hypothesis 1)	Not confirmed	Not confirmed
Gender (hypothesis 2)	Confirmed (+)	Confirmed (+)
Foreign (hypothesis 3)	Confirmed (+)	Not confirmed

Source: Developed by the authors.

conclusion cannot be generalized to smaller businesses. It should also be noted that the study's result is significant at the 5% level, which means that the probability that the size does not actually affect ROE is 5%. This demonstrates the significance of this variable.

The second variable that has a strong impact on the ROE score is the share of women on the board of directors. This coefficient has a 1% significance. In other words, the error probability in estimating the significance of this change in ROE is 1%. According to the regression analysis, the inclusion of women on the board has a positive impact on ROE. As a result, we observe a trend: increasing the share of female directors has a positive impact on return on equity.

There are several arguments for positive impact of female directors on the company's financial results. It is mostly due to men and women's distinct ways of thinking in general. Men perceive the world in a more linear and rational manner, and they are required to respond to fewer streams of information at the same time. As a result, the natural restriction of strictly "male" thinking may be a lack of diversity of possibilities and an inadequate perspective of the current condition of things. In doing so, women perceive the world more broadly, with more dimensions and a wider range of experiences available. Women are able to step out of line and offer non-standard actions and solutions to problems that are almost impossible to solve logically [19, 20]. The downside of this perception is often the inability to organize the layers of perceived information and understand the causal relationships between phenomena. We can improve the quality of the board's overall decision-making through integrating the best features of both types of thinking, namely male rationality, consistency, and pragmatism, and female volumetric vision and more intuitive thinking. This will lead to better management and financial results.

At the same time, it should be understood that the positive dynamics of the ROE development is observed with the existing ratio of men and women on the board of directors, namely about 6:1. It cannot be stated that if this ratio changes in any direction, the positive dynamics will continue.

The share of directors with foreign citizenship and the share of independent directors had no statistically significant impact on the profitability of banks. Similarly, the level of leverage did not affect the banks' profitability.

The analysis of ROA indicates the following. The regression analysis showed that characteristics such as company size, gender, and the number of foreigners on the board of directors had the greatest impact on ROA. The size of the company and the number of foreigners on the board of directors negatively affects the ROA indicator. But the gender variable (the presence of women in the BD) has a positive effect.

It should be noted that the presence of foreign directors negatively affects the ROA indicator at 1%. That is, the probability that the presence of foreigners in the BD does not matter for the ROA is 1%. Thus, as a result of

testing hypotheses, it should be noted that not all of them were confirmed (*Table 4*).

The impact of women's share in BD and company size on financial results was explained above. Positive influences of the presence of foreigners in the BD were also noted, such as the expansion of business ties, objective evaluation from outside and new business experience. However, we must not overlook the negative aspects of the study, which were more significant. Because of variations in education, mentality, and culture, foreigners sometimes have difficulties with understanding the nuances of the activities of organizations in a given nation. In this instance, foreigners are more likely to interfere with management rather than to assist it. Moreover, an agency conflict arises from disagreements between independent directors and managers, and as a result, practices designed to improve corporate governance have the opposite effect.

CONCLUSION

The paper is devoted to the role of corporate governance practices in the main Russian banks. The impact of BD characteristics on company financial results has been studied in specific. The use of panel regression analysis allows us to assess the impact of BD members' socio-demographic characteristics on bank profitability, namely ROA and ROE. For both dependent variables, the random effects model proved to be more effective. This suggests that the corporate governance practices presented by the selected variables are quite similar in all banks in the sample. At the same time, it should be noted that these results apply exclusively to the country's top banks; extending them to, for example, smaller banks or non-financial businesses would be incorrect because these companies would have different features.

The analysis showed that gender diversity on the board of directors has a statistically significant positive impact on both overall profitability and profitability of banks' equity capital.

At the same time, the presence of foreigners on the board has no influence on the profitability of equity capital but has a negative impact on the total profitability of the company.

Besides the BD's characteristics, bank size was an important aspect in determining the company's success. This indicator's negative role should not be taken literally. As it was noted, since the largest Russian banks were analyzed, further growth of their assets is associated with a decrease in profitability in relative terms. The analysis also showed that the share of independent directors and the level of bank leverage had no statistically significant impact on the profitability of banks.

The influence of corporate governance practices on financial performance is a relatively unexplored issue in Russian management literature. In the practice of corporate governance, at least 15–20 criteria that have a pronounced and statistically significant influence on company profitability can be identified. Furthermore, by comparing the obtained results with those in other contexts, the results may be improved and deepened. These might include samples from non-financial institutions, smaller banks, similar samples of banks from other countries (both developing and developed economies), and samples from different time periods.

It should be noted that the regression analysis used in the work does not give a complete picture. It does not reflect causal relationships between variables. The hypotheses are based on the existing literature, however there is no guarantee that the relationships applied in this sample are the same as those used by other authors in the past. Regression analysis also assumes linearity between variables whereas in reality the relationship may be non-linear [21, 22].

The results of this study may be valuable to managers of certain companies (particularly those sampled) as additional sources of information since they suggest various management decisions.

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L. A. Shmeleva — description of the methodology used and calculations, analysis of the results obtained, formation of the conclusions of the study.

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

The article was submitted on 09.01.2023; revised on 09.02.2023 and accepted for publication on 27.02.2023.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-199-208
UDC 330.45,334.021.1,336.115(045)
JEL C65, G31, H54

Preliminary Evaluation Methodology for Payback Infrastructure Projects in Private-Public Partnership

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ABSTRACT

The authors of the article present the results of scientific and practical research on the development of methods of primary assessment of the efficiency of payback infrastructure projects public-private partnerships achieved through the monitoring and analysis of the state company's investment activities and project portfolio management. The purpose of this study is to develop methodology for preliminary evaluation of payback infrastructure projects, that is able to be used to evaluate efficiency of capital investment at the stage of initial project appraisal and planning and to range perspective projects in accordance with their efficiency. The subject of the article: efficiency of payback investment projects in the infrastructure industry. The relevance of the study is determined by absence of a generally accepted methodology for initial evaluation of investment projects, that allows for into consideration the legal and economic specifics of federal projects approval and implementation in the regions of Russia. The methodology formed on the basis of an interdisciplinary approach implemented in the course of approval and evaluation practice of investment projects appraisal within the framework of the activities of a state-owned company. The instrumentation reviewed in this paper is based on data from financial modeling of infrastructure projects, with preliminary geographical modeling of traffic flow intensity. It includes the following modified indicators based on discounted cash flows: consolidated coverage ratio, ratio of operating income to capital investment, share of extrabudgetary funding in the life cycle of a project, internal rate of return. These indicators are unified into a single integral indicator, which allows to rank and manage future projects in a company's portfolio. The applicability of the proposed methodology has been verified by the results of implementation of the public-private partnership projects. Based on the results of the study a financial model for initial assessment of project efficiency has been prepared, which can be used as the initial stage of project justification.

Keywords: investment; project finance; spatial modelling; project management; corporate finance; public-private partnership; Russian regions; infrastructure; performance indicators; subsidy; budgeting

For citation: **Shergin D.A., Annenkov G.A. Preliminary evaluation methodology for payback infrastructure projects in private-public partnership.** ***Finance: Theory and Practice.*** **2023;27(3):199-208. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-199-208**

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INTRODUCTION

The market of public-private partnership projects (further — PPP) in Russia has achieved a trajectory of qualitative progress over the past 15 years: new unique federal, regional and municipal investment projects are formed, requiring significant capital investment, careful monitoring and effective application of advanced technologies (including: high-speed highway of M-11 "Moscow — St. Petersburg", construction of aviation infrastructure of Sheremetyevo airfield and other projects). From 2012 to 2020, the cost of projects and the number of concluded PPP agreements doubled: about 200 contracts with a cost over 1 bln rubles were signed [1]. The extensive experience of collaboration between state and private companies serves as the foundation for optimal methodological, managerial, and organizational approaches to project management, even for unprecedented federal projects.

At the same time, generally recognized and effective approaches to evaluation of PPP investment projects in relation to Russian implementation experience have not been fully presented in the scientific literature and are not currently the subject of intensive discussion by the scientific and business communities, and the existing legal framework for qualitative and quantitative criteria for determining the efficiency of such projects does not yet have a consistent experience of application [1–4]. Many Russian methodological approaches to financial analysis of PPP projects are based on foreign research and experience, as such a methodology for evaluating the performance of projects based on direct experience of conclusion, implementation and closure of PPP infrastructure projects in Russia, has not been developed. There is also a lack of agreement within the international community on best practices for project pre-assessment, since multiple criteria and models are recognized as optimal for estimation of cost-effectiveness of PPP [5]. The scientific literature identifies two groups of criteria to evaluate capital efficiency: investment efficiency criteria (net present value, internal rate of return and others) and budgetary efficiency criteria (revealed comparative advantage index, net present value of budget investments). At the same time, research criteria for preliminary, initial evaluation of PPP-projects are not sufficiently represented in scientific research. This fact supports the scientific relevance of the methodology developed in this article for the initial assessment of infrastructure projects, which can be used for practical application-oriented investment planning, and is based on first-hand experience of large federal concessions and long-term infrastructure investment agreements.

The purpose of the study — is to develop a methodology for the initial assessment of the payback of infrastructure projects, that will allow to assessment the effectiveness of investment at the preliminary project preparation stage and the ranking of prospective projects on efficiency. The paper is organized as follows: the first section provides a literary review of current approaches to evaluation of PPP infrastructure projects, and the second section develops methodologies to evaluate the cost-effectiveness of PPP projects.

EVALUATION METHODS FOR PPP PROJECTS

The scientific and business communities' interest in developing public-private partnerships has increased significantly during the last 30 years [5]. The main research topics of PPP projects are: efficiency, financial closure, project risks, value for money and institutional factors. Both qualitative and quantitative research approaches are being developed. Quantitative methods are used to assess the effectiveness of projects, determine the agency relations between the parties in the framework of game theory, assess the net present value of projects and risks, and model interactions within PPP projects using fuzzy

set theories, analytical hierarchy processes and dynamic systems.

In English-language PPP studies the most commonly used model for financial efficiency estimation of a project is the model of real options. Real option theory is used to determine the duration of agreements and the cost of capital investment [6] and to form adaptive investment scenarios based on project indicators [7]. Another widespread approach to the effectiveness of PPP projects — simulation models. Y. Zhang et al. [8] uses a dynamic system experimental model, in which long-term implications of different decisions under financial project planning are examined by causal relations between PPP participants for choosing the optimal investment strategy.

The most commonly used approach to estimation of comparative advantages of PPP is value for money (VfM), which can be detected in early [9] and recent studies [10]. VfM method is suitable for preliminary and retrospective analyses: this method is used for economic justification of public-private partnerships, for evaluation of projects in relation to key indicators, and for analysis of efficiency of already completed PPP-cases [11].

The paper of F. Kurniawan et al. [12] suggests another method of evaluation — a step-by-step review of cost-effectiveness of a project: at the senior debt-raising stage and at the operational stage to define the sensitivity of the project indicators to market changes, as well as to guarantee an effective operational cash flow of the project at later stages, taking into account debt servicing. Another paper focuses more on the profits and losses of each party to the agreement and presents a method for efficiency estimation by use of a weighted criterion based on the parametric estimations obtained [17].

Empirical research in English-language sources is mainly based on case studies, and is consequently limited by the availability of data, which often constitutes commercially confidential information and is not publicly disclosed. Theoretical English-language papers, however, rarely implement hypothesis testing through multiple case comparison. Based on this, it can be concluded that in many foreign papers a weak body of evidence can be observed regarding independent practice of PPP implementation. In addition, the possibilities of comprehensive modeling in the course of direct project management may be limited by the uncertainty of key preconditions, which underlines relevance of an integrated approach to preliminary assessment of PPP projects based on financial metrics.

In the Russian-language papers, descriptive and comparative approaches to the theoretical side of the question [14] are thoroughly studied — a general theory is developed, that explains the emergence of PPP as a form of market relations and studies the structure and distinctive properties of PPP projects, as well as their risks. However, a relatively small number of papers are focused on project assessment methodologies with respect to the infrastructure sector. The paper of E.I. Gabdullina [15] develops a step-by-step general approach to project evaluation, which includes the definition of an information base, evaluation of project indicators, and financial and economic justification. This approach is subsequently developed on the basis of the structural and logical system for evaluation of project efficiency by other authors [16]. Research by L.S. Shakhovskaya et al. [17] proposed a methodology for evaluating the investment effectiveness of PPP projects, that is entirely based on classical financial performance indicators within the method of discounted flows (profitability index, net present value, internal rate of return and others), as well as defining a primary risk assessment matrix. A complex methodology of assessment on the basis of risks is applied in general to capital investment and, in particular, to the oil and gas industry: it is developed on the rule of formation of cash flows [18] and with the help of PEST-analysis [19], and consideration of existing project

management tools applied to this industry is carried out in the paper of M.V. Gracheva and M.V. Stepanova [20].

Thus, there is a need to develop a methodology for *primary* assessment of infrastructure projects in Russia, which cannot be ensured by existing Russian and English-language scientific papers, as well as national normative legal acts. The English-language papers consider a large number of methods, which differ in complexity, but there is no unified approach to the primary integrated assessment, which could take into account the Russian specifics of investment in capital infrastructure. In Russian-language studies, assessment approaches need more theoretical formulation in relation to the industry practice of implementing of PPP projects.

EVALUATION METHODOLOGY

The article presents a summary of the practical investigations of the authors — the methodology for selecting infrastructure projects for the construction or reconstruction of roadways [parts of motorways and (or) artificial road structures, inseparable improvements without accounting for repair and capital repair], to be operated on a paid basis. This methodology has been tested by the results of implementation of PPP-projects and direct management of projects and investment commitments within the framework of the company, which for more than 12 years has held the primacy of industry leader.

The authors developed on the basis of the discounted cash flow approach, an integrated form of assessment for financial indicators, which were modified in accordance with the industry specifics of repayable infrastructure projects. The paper examines a universal approach to definition, calculation and accounting of integrated assessments of infrastructure projects for construction or reconstruction of roads, on the basis of which the primary assessment is carried out of project financial feasibility. Distinctive features of infrastructural investment projects are long planning period (from 15 to 30 years) and increased risks throughout the operational phase. These risks include both the risks of not reaching the forecasted traffic intensity and the financial risks associated with increased debt liabilities of project participants if determined on the basis of floating rates (consumer price index, key interest rate of the Central Bank of the Russian Federation or investment in fixed assets). In particular, the scientific significance of the paper is achieved through the proposed comparable values of indicators that characterize infrastructure projects throughout their life cycle. This is especially relevant for infrastructure payback projects, which are characterized by a significant increase in maintenance costs associated with carrying out repairs.

The methodology is based on quantitative criteria for the selection of investment projects, including cost-effectiveness indicators, which are unified into a single weighted sum of the values of each criterion, taking into account weighting factors. This evaluation is performed as part of the initial stage of project justification, which is then supported via technical, financial, and administrative expertise, including the calculation of the expected cost of implementation, financial model, and risk matrix.

QUANTITATIVE-INDICATORS

Quantitative indicators — key parameters of a PPP infrastructure project, on the basis of which it is possible to calculate the quantitative feasibility assessment of the project. Quantitative parameters according to the developed methodology include:

1. consolidated coverage ratio;
2. operation income/capital expenditure ratio;
3. project cost;
4. non-budget share;
5. internal rate of return;

6. intensity of road traffic.

The approach for determining key quantitative indicators to measure the efficiency of infrastructure projects is described below.

1. Consolidated Coverage Ratio (CCR)

PPP infrastructure projects are characterized by a large disproportion in the durations of the investment and operational phases and a rather high sensitivity of the financial indicators to changes in key factors throughout the life of the project. At the operational stage, the financial sustainability of the project is quite dependent on both changes in the revenue component and the servicing of debt financing attracted at the investment stage. Even in the final stages of the project, the need to maintain a positive cash balance after accounting for historical accumulations remains, as additional maintenance costs for repairs (after 12 years) and major repairs (after 24 years) are required in accordance with Decree of the Government of the Russian Federation No. 658. Therefore, a key measure of the financial sustainability of the projects is the consolidated coverage ratio. This indicator is calculated as the ratio of discounted values of all future project revenue and income to all project operating costs and debt service payments at the operational stage under the following formula:

$$CCR = \sum_{t=1}^{T} \frac{TC_t + STB_t}{(1+r)^t} \Big/ \sum_{t=1}^{T} \frac{OP_t + IP_t + CBP_t}{(1+r)^t}, \quad (1)$$

where t — financial model period counter (usually year); T — year corresponding to the end of the project (the last year of the PPP agreement and the last year of the project financial model); TC_t — income from tolls collection (*TC*) for the transportation of vehicles on the paid section of the road in the period t of this project; STB_t — short-term borrowings (*STB*) attracted in a year t to cover the cash gap during implementation of the project (balancing bond loans — up to 5 years); r — required return based on project implementation risks, most often used rate on STB_t; OP_t — operating payments (*OP*) in the year t в in favor of the project contractor (usually include the cost of maintenance toll systems (further — *TS*), operations, maintenance of the Traffic Management System (further — *TMS*) and services of emergency commissioners, as well as the maintenance, repair and overhaul of the road within the project); IP_t — investment payments (*IP*) in the year t in favor of the project executor (principal repayment and interest on the investment of the contractor); CBP_t — coupons and bond payments (*CBP*) in the year t (include repayment of both investment and short-term loans — STB_t).

Recommended target value of the indicator $CCR \geqslant 1{,}3$. *CCR* target value can decline to 1.1 with additional measures to manage the traffic intensity risk. The minimum $CR_t \geqslant 1.1$ value can be used to calculate coverage ratio for a specific period of the operational phase of the project. The minimum $CR \geqslant 1.2$ value is allowed for calculation of the current cover ratio for the repayment period of the principal involved in a loan financing project. Deviations from the recommended values are allowed if additional project structuring elements are applied to ensure the financial stability of the project in case of traffic risks. For repair and overhaul periods, the factor may take values less than 1, but the availability of accumulated liquidity in the form of available project cash must be guaranteed to achieve the optimum average value and the fall of the consolidated coverage ratio below the target level should not exceed three consecutive periods.

2. Operating Income/Capital Expenditure Ratio (OICR)

For comparative analysis of infrastructure project structure at investment and operational stages of implementation, it is

advisable to apply the operating-income/capital expenditure ratio. This metric is able to demonstrate the effectiveness of investment in a project in the long term, taking macroeconomic assumptions into account. The operating income/capital expenditure ratio is calculated as the ratio of the amount of the discounted income from the collection of the tolls, reduced by the value of operating payments, to the total amount of discounted capital investment according to the following formula:

$$OICR = \frac{\sum_{t=1}^{T} \frac{(TC_t - OP_t)}{(1+r)^t}}{\sum_{t=1}^{T} \frac{Capex_t}{d_t}}, \quad (2)$$

where $Capex_t$ — project capital expenditure (*Capex*) in the period t (from all sources of funding); d_t — discount factor for investment based on investment index in fixed assets (further — *IIFA*) adjusted by choice of degree for optimal discount periods.

This synthetic indicator measures how many times the income from the project exceeds the capital cost of establishing it without taking into account the sources of funding. There is no standard value. The value of $OICR \geq 1$ indicates a very high prospect of the project (and indirectly, excluding the value of the debt, indicates the possibility of recouping the capital investment during the period of the agreement).

3. Project Cost (PC)

For infrastructure projects, it is especially important to calculate the total cost of the project on the life cycle correctly, as often the project may require much more investment at the operational stage, which, if critical levels of return are not reached, will create an additional need for funding. As a result, in order to properly evaluate the project, the total cost of the project over the entire life cycle must be calculated, which is defined as the sum of the discounted costs for construction and maintenance of the infrastructure facility from all sources for the entire duration of the agreement (Project Cost) by the following formula:

$$PC = \sum_{t=1}^{T} \frac{Capex_t}{d_t} + \sum_{t=1}^{T} \frac{OP_t}{(1+r)^t}. \quad (3)$$

The total cost of the project over its life cycle shows the present value of the infrastructure facility, excluding the cost of paid maintenance and extrabudgetary financing. Attracting extrabudgetary funding and implementing the project on a paid basis will relieve some of the burden on the government budget for the facility's construction and upkeep throughout its life cycle.

4. Non-Budget Share (NBS)

Determining non-budget share is important for evaluation of a PPP-project. It should be noted, however, that non-budget funding is attracted not only during the project's investment stage, as the costs of the project's operating phase may not be covered by toll collection income (which is especially relevant in the first years of operation, when traffic intensity is not yet reaching full volumes due to addictive effects). As a result, the complete life cycle of a PPP-project should be taken into account in order to accurately assess the percentage of non-budget expenditure. Non-budget share (*NBS*) is calculated as the ratio of discounted costs for creation and maintenance of the facility from non-budget sources to the total amount of costs from all sources (see above) according to the following formula:

$$NBS = \frac{\sum_{t=1}^{T} \frac{NBInv_t}{d_t} + \sum_{t=1}^{T} \frac{OP_t^{tall}}{(1+r)^t}}{PC}, \quad (4)$$

where OP_t^{tall} — operating payments (*OP*) in the period t, which are financed from toll collection (non-budget sources).

Table

Weight Coefficients for Integral Appraisal of Infrastructure Projects

No.	Coefficient	Score	Score 0.5	Score 1	Weight
1	Consolidated coverage ratio	< 1.0	1.0–1.29	>= 1.3	w_1
2	Operating income / investment	< 1.0	–	>= 1.0	w_2
3	Non-Budget Share	< 20%	20–60%	> 60%	w_3
4	IRR of the project	$< \min(r_{pr};7,0\%)$	$\epsilon[\min(r_{pr};7,0\%); \max(r_{pr};11\%)]$	$> \max(r_{pr};11\%)$	w_4
	Total				100%

Source: Compiled by the authors.

Operating payments account for a significant proportion of the total life cycle cost of the project, which in the case of PPP can be 100% financed from the income from trust activities (revenue from toll collection). Financing operating costs from collection revenue reduces the overall burden on the budget. In this case, the non-budget share in analysis of projects is significantly higher, which is important when justifying PPP-projects before the federal executive authorities for purposes of the project's inclusion in structural documents. Priority is given to projects, which may maximize financing requirements from non-budget sources, increasing infrastructure development while reducing budget costs.

5. Internal Rate of Return ($IRR_{project}$)

The value of the internal rate of return of an infrastructure project ($IRR_{project}$) is determined by the following formula:

$$0 = \sum_{t=0}^{T} \frac{FCF_t}{\left(1 + IRR_{project}\right)^t}, \quad (5)$$

where FCF_t — free cash flow (*FCF*) of the infrastructure project in the period t, rubles; (FCF — Free Cash Flow); $IRR_{project}$ — internal rate of return on the infrastructure project, %; t — period of time; T — final period of implementation of the infrastructure project.

The value of the free cash flow numerator in each period t (FCF_t) is determined by the following formula:

$$FCF_t = TC_t - OP_t - Capex_t, \quad (6)$$

where TC_t — revenues from the toll collection in the period t of this project; OP_t — operational payments in the year t to the project contractor (includes, as a rule, TS maintenance, TMS operations and emergency commissioners services, as well as

maintenance, repair and overhaul of the road under the Agreement); $Capex_t$ — project capital expenditure in the period t (from all sources of funding); t — period of time.

CALCULATION OF AN INFRASTRUCTURE PROJECT'S INTEGRAL APPRAISAL

Following the evaluation of the project indicators, the data is compiled into an overall integrated assessment, which simplifies project comparison and is required for the project's implementation decisions. To calculate the integral evaluation of an infrastructure project (Ef_{eff}) it is necessary to calculate the weighted average sum of the indicators on the basis of the calculation of points according to the selection criteria (in accordance with *Table*):

$$Ef_{eff} = \sum_{j=1}^{N} \alpha_j \beta_j, \qquad (7)$$

where α_j — weight coefficient defined for the selection j — criterion; β_j — score corresponding to the selection criterion j; N — total number of selection criteria.

To calculate the integral evaluation of an infrastructure project, the weights are determined as follows (see *Table*).

Integral assessment allows the company to rank prospective projects in accordance with the best investment efficiency, as well as quickly manage the project portfolio and build its investment policy. Weights are determined with small deviations from equal values within 100%. Projects with the largest integral assessment indicator have priority for implementation, as they achieve payback in the shortest possible time and create positive flows, which increase development opportunities for the company. However, inclusion of projects with a low integral rating could significantly impair the investment performance of the company's portfolio and reduce flexibility of the operational response.

CONCLUSION

The article describes a method for primary selection and assessment of PPP infrastructure projects based on an integral indicator of the major financial efficiency metrics. The suggested method is applicable to any infrastructure project, which includes mechanisms for return on investment and self-profitability. Applicability and effectiveness of the developed method were tested through a pre-project study on selected payback projects, as well as through actual practice of implementing PPP infrastructure projects throughout the life cycle as part of the core business of the market's largest company — the infrastructure PPP project initiator. In the future, methods of accelerated preliminary modeling of projects on the basis of the proposed methodology could be developed in order to more accurately budget the financial structure of a project and to determine the main flows of projects, as well as further refinement of the proposed methodology based on project risk assessment.

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

The article was submitted on 06.02.2023; revised on 06.03.2023 and accepted for publication on 27.03.2023.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-209-220
UDC 336(045)
JEL L10, O30

Methodology for Assessing Information Disclosure on Stakeholder Risks in Non-Financial Reporting of Oil and Gas Companies

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ABSTRACT

The **subject** of the study was the public non-financial reporting of oil and gas companies in Vietnam and Russia. The research methodology is based on the analysis of theories, methods for assessing and rating the best practices of public non-financial reporting from the standpoint of disclosing stakeholder risks when making economic, including investment decisions. The analysis revealed the limitations of the studied methods within the framework of openness and the absence of an important component of quantifying the satisfaction of stakeholders with the disclosure of information that is of high importance to them from in terms of key risks associated with the company's activities. In this regard, the **purpose** of the study was to develop a methodology and analytical tools to assess the degree of disclosure of information about stakeholder risks in the non-financial reporting of oil and gas sector companies (the degree of satisfaction of the most significant stakeholders). The **methodology** is based on the identification and correlation of companies' key risks with the interests of the most significant stakeholders, which is the theoretical significance of the study, and also includes a compliance approach, mathematical and statistical assessment of the degree of satisfaction of stakeholders' interests. The empirical base of the study was the 20 leading companies in Russia according to the RUIE 2022 ranking and the 23 largest companies in Vietnam according to the VN 500 2022 ranking in terms of revenue. The practical significance of the methodology lies in the fact that its results make it possible to increase the effectiveness of the company's communications with the most significant stakeholders in order to achieve the goals set in the field of sustainable development.

Keywords: oil and gas sector; ESG information; sustainable development policy; key risks; degree of stakeholders' satisfaction

For citation: **Doan T.L., Kazakova N.A. Methodology for assessing information disclosure on stakeholder risks in non-financial reporting of oil and gas companies. *Finance: Theory and Practice*. 2023;27(3):209-220. DOI: 10.26794/2587-5671-2023-27-3-209-220**

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INTRODUCTION

The energy and oil and gas sectors are among the system-forming sectors of growing world economies, and their operation is inextricably related to high political risks and public policy. According to the Energy Research Institute of the Russian Academy of Sciences' scenario forecast of the consequences of the observed technological transition of the world energy from the use of organic fuel to non-carbon energy resources, "the main direction of world energy development will be determined by the influence of changes in energy policy and new technologies",[1] which will be the main dominant of energy development worldwide, and its most import. This is indicated in the papers of A.G. Aganbegyan [1] and B.N. Porfiriev [2]. At the same time, the attraction of investments is significantly tightened by the risks associated with the implementation of the strategy of environmental, social and governance responsibility of the business (Environmental, Social and Governance, further — ESG).[2] Global trends and the global community's attitude toward the importance of corporate reporting demonstrate that the compilation and presentation of information about ESG-factors of sustainable development is an unavoidable process, as confirmed by KPMG research on the state of such reporting by the world's largest companies in all sectors of the economy from 2008 to 2022. A 2022 analysis of non-financial reporting by the world's biggest revenue companies in Group N 100 (5 800 companies) and Group G 250 (250 companies) shows the evolving dynamics of non-financial reporting companies,[3] furthermore, 18% of the N Group 100 and 37% of the G 250 Group firms provided non-financial disclosures based on Task Force on Climate-related Financial Disclosures (TCFD). More than 90% of interested users of non-financial reporting responded positively to the relevance and usefulness of companies' financial impact disclosure on climate change.[4]

The research we conducted was based on an examination of the non-financial reporting practices of companies in Russia's oil and gas sector (the sample included 21 companies, including leaders in Russian Union of Industrialists and Entrepreneurs (further — RUIE) ranking (2022) and Vietnam (sample of 23 largest companies by VN 500 revenue in 2022). As of 14 October 2022, according to the National Register of Corporate Non-financial Reports, 225 companies and their 1 314 reports submitted Russian practice. Comparative structure of different types of non-financial reports of oil and gas companies among the companies of other sectors of the economy presented sustainable development reports (*SD*), social reports (*S*), environmental reports (*E*), integrated reports (*I*) (*Fig. 1*).

The results of ESG-indices of RUIE in 2021 revealed the leading oil and gas companies, which were included in two groups A and B+ on the index "Responsibility and Openness" (Gazprom, Lukoil, Rosneft, Tatneft — Group A; NOVATEK, Sakhalin Energy, Transneft — Group B). Average industry index increased from 0.63 to 0.75 in 2020.[5] Analysis of the best Vietnamese practices based on the rating of VN 500 in 2022 allowed to form two groups of companies by types of activity: the first group — oil and gas exploration

[1] World Energy Development Forecast 2019. Energy Center of the Moscow School of Management SKOLKOVO. URL: https://energy.skolkovo.ru/downloads/documents/SEneC/Research/SKOLKOVO_EneC_Forecast_2019_Rus.pdf (accessed on 25.08.2022).

[2] The New World Order of ESG. URL: https://gaap.ru/articles/Novyy_mirovoy_standart_ESG_raskrytiy/ (accessed on 20.05.2022).

[3] KPMG.Big shifts, small steps. Survey of Sustainability Reporting 2022. URL: https://assets.kpmg/content/dam/kpmg/xx/pdf/2022/10/ssr-small-steps-big-shifts.pdf html (accessed on 14.02.2022).

[4] Task Force on Climate-related Financial Disclosures 2021 Status Report. URL: https://www.fsb.org/wp-content/uploads/P141021–1.pdf (accessed on 21.04.2022).

[5] Indices of the RUIE in the field of sustainable development — 2021. ESG-index of the RUIE: "Responsibility and openness" and "Vector of sustainable development". URL: https://media.rspp.ru/document/1/e/0/ e03632d895731fcd79e2b7d02aa28c37.pdf (accessed on 15.06.2022).

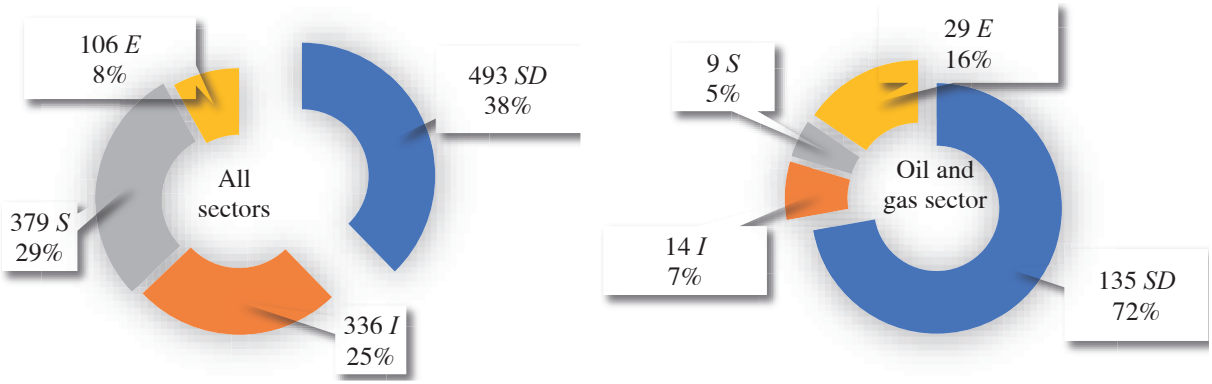

Fig. 1. **Structure of Non-Financial Reports in Russia, %**

Source: Compiled by the authors.

and production,[6] the second — sales of petroleum products and related products.[7] We researched further at the actual content and presentation of information in non-financial company reporting from 2007 to 2021. The 162 published non-financial reports analysed include: annual report (150 *A*), corporate social responsibility reports (6 *CSR*) and sustainable development reports (6 *SD*) (*Fig. 2*). At the same time 54% of the annual reports compiled contained integrated ESG-information, the remaining annual reports (46%) — only partial information on certain aspects: corporate governance (*G* - factor), ecology *(E* - factor) or social responsibility (*S* - factor)

In the first phase of the study, we reviewed widely used methodologies for assessing ESG-disclosure practices information and rating of company performance in the field of sustainable development and generalized the identified limitations of the existing methods to the framework of openness and the absence of an important component of the quantitative assessment of stakeholder satisfaction with information, highly significant for them from the point of view of disclosure of key risks

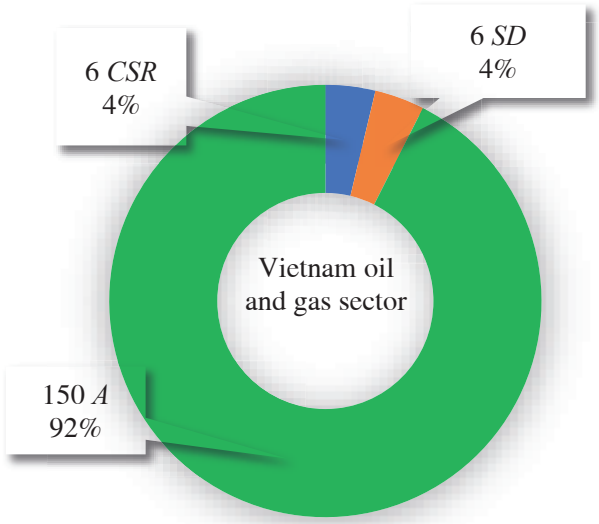

Fig. 2. **Structure of Non-Financial Reports of Oil and Gas Companies in Vietnam, %**

Source: Compiled by the authors.

related to the company's activities, which served as the basis for the development of the author's methodology.

The author's methodology consists of a series of analytical procedures that ensure the identification and reconciliation of key risks of companies with the interests of the most significant stakeholders, mathematical and statistical assessment of the level of satisfaction of stakeholders' interests, and visualization of the obtained results, which contributes to a better understanding of the company's business model in relationships with stakeholders, and also serves as a guideline. The practical significance of the author's methodology resides in its emphasis

[6] List of Group 1 oil and gas companies. URL: https://vnr500.com.vn/Nganh-nghe/Tham-do-khai-thac-dau-mo-va-hoat-dong-ho-tro-Post/21.html (accessed on 20.08.2022).

[7] List of Group 2 oil and gas companies. URL: https://vnr500.com.vn/Nganh-nghe/Kinh-doanh-xang-dau-va-cac-san-pham-lien-quan-Post/22.html (accessed on 20.08.2022).

on achieving sustainable development goals by improving the efficiency of communication management with the most important stakeholders.

REVIEW OF SCIENTIFIC-PRACTICAL APPROACHES TO ESG-INFORMATION DISCLOSURE AND STAKEHOLDER RISKS

The examination of theoretical and empirical research on the disclosure of non-financial indicators in corporate reporting indicates the significant scientific interest in the study of the influence of ESG-information on the efficiency of enterprises in the real sector. almost the last five years, almost 3000 publications on ESG have been published in the English-language scientific journals of the Scopus scientific citation base [3]. Many Russian scientists — S. D. Bodrunov [4], S. N. Bobylev [5], V.V. Yankovskaya [6], A. A. Makarov [7] — regard investment attraction as one of the primary drivers of the Russian economy's long-term development, stating that "the investment attractiveness of business will be influenced primarily by detailed disclosure of information on corporate environmental risks" in companies' public non-financial reports. Questions of improving the quality of public non-financial reporting of companies in various sectors of the economy, assessing the impact of ESG-information on the reputation and market value of the business, balanced disclosure of interests of different groups of stakeholders are devoted researches of M. A. Fedotova, O.V. Loseva, V.V. Bogatyreva [7], E. Yu. Makeeva, I. V. Ivashkovskaya, L. S. Ruzhanskaya, K. A. Popov [9], Tensie Whelan, Elise Douglas,[8] O. V. Efimova, M. A. Volkov, D. A. Koroleva [10]. Scientists Y. Wang and Y. Chen [11] consider that the company's participation in ESG-ratings is a positive signal to investors and raises the price of shares. At the same time, J. Fijałkowska and D. Hadro explain the mechanism of impact of corporate governance on the efficiency of the company by balancing the interests of investors, shareholders and other stakeholders [12].

The impact of "green" investments on business efficiency and relationships with stakeholders reveals the results of empirical research of scientists from Vietnam, Malaysia, Oman [13], Portuguese scientists J. Costa and J. P. Fonseca [14]. At the same time, the materials of the significant energy company EDF, that are no longer informative, since they focus exclusively on the Kyoto Protocol criteria and the assessment of greenhouse gas emissions.[9] The existing methods, according to the authors and a number of scientists, are largely based on a compliance-based approach: assessment of the level of compliance of management actions with accepted standards, as well as the degree of openness (transparency) of business, which is, of course, important.[10] The risk impact on investment attractiveness and business value for any significant stakeholder groups, which is critical for industry growth, does not appear from the methodology [15].

According to Harvard School researchers under the guidance of Professor D. Freiberg [16], economic sanctions, reputational costs and damage compensation from accidents account for a significant share of business costs, while information openness and business transparency increase investor confidence and investment attractiveness. Compliance with the objectives of sustainable development is now a major focus of Russian State policy.[11]

[8] Whelan T., Douglas E. The price of social responsibility. URL: https://big-i.ru/biznes-i-obshchestvo/etika-i-reputatsiya/854831 (accessed on 18.04.2022).

[9] EDF group's Environmental, Social and Governance Indicators. 2021. URL: https://www.edf.fr/en/the-edf-group/taking-action-as-a-responsible-company/reports-and-indicators/non-financial-kpis/esg-indicators (accessed on 05.03.2022).

[10] Green Bond Guidelines for the Real Estate Sector. GRESB Real Estate Debt. October 2016. URL: https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/Green-Bond-Guidelines-for-the-Real-Estate-Sector.pdf (accessed on 20.11.2020).

[11] Recommendations on the disclosure by public joint stock companies of non-financial information related to the activities of such companies. Information letter of the Bank of Russia No. IN-06–28/49 from 12.08.2021. URL: http://www.

Table 1

Qualitative Differences in Rating Methods for Russian Companies in Terms of Taking Into Account Significant Criteria and Risks of Economic Decision Making in the Oil and Gas Industry

Comparison criteria	ACRA 2021	WWF Russia 2019	RSPP 2018	RAEX Europe 2019
Scope of application of the methodology: the availability of accounting for the industry, including oil and gas	–	+	–	–
Use of public reporting	+	+	+	–
Correspondence of disclosed indicators to the interests of stakeholders	–	–	–	–
Evaluation of disclosure level	+	+	+	+
Information on key stakeholders	–	–	–	–
Identification of stakeholder risks	–	–	–	–
Advantages	A universal approach covering different sectors of the economy	Evaluation of the degree of openness of oil and gas companies	Set of SD/CSR disclosure indices and trends	Existence of an ESG-rating and separate E, S, G ratings, risk management assessment and potential opportunities
Limitations	Lack of specific criteria for assessing the level of transparency of information of companies in one industry	Lack of assessment of the degree of disclosure of interests of different stakeholders	It does not assess the information needs of stakeholders, does not include the risk assessment and level of disclosure	Lack of accounting of interrelationships, assessment of key risks, most significant stakeholders, use of subjective information

Source: Compiled by the authors.

"Interfax" survey results confirm high demand for ESG-information.[12] Information is becoming increasingly important for all stakeholders, not just shareholders, investors, governments, and regulators. Furthermore, more than half of the ESG-disclosures in public reports do not meet the information quality criteria for different stakeholders to make informed decisions, but are presented at the level of declarations or abstract statements, making it difficult for stakeholders to retrieve relevant and useful information [17].

consultant.ru/document/cons_doc_LAW_390868/36110d9bf13d5bacbfdaa864b854ac53070881df/ (accessed on 27.12.2021).

[12] ESG-disclosure: theory and practice of implementing new Central Bank' recommendations. Interfax. 2021. URL: https://group.interfax.ru/interfax/about/smi/esg-raskrytie-teoriya-i-praktika-vypolneniya-novykh-rekomendatsiy-tsb/ (accessed on 20.01.2022).

Table 2

A Comparative Analysis of Corporate Reporting in Russian and Vietnamese Oil and Gas Companies

Comparison criterion	Russia	Vietnam
Type of Corporate Reporting	21 non-financial corporate reports: including 14 reports in SD; 2 annual reports, 3 environmental reports	8 non-financial corporate reports, including 7 annual reports, 1 report in SD
Standards and/or methods used for the preparation of corporate reporting	14 companies (70%) used the GRI Guidelines; 3 companies (15%) did not specify the methods/ standards used; 3 companies (15%) used other methods/standards	3 companies used the GRI Guidelines; 5 companies did not disclose information on methodologies and standards used
Presence and form of certification of corporate reporting information	6 companies – no certification; 14 companies – existence of the certification, including: 4 companies – public assurance; 2 companies – independent and public assurance; 2 companies – review of external advisory commission on sustainable development; 5 companies – independent assurance; 1 company – limited independent assurance	Non-financial corporate reports (annual reports and SD report) were not supported by certified procedures

Source: Compiled by the authors.

We performed a comparison of four ESG-disclosure ranking methods (ACRA, WWF Russia, RUIE, RAEX Europe) (*Table 1*).

Thus, the practice of disclosure in public non-financial reports is constantly developing, and the generalization and comparative analysis of the reviewed methodologies show their demand. At the same time, their detailed analysis shows that the tools used to assess the level of satisfaction of stakeholders' interests with information of public non-financial reports from the perspective of the presence of risks for making economic decisions are insufficiently relevant and representative, which does not provide guidance to companies on how to manage risk disclosure and better achieve sustainable development.

DESCRIPTION AND TESTING OF A METHODOLOGY FOR ASSESSING STAKEHOLDER RISK DISCLOSURE IN NON-FINANCIAL REPORTING

The second stage of the study is devoted to the development of a methodology for assessing the disclosure of information on stakeholder risks in non-financial reporting or the level of satisfaction of the most significant stakeholders using the empirical base of SD companies in the oil and gas sector of Russia, including the leading ranking companies of RUIE 2022 and the largest companies of Vietnam (CRV) on the rating VN 500 2022.

The review identified issues with the use of various methods for reporting and guidelines, as well as insufficient disclosures in terms of quantity and quality of reporting. The perimeter of the study and its results are presented in *Table 2*.

Algorithm of stakeholder risk disclosure in non-financial reporting of oil and gas sector companies to assess the level of satisfaction of the most significant stakeholders includes the following stages, implemented on the basis of compliance approach and mathematical and statistical analysis through analytical procedures that:

- identification of key risks of sustainable development of oil and gas sector companies;
- determination of the most significant stakeholder groups;
- consolidation of key risk information in public non-financial reporting (section "Risks and opportunities", GRI 102–15) and linking them to the most important stakeholders;

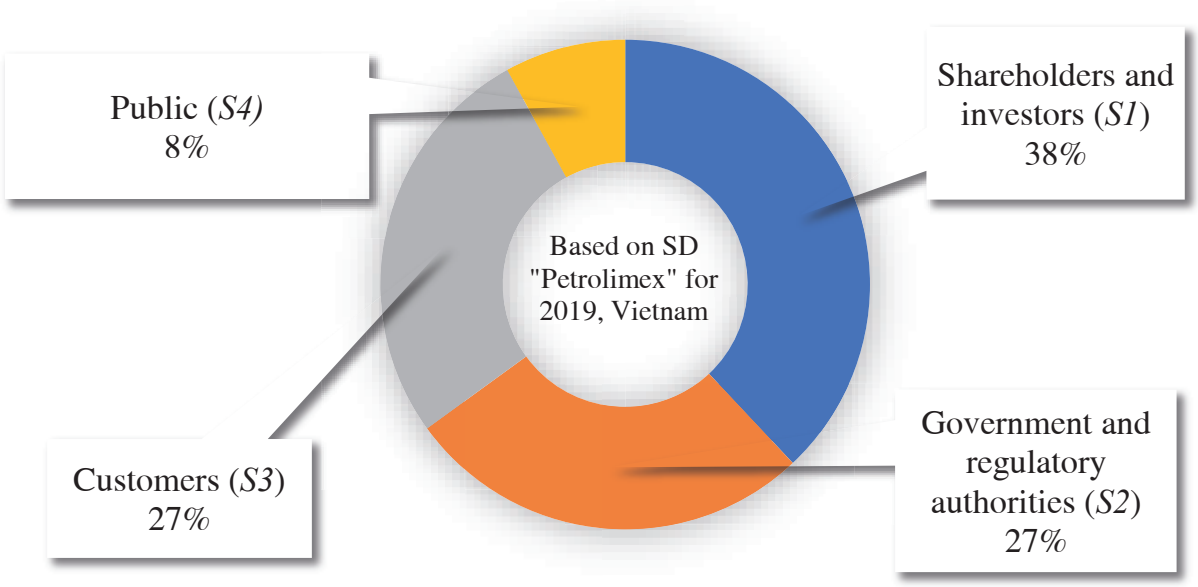

Fig. 3. **General Level of Interest in Risk Information Among Significant Stakeholder Groups, %**

Source: Compiled by the authors.

• calculation of the risk disclosure rate in accounting indicators according to stakeholder interests by forming a stakeholder risk matrix (in absolute and relative terms);

• visualization of the results in a comprehensible format (chart, graph, table) and formation of conclusions. As it contributes to a better understanding of the company's business model in relation to stakeholders, and also serves as a navigator to ensure the expected level of risk disclosure for significant stakeholders, the visualization process allows the company to increase the efficiency of communication with the most important stakeholders in order to achieve the set goals in the field of sustainable development.

The compliance approach was to verify that the company's disclosure in non-financial reporting met the formal requirements for its content, without taking into account the quantitative values of the disclosed indicators and their inclusion in certain areas (blocks) of the report. The approbation of the methodology was carried out on the Vietnamese national oil Group "Petrolimex" (one of 8 public oil and gas companies with the best practice of corporate reporting).

Based on the study of business environment of Vietnam oil and gas sector companies, the most significant groups of stakeholders and their influence on the company were identified. Shareholders and investors (*S 1*) are most interested in the company's operational operations and prospects for sustainable business development. Risks associated with climate change and the danger of inaccuracy of information in reporting are also important to them.

Government and regulatory authorities (*S 2*) have a significant impact on current activity by licensing, changing policies or imposing various restrictions. Customers (*S 3*) — one of the key stakeholders of oil and gas companies. Their interest in information in corporate reporting is closely linked to risks that may affect their relationship with the company as a regular customer and/or partners. The public, including local residents and public organizations (*S 4*), represents interests to the jobs created, environmental and industrial safety, preservation of the natural environment, public health, and the company's contribution to socio-economic potential of the business region.[13]

[13] Climate risks and opportunities: what challenges oil and gas industry companies must solve. Deloitte. 2020. URL: https://en.unecon.ru/sites/default/files/en/maria_spiridonova_polina.pdf (accessed on 02.12.2021).

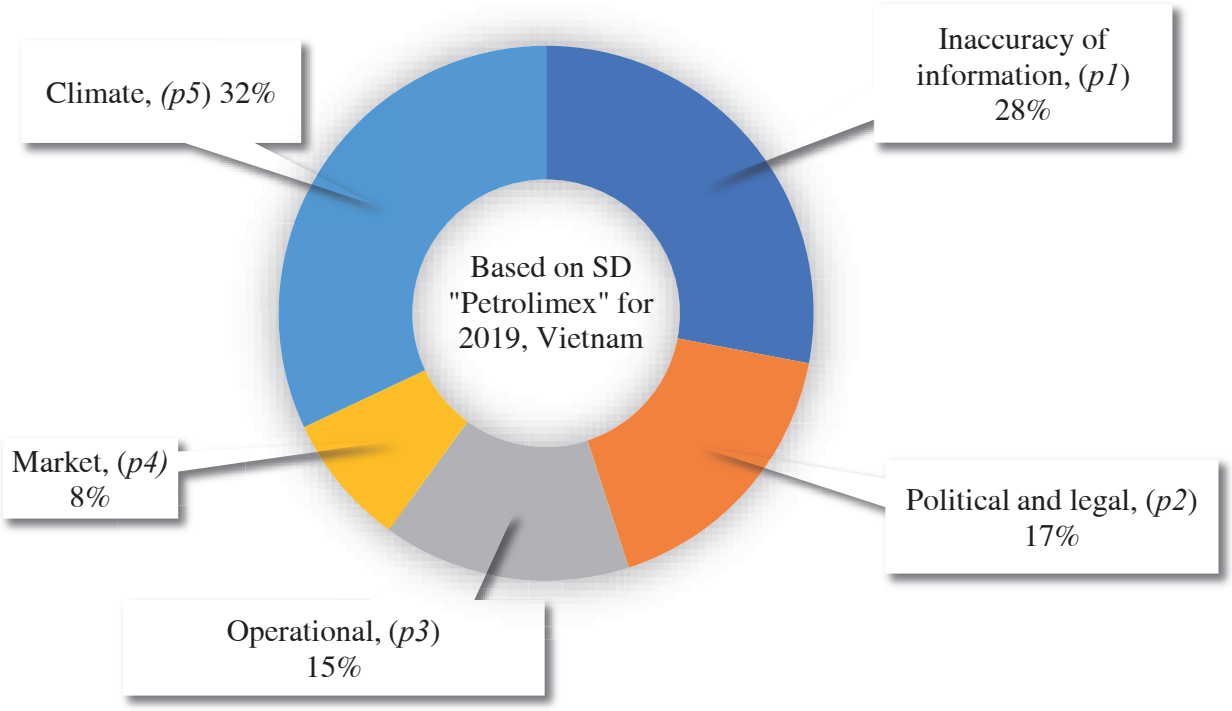

Fig. 4. **The Structure of Disclosed Stakeholder Risks in Public Non-Financial Reporting, %**

Source: Compiled by the authors.

The number of indications provided in the SD indicating the interests of each category was used to estimate stakeholders' interests. Thus, the interests of shareholders and investors were represented in 38% of the total SD information; government and regulators — 27%, customers — 27%, public — 8% (*Fig. 3*).

The author's approach to the classification of stakeholder risks was based on the study of corporate reporting practices of oil and gas companies in Russia and SRV, international standards [non-financial reporting, financial statements (IFRS), auditing (ISA)], related to risks, Russian and international risk management standards. Taking into account the specifics of the oil and gas business, we have identified 5 groups of risks that are important both for the business itself and for external groups of stakeholders: risks of inaccuracy information (*p1*); political and legal risks (*p2*); operational risks (*p3*) including emergency risks; market risks (*p4*); climate risks (*p5*). Independent assurance procedures minimize these risks by confirming them (ISA 315).[14] To ensure the quality of economic decisions and meet the need for reliable information of different stakeholders, they should be considered as significant risks.

Our suggested method evaluates the extent of risk disclosure in SD reporting from the standpoint of important stakeholders' interests (*Fig. 4*).

The quantitative assessment of the risk disclosure revealed that the company is more likely to disclose the risks associated with climate change (32% of the information); 28% are risks of inaccuracy information; 17% — political and legal risks; 15% — operational; information disclosing market risks is 8%. However, it should be noted that there is no criterion threshold for the structure of disclosed risks in the public non-financial reporting. The degree of disclosure of information (satisfaction of stakeholders) is determined by the company depending on

[14] ISA 315 (revised) "Identification and assessment of risks of significant distortion", implemented in the territory of the Russian Federation by order of the Ministry of Finance of the Russian Federation No. 163 from 27.10.2021.

Table 3

Matrix for Assessing the Disclosure of Key Stakeholder Risks in Public Non-Financial Reporting

Ключевые риски / Key risks, *pi*	Share of indicators disclosed in ASD representing the interests of groups of the most significant stakeholders, %				Degree of disclosure of a particular risk in ASD for all stakeholders, %
	S1	*S2*	*S3*	*S4*	
p1	*p1S1*	*p1S2*	*p1S3*	*p1S4*	$\sum_{j=1}^{4} p_1 S_j$
p2	*p2S1*	*p2S2*	*p2S3*	*p2S4*	$\sum_{j=1}^{4} p_2 S_j$
p3	*p3S1*	*p3S2*	*p3S3*	*p3S4*	$\sum_{j=1}^{4} p_3 S_j$
p4	*p4S1*	*p4S2*	*p4S3*	*p4S 44*	$\sum_{j=1}^{4} p_4 S_j$
p5	*p5S1*	*p5S2*	*p5S3*	*p5S4*	$\sum_{j=1}^{4} p_5 S_j$
Level of disclosure of all identified risks per group of stakeholders, %	$\sum_{i=1}^{5} p_i S_1$	$\sum_{i=1}^{5} p_i S_2$	$\sum_{i=1}^{5} p_i S_3$	$\sum_{i=1}^{5} p_i S_4$	100

Source: Compiled by the authors.

existing priorities on their significance for business activities and their role in ensuring sustainable development.

ALGORITHM FOR QUANTIFYING STAKEHOLDER SATISFACTION BASED ON NON-FINANCIAL REPORTING RISKS

Table 3 introduces a matrix to analyze the key risks disclosed according to the interests of the most significant stakeholder groups. For each type of risk p_i the level of disclosure of interests to it by each group of stakeholders S_j is calculated. The rows represent the level of disclosure of a certain risk by the interest of each group of significant stakeholders (from S_1 to S_4), as well as the aggregate interest in this risk. The total sum of the shares of this risk in each row reflects the overall degree of disclosure of the stakeholders' risk in the non-financial report. Columns show the extent to which a particular risk is exposed for each stakeholder group (from p_1 to p_5). The total amount per column indicates the degree of disclosure of all identified risks for each

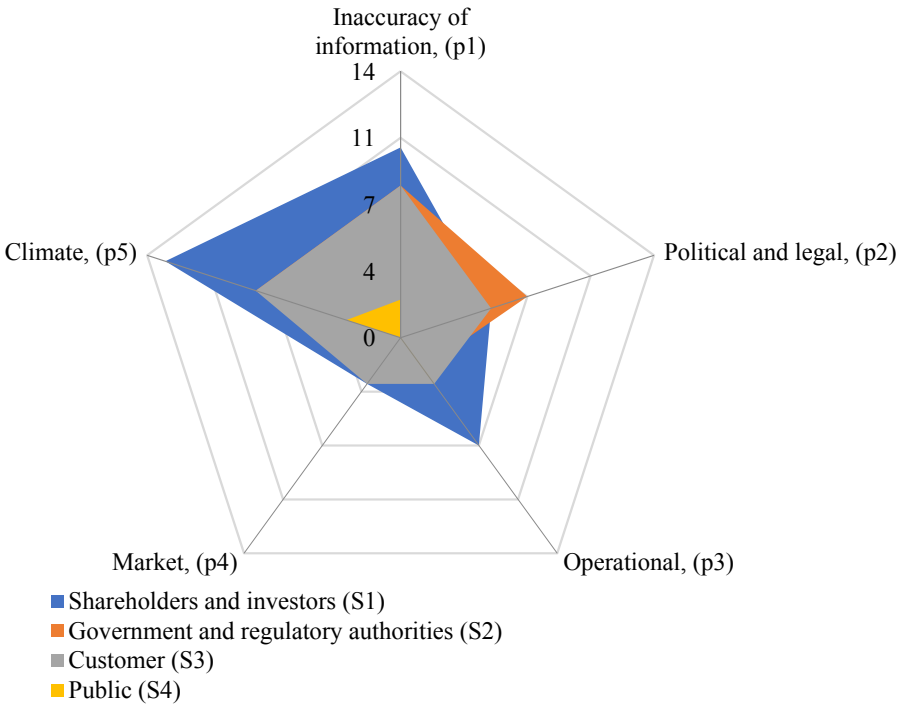

Fig. 5. **The Degree of the Stakeholders Interests' Satisfaction Based on the Disclosed Key Risks in Non-Financial Reporting, %**

Source: Compiled by the authors.

stakeholder group, which corresponds to the level of satisfaction of significant stakeholders of the company with SD disclosure. The total sum for rows and columns is 100%.

The procedure of visualization of the results of the calculations is their presentation in the format of a diagram showing the structure of the disclosed information about the most significant risks and the degree of satisfaction of the interests of key stakeholders (*Fig. 5*). The results show the company's priorities in relations with key stakeholder groups. The greatest risk disclosure and, as a result, degree of satisfaction (38%) is in the interests of shareholders; among the most exposed risks are climate (13%) and risks of information inaccuracy (10%). The next most important are the interests of buyers, the degree of their satisfaction 27%, and the most disclosed risks — climate (their share is 8%), risks of information inaccuracy (8%) and political and legal risks (5%). Government and regulatory authorities are the third most important in risk disclosure: among the most disclosed risks are political and legal (7%), climate (8%) and risks of information inaccuracy (8%). The lowest level of risk disclosure and, consequently, satisfaction (8%) falls on the public interest, which includes indicators of climate risks (3%), operational risks (3%) and information inaccuracy risks (2%).

It should be noted that the oil and gas industry is sufficiently volatile to political and regulatory changes, and that it is greatly impacted by the market environment, the influence of related industries and sectors of the economy, as well as international standards and organizations operating in different regions of the world. In this regard, for industry computers operating in rapidly changing conditions, a certain adaptation of meta-information is required. The developed methodology is distinguished in particular by its simplicity and ease of use, as well as sufficient ease of adjustment when changing the business parameters while taking into consideration its institutional specifics, the composition of key risks and the approach to their classification, and the identification of the most significant groups of stakeholders in terms of industry and sectoral specifics.

CONCLUSION

The study allowed the development of a methodical toolkit, which included a compliance-approach and a mathematical-statistical assessment of the degree of satisfaction of stakeholders' interests in information about risks associated with the company's activities, which was included in its public non-financial records.

Due to the various sources of information used for Russian and Vietnamese companies, standards and local requirements for the production of non-financial reporting and its independent assurance in different countries, and inadequate approved companies, our research has certain limitations.

Further research on the methodology's development will aim to broaden the scope of the studied oil and gas companies in the region of presence, taking into account their specifics and the macroeconomics of the region, as well as clarify stakeholder groups and their preferences in disclosing the most significant risks in reporting.

The results of the methodology demonstrate the need to change the practice of forming public non-financial accounts of companies in the oil and gas sector in order to ensure a balance between stakeholders' interests and sustainable development priorities.

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

The article was submitted on 21.10.2022; revised on 10.11.2022 and accepted for publication on 06.12.2022.
The authors read and approved the final version of the manuscript.

ORIGINAL PAPER

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DOI: 10.26794/2587-5671-2023-27-3-221-238
UDC 336.763(045)
JEL G11, G12, G17, G32

Upper Limits of Financial Risk Measures of Various Degrees of Catastrophicity

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ABSTRACT

The question of assessing the magnitude of risks using certain risk measures presents one of the most important problems of modern finance. However, many modern risk measures require considerable effort at times and, in practice, the investor would have sufficient knowledge of the upper limits of those risks. Comparing them with their risk appetite, an investor, in the case when the upper limits of risk measures would fit into their risk appetite, could assess this risk as acceptable to themselves. Only if the upper limit of the appropriate risk measure exceeded their risk appetite would there be a need for a detailed assessment of the appropriate risk measure. **The aim** of this paper is to consider upper limits first for known risk measures such as value at risk, *VaR*, and expected deficit or notional value at risk of *ES*. Next, upper limits are obtained for the risk measures *VaR* to the degree of t, $VaR^{(t)}$ and ES to the degree of t, $ES^{(t)}$ introduced by the author into scientific use. Also, using the results of V. Hürlimann, representations for maximum values of risk measures $VaR^{(t)}$ and $ES^{(t)}$. The **method** of obtaining the described results is the application of certain representations of all these risk measures, the application of P. Chebyshev's inequalities, as well as the results of V. Hürlimann. As a **result** of the study, descriptions have been proposed for the upper limits, expressing them only after a few first moments of the loss distribution law. The author **concludes** that the study of the upper limits of important risk measures of scientific interest has practical value for the express assessment of relevant risks.

Keywords: upper limits of risk measures; *VaR* risk measure; *ES* risk measure; $VaR^{(t)}$ risk measures; $ES^{(t)}$ risk measures; catastrophic risk measures

For citation: **Minasyan V.B. Upper limits of financial risk measures of various degrees of catastrophicity. *Finance: Theory and Practice.* 2023;27(3):221-238. (In Russ.). DOI: 10.26794/2587-5671-2023-27-3-221-238**

INTRODUCTION

One of the central issues of risk management is the idea of *extremum* of certain risk measures assessed in relation to the most important risks for it. But in reality, a risk manager sometimes acts conservatively, based on the least attractive risk measure, which is consistent with the incomplete information available to it. This can be done by identifying an upper limit for the measure in a given risk class consistent with partially known information [1].

In this article we examine the upper limits of the risks assessed by certain risk measures distorted expectations, when the main risk is not fully defined and only some information about its timing is available. This problem is relevant for various reasons. First, risk measures of distorted expectation have many important properties that are generally expected to have "good" risk measures [2]. Second, portfolio risk measurement is at the center of risk management. When the margin functions of the allocation of portfolios as well as the asset dependency structure are known, portfolio risk can be quantified using, for example, Monte Carlo simulation. In most cases, however, full information on the dependency structure is not expected to be available, and various stakeholders, such as investors and regulators, may be interested in learning the worst-case scenario for the portfolio (i.e. scenarios where the risk measure reaches the highest). In this regard, note that there is a rich literature on the search for limits for the quantiles — also called value at risk (*VaR*) portfolio, provided that all margin distribution functions are known, but the dependencies are unknown [3–8].

In this article, however, we do not fix the marginal distribution functions, but we get limits when we only know some moments of portfolio loss (for example, based on portfolio statistics) without specifying the marginal distribution functions.

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The most famous risk measures of distorted expectation are the *VaR* value and the notional value at risk, also called as expected shortfall *ES* measure in the literature [1]. Actually, *ES* is the smallest coherent risk measure that is more *VaR* risk measure, which is the most commonly used risk measure in risk management and market surveillance practices, but is not a subadditive and therefore a coherent risk measure [2]. In fact, *VaR* is a specific distribution quantum, while ES is more focused on the right end of the distribution in the sense that it measures the expected loss provided it is greater than *Va* R. Instant limits for *VaR* and *ES* have been studied in literature by several authors including Kaas, Goovaerts [9], Denuit etc. [10], De Schepper, Heijnen [11], Hürlimann [12, 13]. In particular, Hürlimann [12] finds analytical limits for *VaR* and *ES* with knowledge of medium, variance, asymmetry and excess.

In this context, it should be noted that it cannot be expect, that there is a risk measure (i.e. one number) that describes all risk characteristics and provides a complete picture of portfolio risk (i.e. a random value). For example, Hürlimann research [12] about *ES* for various two-parameter distribution functions with fixed mean and loss probability variance show that *ES* does not always correctly reflect the increase in risk (tail) from one distribution to another. Moreover, risk measures are used in different contexts such as risk management (McNeil et al. [14]), price formation (Wirch, Hardy [15]), capital allocation (Dhaene et al. [16]) and regulation (Danielsson et al. [17]), and risk management suitable for one purpose, could be inappropriate in another context.

V. B. Minasyan [18] introduced *VaR* risk measures in the degree *t*, and [19] proved that the *VaR* measures in the degree *t* is a subset of the risk measures of distorted expectation. That is, every *VaR* risk measure in the degree *t* ($VaR_p^{(t)}$) at any $t \geqslant 1$ is a risk measures of distorted expectation with a certain distortion function. The function was presented. In the latest paper, a group of new risk measures called "*ES* in the degree *t*" ($ES_p^{(t)}$) at any confidence probability *p* and any real $t \geqslant 1$ were introduced. The paper examined the relationship between two classes of risk measures: risk measures of distorted expectation and *ES* measures in the degree *t*, and proved that the group of *ES* measures in the degree *t* is a subset of the set of risk measures of distorted expectation. That is, that every *ES* risk measure in the degree *t* at any $t \geqslant 1$ is risk measures of distorted expectation with a certain distortion function. The function was presented.

As mentioned, there cannot be a separate risk measure, which is able to cover all risk characteristics. There is no such ideal measure. The group of *VaR* risk measures in the degree *t* and *ES* in the degree *t*, as specified in [18, 19], allow to investigate the right tail of the loss distribution with any accuracy necessary for the case, i.e. to investigate the distribution tail so thoroughly, as required under the circumstances. Generally, it is reasonable to look for risk measures that are ideal for a particular private problem. Since all proposed risk measures have disadvantages and limitations in application, the choice of appropriate risk measure continues to be a highly discussed topic in risk management.

We offer upper limits of *VaR* and *ES* measures, and $VaR_p^{(t)}$ and $ES_p^{(t)}$. measures in this paper. In addition, using the results of Hürlimann [12], we get the values for the maximum of $VaR_p^{(t)}$ and $ES_p^{(t)}$ risk measures, when ignorance of the theory of loss allocation and the use of only the first few points of the theory of loss allocation. In addition, summarizing the consideration of Hürlimann [12], the author presented economic capital assessment in hedging losses above their lowest possible upper level using $ES_p^{(t)}$ risk measures.

UPPER LIMITS OF *VAR* AND *ES* RISK MEASURES WITH THE FIRST TWO MOMENTS IN LOSS DISTRIBUTION LAW

Let's start by defining the upper limit for normal *VaR* risk measure.

To this end, let's introduce inequality from paper [1] (see exercise 2.7.7).

Statement 1. (Basic inequality for *VaR* through first-order moment). Let $X > 0$ — is

random value representing the amount of possible losses. Then the inequality $VaR_p[X] \le \frac{E[X]}{1-p}$ is true for any p.

In the paper [18], group measures "*VaR* in the degree t" were introduced, where t — any real number $t \ge 1$, denoted as $VaR_p^{(t)}[X]$.

Any real number $t \ge 1$ can be uniquely represented as:

$t = k + \alpha$, where k — natural number, and α — real number, and $0 \le \alpha < 1$. Obviously, k is the integer part of t, and α — its fractional part.

In the paper [18], the following formula was proved, expressing them through the usual *VaR* risk measures.

For *VaR* risk measure in any real degree $t \ge 1$, $VaR_p^{(t)}[X]$ the following formula is valid:

$$VaR_p^{(t)}[X] = VaR_{1-(1-p)^k(1-\alpha p)}[X]. \qquad (1)$$

Thus, in order to calculate $VaR_p^{(n)}$, risk measure, need to calculate the *VaR* risk measure with a confidence probability $1-(1-p)^k(1-\alpha p)$.

Then, given formula (1) and statement 1, the following statement is true.

Statement 2. (Basic inequality for $VaR_p^{(t)}$ through first-order moment). Let $X > 0$ — is random value representing the amount of possible losses. Then the inequality

$$VaR_p^{(t)}[X] \le \frac{E[X]}{(1-p)^k(1-\alpha p)}$$

is true for any p.

Let's define the upper limit for *ES* risk measure.

In paper [1] (see exercise 2.7.15) it is argued that for any random value of X loss with an average μ and variance σ^2 the following inequalit $ES_p[X] \le \mu + \sigma\sqrt{p(1-p)}$ is true for any p.

However, it is easy to understand that for a random quantity X with a random probability distribution such an inequality cannot be true, as $ES_p[X]$ risk measure when the confidence probability p is closer to 1, the value of the measure should approach indefinitely the upper limit of the loss allocation. In particular, for probability distributions of loss with infinite value (for example, for a normal distribution) when the confidence probability p is closer to 1, the value of the measure must be infinitely close to $+\infty$. However, in the given inequality, the upper limit for $ES_p[X]$ tends to the finite value μ, at the approach of the confidence probability p to 1, which, in the case of an arbitrary distribution, cannot be.

However, interesting is the fact of getting any right inequality $ES_p[X]$, that valid for any p.

Further, we prove the following statement.

Statement 3. (Basic inequality for *ES* through first and second order moments).

Let X — random value representing the value of possible losses with average μ and variance σ^2. Then inequality

$$ES_p[X] \le \mu + \frac{2\sigma}{\sqrt{1-p}}$$

is true for any p.

Verification. As is known (see [1]), $ES_p[X]$ risk measure is expressed through the appropriate *VaR* values as follows:

$$ES_p[X] = \frac{1}{1-p}\int_p^1 VaR_q[X]dq.$$

According to the *VaR* definition we have:

$\Pr[X \le VaR_q[X]] = q$, which is equivalent to

$$\Pr[\frac{X-\mu}{\sigma} \le \frac{VaR_q[X]-\mu}{\sigma}] = q.$$

Then, if we mark the value of the respective normalized random value by

$$X^{(0.1)} = \frac{X-\mu}{\sigma}, \text{ we get:}$$

$$\Pr[X^{(0.1)} \le \frac{VaR_q[X]-\mu}{\sigma}] = q, \qquad (2)$$

where $E[X^{(0.1)}] = 0$ и $\sigma[X^{(0.1)}] = 1$.

It follows from the equation (2), that $k_q^{(0.1)} = \frac{VaR_q[X]-\mu}{\sigma}$ value is a quantile of standardized random $X^{(0.1)}$ value with confidence probability q. The last ratio is followed by the following representation for *VaR*:

$$VaR_q[X] = \mu + k_q^{(0.1)}\sigma. \quad (3)$$

Using (3), we get the following equation for $ES_p[X]$:

$$ES_p[X] = \mu + \frac{\sigma}{1-p}\int_p^1 k_q^{(0.1)} dq. \quad (4)$$

Next, we got an estimate for quantil $k_q^{(0.1)}$. Take the second Chebyshev's inequality [20] which states that for any random quantity X, $\Pr[|X-\mu|>\varepsilon] \le \frac{\sigma^2[X]}{\varepsilon^2}$ is true for any positive ε.

Applying this inequality to the normalized random valu $X^{(0.1)}$ and choosing $\varepsilon = k_q^{(0.1)}$, we get: $\Pr[|X^{(0.1)}|>k_q^{(0.1)}] \le \frac{1}{(k_q^{(0.1)})^2}$, which implies that

$$1-q \le \Pr[X^{(0.1)} > k_q^{(0.1)}] + \Pr[X^{(0.1)} < -k_q^{(0.1)}] = \Pr[|X^{(0.1)}|>k_q^{(0.1)}] \le \frac{1}{(k_q^{(0.1)})^2}.$$

From the latter inequality follows the estimate for quantile:

$$|k_q^{(0.1)}| \le \frac{1}{\sqrt{1-q}}. \quad (5)$$

Using inequality (6), we get:

$$\int_p^1 k_q^{(0.1)} dq \le \int_p^1 \frac{dq}{\sqrt{1-q}} = -2\sqrt{1-q}\,|_p^1 = 2\sqrt{1-p},$$

from where using (4) we get: $ES_p[X] \le \mu + \frac{2\sigma}{\sqrt{1-p}}$, which was to be proved.

Note that the right side of the inequality is close to $+\infty$, at the approach of the confidence probability p to 1 not contradicting that the $ES_p[X]$ risk measures for infinite value distributions approach the confidence probability p к 1 infinitely close to $+\infty$.

In the paper [19] group measures "*ES* in the degree *t*", where *t* — any real number $t \ge 1$, denoted as $ES_p^{(t)}[X]$.

Any real number $t \ge 1$ can be uniquely represented as: $t = k + \alpha$, where k — is a natural number, and α — real number, and $0 \le \alpha < 1$. Obviously, k is the integer part of t, and α is its fractional part.

Then for the risk measures from this group in [19] were found the next presentation, expressing them through the usual *ES* risk measures.

For *ES* risk measure in any real degree $t \ge 1$, $ES_p^{(t)}[X]$ the following formula is valid:

$$ES_p^{(t)}[X] = ES_{1-(1-p)^k(1-\alpha p)}[X]. \quad (6)$$

Thus, in order to calculate the $ES_p^{(t)}$, risk measure, need to calculate the *ES* risk measure with a confidence probability $1-(1-p)^k(1-\alpha p)$.

Statement 4. (Basic inequality for $ES_p^{(t)}$ through first and second order moments).
Let X — random value representing the amount of possible loss. Then the inequality

$$ES_p^{(t)}[X] \le \mu + \frac{2\sigma}{\sqrt{(1-p)^k (1-\alpha p)}}$$ is true for any p.

MAXIMUM *VAR* AND *ES* RISK MEASURES, $VaR^{(t)}$ AND $ES^{(t)}$ IN LIMITED DISTRIBUTIONS

In paper W. Hürlimann [12], the following result is given about maximum values of *VaR* and *ES* risk measures for random values, representing relevant risks with probability distributions with limited and fixed values of expected values and standard deviations.

We will introduce to consider a set of random variables.

Suppose that the value of the relevant distributions is the same as [*A, B*] segment, and by $D_2 = D_2([A,B];\mu,\sigma)$ denote the set of all random values X with [*A, B*] (*suppX* = [*A, B*]), with the expected value $E[X] = \mu$ and variance $D[X] = \sigma^2$.

In the paper [12] the following theorem has been proved (it is given using symbols in this paper).

Theorem 1 (Hürlimann W.). The maximum value of the *VaR* and risk measures on a set $D_2 = D_2([A,B];\mu,\sigma)$ is defined as follows:

Case 1: if $p \ge \frac{(B-\mu)^2}{\sigma^2 + (B-\mu)^2}$, then $\max\limits_{X \in D_2}\{VaR_p[X]\} = \max\limits_{X \in D_2}\{ES_p[X]\} = B$.

Case 2: if $\frac{\sigma^2}{\sigma^2 + (\mu - A)^2} \le p \le \frac{(B-\mu)^2}{\sigma^2 + (B-\mu)^2}$, then $\max\limits_{X \in D_2}\{VaR_p[X]\} = \max\limits_{X \in D_2}\{ES_p[X]\} = \mu + \sqrt{\frac{p}{1-p}}\sigma$.

Case 3: if $p \le \frac{\sigma^2}{\sigma^2 + (\mu - A)^2}$, then $\max\limits_{X \in D_2}\{VaR_p[X]\} = \mu + \frac{(\mu - A)(B - A)p - \sigma^2}{(B-A)(1-p) - (\mu - A)} \le$

$\le \max\limits_{X \in D_2}\{ES_p[X]\} = \mu + (\mu - A)(\frac{p}{1-p})$.

Comparing this statement with the measures upper *VaR* and *ES* risk measures given in statements 1 and 3, it is worth noting that the measures above the estimates of these risks in theorem 1, being maximal on a set of random variables (risks) $D_2 = D_2([A,B];\mu,\sigma)$, are more accurate, and estimates in statements 1 and 3 may be overstated in certain cases. However, the advantage of estimates in statements 1 and 3 is that they are valid for any random values (risks) with not necessarily limited value of the relevant probability distributions.

Let's move from the description of the maximum values of the respective $VaR^{(t)}$ and $ES^{(t)}$ risk measures and any real value $t \ge 1$ [18, 19].

Theorem 2. The maximum value of $VaR^{(t)}$ and $ES^{(t)}$ risk measures on a set of random values $D_2 = D_2([A,B];\mu,\sigma)$ is determined as follows: imagine the real number t as $t = m + \alpha$, where m — natural number, and α — real number within $0 < \alpha \le 1$.

Case 1: if $p \ge p_0$, where p_0 — unique solution to the equation $(1-p)^m(1-\alpha p) = \frac{\sigma^2}{\sigma^2 + (B-\mu)^2}$, then

$\max\limits_{X \in D_2}\{VaR_p^{(t)}[X]\} = \max\limits_{X \in D_2}\{ES_p^{(t)}[X]\} = B$.

Case 2: if $p_1 \le p \le p_0$, where p_1 — unique solution to the equation

$$(1-p)^m(1-\alpha p) = \frac{(\mu - A)^2}{\sigma^2 + (\mu - A)^2}, \text{ then}$$

$$\max_{X \in D_2}\{VaR_p^{(t)}[X]\} = \max_{X \in D_2}\{ES_p^{(t)}[X]\} = \mu + \sqrt{\frac{1-(1-p)^m(1-\alpha p)}{(1-p)^m(1-\alpha p)}}\sigma.$$

Case 3: if $p \le p_1$, then $\max_{X \in D_2}\{VaR_p^{(t)}[X]\} = \mu + \frac{(\mu - A)(B - A)(1-(1-p)^m(1-\alpha p)) - \sigma^2}{(B-A)(1-p)^m(1-\alpha p) - (\mu - A)} \le$

$$\le \max_{X \in D_2}\{ES_p^{(t)}[X]\} = \mu + (\mu - A)\frac{1-(1-p)^m(1-\alpha p)}{(1-p)^m(1-\alpha p)}.$$

Verification. Taking into account the formulas connecting the $VaR^{(t)}$ and $ES^{(t)}$ risk measures and the usual *VaR* and *ES* risk measures, $VaR_p^{(t)}[X] = VaR_{1-(1-p)^m(1-\alpha p)}[X]$ and $ES_p^{(t)}[X] = ES_{1-(1-p)^m(1-\alpha p)}[X]$, we understand that to obtain theorem 2 statements it is enough in theorem 1 to replace p on $1-(1-p)^m(1-\alpha p)$.

Then Case 1 is realized with the confidence probability values satisfying the condition

$1-(1-p)^m(1-\alpha p) \ge \frac{(B-\mu)^2}{\sigma^2 + (B-\mu)^2}$, which is equivalent to the condition

$$(1-p)^m(1-\alpha p) \le \frac{\sigma^2}{\sigma^2 + (B-\mu)^2}, \tag{7}$$

where $\frac{\sigma^2}{\sigma^2 + (B-\mu)^2} \le 1$.

For the study of the set of solutions of the last inequality, we consider the function: $f(p) = (1-p)^m(1-\alpha p)$.

Then $f'(p) = -m(1-p)^{m-1}(1-\alpha p) - \alpha(1-p)^m = -(1-p)^{m-1}[m(1-\alpha p) + \alpha(1-p)) =$

$$= (1-p)^{m-1}[\alpha p(1+m) - m - \alpha] = (1-p)^{m-1}\alpha(m+1)[p - \frac{m+\alpha}{\alpha(m+1)}]. \tag{8}$$

However, it is easy to verify that inequality $p \le \frac{m+\alpha}{\alpha(m+1)}$, is always true, because inequality $\frac{m+\alpha}{\alpha(m+1)} \ge 1$, is true also, that is equivalent $m(1-\alpha) \ge 0$.

Then it follows from (8) that $f'(p) \le 0$, and therefore, the function $f(p) = (1-p)^m(1-\alpha p)$ is non-increasing, and $f(0) = 1 \ge \frac{\sigma^2}{\sigma^2 + (B-\mu)^2}$.

It follows that the equation $(1-p)^m(1-\alpha p) = \frac{\sigma^2}{\sigma^2 + (B-\mu)^2}$ has a single solution p_0 $(0 \le p_0 \le 1)$, and $p \ge p_0$ inequality is executed (7).

This theorem is referenced in Case 1.

Case 2 is realized with confidence probability values satisfying the conditions

$\frac{\sigma^2}{\sigma^2 + (\mu - A)^2} \le 1-(1-p)^m(1-\alpha p) \le \frac{(B-\mu)^2}{\sigma^2 + (B-\mu)^2}$, which are equivalent to the conditions

$$\frac{\sigma^2}{\sigma^2+(B-\mu)^2} \le (1-p)^m(1-\alpha p) \le \frac{(\mu-A)^2}{\sigma^2+(\mu-A)^2}. \quad (9)$$

Similarly, Case 1 proves the existence of a single value p_1 $(0 \le p_1 \le p_0 \le 1)$, solutions of the equation $(1-p)^m(1-\alpha p) = \frac{(\mu-A)^2}{\sigma^2+(\mu-A)^2}$, and $p_1 \le p \le p_0$ inequality is executed (9).

This theorem is referenced in Case 2.

And Case 3 is realized with the confidence probability values satisfying the condition $1-(1-p)^m(1-\alpha p) \le \frac{\sigma^2}{\sigma^2+(\mu-A)^2}$, which is equivalent to the condition

$$(1-p)^m(1-\alpha p) \ge \frac{(\mu-A)^2}{\sigma^2+(\mu-A)^2}. \quad (10)$$

From previous versions, it follows that an inequality $p \le p_1$ is executed (10).

This theorem is referenced in Case 3.

Comparing this statement with the estimates of upper $VaR^{(t)}$ and $ES^{(t)}$, risk measures, given in statements 2 and 4, it is worth noting that the estimates from upper limits of these risk measures in theorem 2 are maximal on a set of random variables (risks) $D_2 = D_2([A,B];\mu,\sigma)$, and are more accurate, but estimates in statements 2 and 4 might prove to be higher than required. However, the advantage of estimates in statements 3 and 4 is that they are true for any random values (risks) with not necessarily a limited value of the relevant probability distributions.

ESTIMATION OF ECONOMIC CAPITAL TO HEDGE LOSSES ABOVE THEIR LOWEST POSSIBLE UPPER LIMIT

Let's take some criteria for random quantities belonging to a set $D_2 = D_2([A,B];\mu,\sigma)$. Note that this criteria for $\mu = 0$ and $\sigma = 1$ is used in paper by W. Hürlimann [12].

Criteria. For any random quantity belonging to a set $D_2 = D_2([A,B];\mu,\sigma)$, the following relationships between parameters that describing a set are valid:

a) $A \le \mu \le B$;
b) $\sigma^2 \le (B-\mu)(\mu-A)$.

Verification. The first inequality follows from taking the expectation in the following random inequalities that are true with probability 1 for all $X \in D_2([A,B];\mu,\sigma)$: $A \le X \le B$.

To prove the inequality *b)* let's go to take the mathematical expectation in the following inequality, which is true with probability 1 for all $X \in D_2([A,B];\mu,\sigma)$: $(B-X)(X-A) \ge 0$.

Then we have:

$$B\mu - E(X^2) - AB + A\mu \ge 0, \text{ or}$$

$$E(X^2) - \mu^2 \le A\mu + \mu B - AB - \mu^2, \text{ i.e.}$$

$$\sigma^2 \le (B-\mu)(\mu-A).$$

Consider a company exposed to loss risks represented by random values belonging to a set $D_2 = D_2([0,B];\mu,\sigma)$ and try to estimate a minimum level of loss B.

From item *b)* it follows that $\sigma^2 \le \mu(B-\mu)$, which it follows that

$$B \ge \mu + \frac{\sigma^2}{\mu} = \mu(1+\frac{\sigma^2}{\mu^2}).$$

By introducing the value $k = \frac{\sigma}{\mu}$ — coefficient of variation, we get the following limit for the value B of the maximum possible loss: $B \ge \mu(1+k^2)$.

Thus, the maximum possible loss of the company cannot be less than the value $\mu(1+k^2)$.

In these circumstances, it is necessary to hedge the company from losses exceeding this amount, using derivatives or buying appropriate insurance.

Furthermore, we assume, for a start, that risk capital is calculated using a ES_p, risk measure and, for example, be assumed to be equal $\max\limits_{X\in D_2}\{ES_p[X]\}$. (From the point of view of practice it is necessary to calculate it as a certain percentage of $\max\limits_{X\in D_2}\{ES_p[X]\}$, but we focus on this assumption for simplicity).

Remember that in these assumptions from theorem 1 it follows that:

$$\max_{X\in D_2}\{ES_p[X]\} = \begin{cases} B, p \ge \dfrac{(B-\mu)^2}{\sigma^2+(B-\mu)^2}, \\ \mu + \sqrt{\dfrac{p}{1-p}}\sigma, \dfrac{k^2}{1+k^2} \le p < \dfrac{(B-\mu)^2}{\sigma^2+(B-\mu)^2}, \\ (1+\dfrac{p}{1-p})\mu, p < \dfrac{k^2}{1+k^2}, \end{cases}$$

when
$B = \mu(1+k^2)$ we have:

$$\frac{(B-\mu)^2}{\sigma^2+(B-\mu)^2} = \frac{(\mu(1+k^2)-\mu)^2}{\sigma^2+(\mu(1+k^2)-\mu)^2} = \frac{\mu^2k^4}{\sigma^2+\mu^2k^4} = \frac{\sigma^2k^2}{\sigma^2+\sigma^2k^2} = \frac{k^2}{1+k^2}.$$

So we have the following compact expression for venture capital:

$$\max_{X\in D_2}\{ES_p[X]\} = \begin{cases} (1+k^2)\mu, p \ge \dfrac{k^2}{1+k^2}, \\ (1+\dfrac{p}{1-p})\mu, p < \dfrac{k^2}{1+k^2}. \end{cases} \quad (11)$$

This scheme belongs to W. Hürlimann [12].

To understand the degree of caution when applying the described risk capital estimate, consider the numerical example.

Suppose that the confidence probability p, with which the ES_p, risk measure is estimated in this company equals p = 0.95. In addition, select the parameter value $\mu = 10$ *ed.* and, by changing the parameter of model σ (and therefore k), we will find out which of the conditions for equality (11) will

Table 1

Calculation of Risk Capital $\max_{X\in D_2}\{ES_{0.95}[X]\}$ at Different Values of Parameters σ, k

No.	σ, k	$\frac{k^2}{1+k^2}$	Criterion	$\max_{X\in D_2}\{ES_{0.95}[X]\}$
1	$\sigma = 2un.,\quad k = 0.2$	0.039	$p \geq \frac{k^2}{1+k^2}$	$B = 10.4$
2	$\sigma = 5un.,\quad k = 0.5$	0.2	$p \geq \frac{k^2}{1+k^2}$	$B = 12.5$
3	$\sigma = 10un.,\quad k = 1$	0.5	$p \geq \frac{k^2}{1+k^2}$	$B = 20$
4	$\sigma = 20un.,\quad k = 2$	0.8	$p \geq \frac{k^2}{1+k^2}$	$B = 50$
5	$\sigma = 50un.,\quad k = 5$	0.96	$p < \frac{k^2}{1+k^2}$	$(1+\frac{p}{1-p})\mu = 190 < B = 260$

Source: Designed and compiled by the author.

be fulfilled — and calculate the risk capital value accordingly. Results of the calculations are presented in *Table 1*.

We can see that with relatively small coefficients of variation k (the first four cases), which results in a relatively small non-hedged part of the possible losses $B = \mu(1+k^2)$, in this model the risk capital is value at the maximum equal to $B = \mu(1+k^2)$. However, in the case of large coefficients of variation (fifth case), the model determines the amount of risk capital required in the form of 190 un., the smaller part of possible losses that is not hedged, which is 260 un., i.e. significantly larger.

This involves how the coefficient of variation, which can range in value from some value between 2 and 5, is used to calculate how much economic capital should be included in the model. We determined this critical value of the coefficient of variation. Clearly, the change begins with implementation of the inequality $p < \frac{k^2}{1+k^2}$, which is equivalent to inequality $k > \sqrt{\frac{p}{1-p}} = \sqrt{\frac{0.95}{1-0.95}} \approx 4.36.$

Thus, at higher coefficients of variation, starting from a critical value of 4.36, the model determines the amount of risk capital required as the value of the smaller, non-hedged part of the potential losses.

We continue to consider our company, which was hedged from losses exceeding the value of $\mu(1+k^2)$, using derivatives or buying appropriate insurance.

In addition, suppose that the risk capital is calculated using the $ES_p^{(n)}$, risk measure, where n — natural number ($n > 1$), and, for example, be assumed to be equal $\max_{X\in D_2}\{ES_p^{(n)}[X]\}$.

We will remind that in these assumptions from theorem 2 it follows that:

$$\max_{X\in D_2}\{ES_p^{(n)}[X]\}=\begin{cases} B, p\geq 1-\sqrt[n]{\dfrac{\sigma^2}{\sigma^2+(B-\mu)^2}}, \\ \mu+\sqrt{\dfrac{1-(1-p)^n}{(1-p)^n}}\sigma, 1-\sqrt[n]{\dfrac{1}{1+k^2}}\leq p<1-\sqrt[n]{\dfrac{\sigma^2}{\sigma^2+(B-\mu)^2}}, \\ (1+\dfrac{1-(1-p)^n}{(1-p)^n})\mu, p<1-\sqrt[n]{\dfrac{1}{1+k^2}}. \end{cases}$$

However, in

$B=\mu(1+k^2)$ we get:

$$1-\sqrt[n]{\frac{\sigma^2}{\sigma^2+(B-\mu)^2}}=1-\sqrt[n]{\frac{\sigma^2}{\sigma^2+(\mu(1+k^2)-\mu)^2}}=1-\sqrt[n]{\frac{\sigma^2}{\sigma^2+\mu^2k^4}}=$$
$$=1-\sqrt[n]{\frac{\sigma^2}{\sigma^2+\sigma^2k^2}}=1-\sqrt[n]{\frac{1}{1+k^2}}.$$

We get the next compact equation for venture capital:

$$\max_{X\in D_2}\{ES_p^{(n)}[X]\}=\begin{cases} (1+k^2)\mu, p\geq 1-\sqrt[n]{\dfrac{1}{1+k^2}}, \\ (1+\dfrac{(1-(1-p)^n}{(1-p)^n})\mu, p<1-\sqrt[n]{\dfrac{1}{1+k^2}}. \end{cases} \quad (12)$$

To understand the degree of caution with the application of the described assessment of risk capital, consider the numerical example.

Let's assume that for estimation of economic capital with model the $ES_p^{(n)}$ risk measure at $n = 2$, i.e. $ES_p^{(2)}$.

Suppose again that the confidence probability p, with which the $ES_p^{(2)}$, risk measure is assessed in this company equals $p = 0.95$. In addition, select the parameter $\mu = 10$ *un.* and, by changing the parameter value of the model σ (and therefore k), we will find out which of the conditions in equality (12) will be fulfilled, and calculate the value of risk capital accordingly. Results of the calculations are presented in *Table 2*.

We see that for all the same values of the coefficients of variation k in this model with the application of $ES_{0.95}^{(2)}$ risk measure instead of $ES_{0.95}$ risk capital is valued at a maximum and equal $B=\mu(1+k^2)$. That is $ES_{0.95}^{(2)}$ risk measure is more cautious than $ES_{0.95}$.

Clearly, there will be a change in the way economic capital is measured in this model, depending on the value of the coefficient of variation, ranging with some value. We defined this critical value of the coefficient of variation. It is clear that change begins with the implementation of inequality

$p<1-\sqrt{\dfrac{1}{1+k^2}}$, which is equivalent to inequality

$$k>\sqrt{\frac{1-(1-p)^2}{(1-p)^2}}=\sqrt{\frac{1-(1-0.95)^2}{(1-0.95)^2}}\approx 19.98.$$

Table 2

Calculation of Risk Capital $\max_{X\in D_2}\{ES^{(2)}_{0,95}[X]\}$ at Different Values of Parameters σ, k

No.	σ, k	$1-\sqrt{\frac{1}{1+k^2}}$	Criterion	$\max_{X\in D_2}\{ES^{(2)}_{0,95}[X]\}$
1	$\sigma = 2\,un.,\quad k = 0.2$	0.194	$p \geq 1-\sqrt{\frac{1}{1+k^2}}$	$B = 10.4$
2	$\sigma = 5\,un.,\quad k = 0.5$	0.1055	$p \geq 1-\sqrt{\frac{1}{1+k^2}}$	$B = 12.5$
3	$\sigma = 10\,un.,\quad k = 1$	0.29	$p \geq 1-\sqrt{\frac{1}{1+k^2}}$	$B = 20$
4	$\sigma = 20\,un.,\quad k = 2$	0.553	$p \geq 1-\sqrt{\frac{1}{1+k^2}}$	$B = 50$
5	$\sigma = 50\,un.,\quad k = 5$	0.804	$p \geq 1-\sqrt{\frac{1}{1+k^2}}$	$B = 260$

Source: Designed and compiled by the author.

At all such values *k,* the risk capital value is equal $\max_{X\in D_2}\{ES^{(2)}_{0.95}[X]\} = (1-\frac{1-(1-0.95)^2}{(1-0.95)^2})10 = 4000\,un.,$ while the non-hedged part of possible losses even at $k = 20$ is equal $B = \mu(1+k^2) = 4010.$

Thus, at high coefficients of variation, starting from the critical value of 19.98, the model determines the amount of risk capital required in the form of the value of a smaller, non-hedged part of possible losses. That is, starting with such large coefficients of variation, and this model do not cautious as possible. Further, if the risk capital model based on $ES^{(3)}_{0.95}$, risk measure is applied, it turns out that the corresponding critical value of the coefficient of variation is even higher — about 89.44 etc.

Let's continue to consider our company, which was hedged against losses exceeding the $\mu(1+k^2)$, value, using derivatives or buying appropriate insurance.

In addition, suppose that risk capital is calculated using $ES^{(t)}_p$, risk measures, where t — real number ($t > 1$), and, for example, be assumed to be equal $\max_{X\in D_2}\{ES^{(t)}_p[X]\}$.

Consider the number t as $t = m+\alpha$, where m — natural number, and α real number when $0 < \alpha \leq 1$. Keep in mind that from these theorem 3 assumptions, it follows that

$$\max_{X\in D_2}\{ES_p^{(t)}[X]\}=\begin{cases}B, p\geq p_0,\\ \mu+\sqrt{\dfrac{1-(1-p)^m(1-\alpha p)}{(1-p)^m(1-\alpha p)}}\sigma, p_1\leq p<p_0,\\ (1+\dfrac{1-(1-p)^m(1-\alpha p)}{(1-p)^m(1-\alpha p)})\mu, p<p_1.\end{cases}$$

Remember, that p_0 — is unique solution to the equation

$$(1-p)^m(1-\alpha p)=\frac{\sigma^2}{\sigma^2+(B-\mu)^2},$$

and p_1 — is unique solution to the equation

$$(1-p)^m(1-\alpha p)=\frac{\mu^2}{\sigma^2+\mu^2}.$$

However, in $B=\mu(1+k^2)$ we get:

$$\frac{\sigma^2}{\sigma^2+(B-\mu)^2}=\frac{\sigma^2}{\sigma^2+(\mu(1+k^2)-\mu)^2}=\frac{\sigma^2}{\sigma^2+\mu^2k^4}=\frac{\sigma^2}{\sigma^2+\sigma^2k^2}=\frac{1}{1+k^2}=\frac{\mu^2}{\sigma^2+\mu^2},$$

i.e. $p_0=p_1$.

Therefore we have the following compact equation for venture capital:

$$\max_{X\in D_2}\{ES_p^{(t)}[X]\}=\begin{cases}(1+k^2)\mu, p\geq p_0,\\ (1+\dfrac{(1-(1-p)^m(1-\alpha p)}{(1-p)^m(1-\alpha p)})\mu, p<p_0.\end{cases}\qquad(13)$$

To understand the degree of caution with the application of the described assessment of risk capital, consider the numerical example.

Suppose that the $ES_p^{(t)}$ risk measure is chosen to estimate the economic capital using this model with t = 1.5, i.e. $ES_p^{(1.5)}$.

Suppose again that the confidence probability p, with which the $ES_p^{(1.5)}$, risk measure is assessed in this company equals p = 0.95. In addition, select the value of the parameter $\mu=10$ *un.* and, by changing the parameter of the model σ (and therefore k), we will find out which of the conditions in equality (13) will be fulfilled and calculate the value of risk capital accordingly.

Note that the choice in the formula (13) of an expression to calculate risk capital depends on whether the $(1-p)^m(1-\alpha p)$ value is greater or less than the $\frac{1}{1+k^2}$. However, in the present case m = 1 and $\alpha=0.5$, then $(1-p)^m(1-\alpha p)=0.02625$.

Results of the calculations are presented in *Table 3*.

We see that for all the same values of the coefficients of variation k in this model using the $ES_{0.95}^{(1.5)}$ risk measure, the risk capital is valued at the maximum equal to $B=\mu(1+k^2)$. That is, the $ES_{0.95}^{(1.5)}$ risk measure as well as $ES_{0.95}^{(2)}$, is more cautious than $ES_{0.95}$.

Table 3

Calculation of Risk Capital $\max_{X\in D_2}\{ES_{0.95}^{(1.5)}[X]\}$ at Different Values of Parameters σ, k

No.	σ, k	$\frac{1}{1+k^2}$	Criterion	$\max_{X\in D_2}\{ES_{0.95}^{(1.5)}[X]\}$
1	$\sigma = 2un.,\ \ k = 0.2$	0.96	$0.02625 < \frac{1}{1+k^2}$	$B = 12.5$
2	$\sigma = 5un.,\ \ k = 0.5$	0.8	$0.02625 < \frac{1}{1+k^2}$	$B = 12.5$
3	$\sigma = 10un.,\ \ k = 1$	0.5	$0.02625 < \frac{1}{1+k^2}$	$B = 20$
4	$\sigma = 20un.,\ \ k = 2$	0.2	$0.02625 < \frac{1}{1+k^2}$	$B = 50$
5	$\sigma = 50un.,\ \ k = 5$	0.039	$0.02625 < \frac{1}{1+k^2}$	$B = 260$

Source: Designed and compiled by the author.

Table 4

Calculation of Risk Capital $\max_{X\in D_2}\{ES_{0.95}^{(1.2)}[X]\}$ at Different Values of Parameters σ, k

No.	σ, k	$\frac{1}{1+k^2}$	Criterion	$\max_{X\in D_2}\{ES_{0.95}^{(1.2)}[X]\}$
1	$\sigma = 2un.,\ \ k = 0.2$	0.96	$0.0405 < \frac{1}{1+k^2}$	$B = 12.5$
2	$\sigma = 5un.,\ \ k = 0.5$	0.8	$0.0405 < \frac{1}{1+k^2}$	$B = 12.5$
3	$\sigma = 10un.,\ \ k = 1$	0.5	$0.0405 < \frac{1}{1+k^2}$	$B = 20$
4	$\sigma = 20un.,\ \ k = 2$	0.2	$0.0405 < \frac{1}{1+k^2}$	$B = 50$
5	$\sigma = 50un.,\ \ k = 5$	0.039	$0.0405 < \frac{1}{1+k^2}$	$(1+\frac{1-(1-0.95)(1-0.2\cdot 0.95)}{(1-0.95)(1-0,2\cdot 0.95)})\cdot 10 = 246,9$

Source: Designed and compiled by the author.

Now suppose that the $ES_p^{(t)}$ risk measure is chosen to estimate economic capital using this model, when $t = 1.2$, i.e. $ES_p^{(1.2)}$.

Suppose again that the confidence probability p, with which $ES_p^{(1.2)}$, risk measure is assessed in this company equals $p = 0.95$. In addition, we choose the parameter $\mu = 10\ un.$, and by changing the

parameter value of the model σ (and therefore k), we will find out which of the conditions in equality (13) will be fulfilled and calculate the risk capital value accordingly.

Note that the choice in the formula (13) of an expression to calculate risk capital depends on whether the $(1-p)^m(1-\alpha p)$ value is larger or smaller than the $\frac{1}{1+k^2}$ value. However, in the present case $m = 1$ and $\alpha = 0.2$, and therefore $(1-p)^m(1-\alpha p) = 0.0405$.

Results of the calculations are presented in *Table 4*.

We observe that with relatively small coefficients of variation k (the first four cases), which results in a relatively small non-hedged part of the possible losses $B = \mu(1+k^2)$, in this model the risk capital is valued at the maximum equal to $B = \mu(1+k^2)$. However, in the case of large coefficients of variation (fifth case), the model determines the amount of risk capital required in the form of 246.9 un., smaller than the non-hedged part of the possible losses, which is 260 un., i.e. significantly larger.

It is clear that this change in the behavior of the measurement of economic capital in a given model, depending on the value of the coefficient of variation, occurs at some value between 2 and 5. And risk capital valuation models using $ES_p^{(t)}$ risk measures at $t \geq 1.5$ are much more cautious than the corresponding models a $t \leq 1.2$ and at the model parameter t, there is also some critical value $0.2 < t_0 < 1.5$, where there is a transition from one policy (less cautious) selection of risk capital to another (more cautious).

MAXIMUM *VAR* AND *ES* RISK MEASURES, $VaR^{(t)}$ AND $ES^{(t)}$ IN UNLIMITED DISTRIBUTIONS

In the paper of W. Hürlimann [12], the following result is given about the maximum values of *VaR* and *ES* risk measures for random values, representing relevant risks with probability distributions with *unlimited* and fixed values of expected values and standard deviations, coefficients of asymmetry and excesses.

That is, it focuses on the set $D_4((-\infty,\infty);\mu,\sigma,\gamma,\gamma_2)$ random quantities with values on $(-\infty,\infty)$ with average μ, variance σ^2, asymmetry γ and excesses γ_2. In all phases, the following extra variables will be used:

$$\Delta = 2+\gamma_2-\gamma^2,\ \ c = \frac{1}{2}(\gamma-\sqrt{4+\gamma^2}),\ \bar{c} = -c^{-1} = \frac{1}{2}(\gamma+\sqrt{4+\gamma^2}). \tag{14}$$

The following theorem is proved in paper [12] (is used in the article with symbols).

Theorem 3. The maximum value of *VaR* for set D_4 is equal

$$\max_{X\in D_4}\{VaR_p[X]\} = \mu + x_p\sigma,$$

where x_p — quantile standardised maximum distribution $F^{(4)}_{ST,\max}(x)$ The following cases provide it:

Case 1: $p \geq 1-P(\bar{c}) = \frac{1}{2}(1+\frac{\gamma}{\sqrt{4+\gamma^2}}),\ p(x_p) = 1-p.$

Case 2: $p < 1-P(\bar{c}) = \frac{1}{2}(1+\frac{\gamma}{\sqrt{4+\gamma^2}}),\ p(\psi(x_p)) = p,$

where $\psi(x)$ and $p(x)$ functions defined as:

$$\psi(u) = \frac{1}{2}\left(\frac{A(u)-\sqrt{A(u)^2+4q(u)B(u)}}{q(u)}\right), \tag{15}$$

$$A(u)=\gamma q(u)+\Delta u,\ B(u)=\Delta+q(u),\ q(u)=1+\gamma u-u^2, \tag{16}$$

$$P(u)=\frac{\Delta}{q(u)^2+\Delta(1+u^2)}. \tag{17}$$

Comparing this statement with the upper limits of *VaR* risk measure given in statement 1, it is worth noting that the upper evaluation of this risk measure in the theorem, being maximum on a set of random variables (risks) $D_4((-\infty,\infty);\mu,\sigma,\gamma,\gamma_2)$, is more accurate, and the rating in statement 1 may be overstated in certain cases. However, the advantage of an estimate in statement 1 is that it is true for any random values (risks) with a fixed expected value but with arbitrary values of standard deviation, asymmetry, and excesses, whereas the assessment in theorem 4 is valid with fixed values of standard deviation, coefficients of asymmetry, and excesses. In addition, the maximal upper estimator algorithm in theorem 4 requires numerical methods because there is no straight formula to calculate it, whereas the estimate according to proposition is extremely simple.

Proceed to a description of the maximum values of the respective $VaR^{(t)}$ risk measures at any valid value $t\geq 1$ (see [18, 19]).

Theorem 4. The maximum value $VaR^{(t)}$ on a set of random variables D_4 is defined as follows: let's suppose the real number t as $t=m+\alpha$, where m — natural number, and α — real number within $0<\alpha\leq 1$.

Then $\max\limits_{X\in D_4}\{VaR_p^{(t)}[X]\}=\mu+x_{1-(1-p)^m(1-\alpha p)}\sigma$, where x_p — quantile standardized maximum distribution $F^{(4)}_{ST,\max}(x)$ it is obtained as follows:

even if p_0 is unique solution to the equation $(1-p)^m(1-\alpha p)=\frac{1}{2}(1-\frac{\gamma}{\sqrt{4+\gamma^2}})$, then:

Case 1: if $p\geq p_0$, then $P(x_{1-(1-p)^m(1-\alpha p)})=(1-p)^m(1-\alpha p)$,

Case 2: if $p<p_0$, then $P(\psi(x_{1-(1-p)^m(1-\alpha p)}))=1-(1-p)^m(1-\alpha p)$.

Verification. Given the formula linking $VaR^{(t)}$ risk measures to the usual *VaR* risk measure: $VaR_p^{(t)}[X]=VaR_{1-(1-p)^m(1-\alpha p)}[X]$, we understand that to obtain theorem 2, it is sufficient in theorem 1 to replace p by $1-(1-p)^m(1-\alpha p)$.

Then case 1 is realized with the confidence probability values satisfying the condition

$1-(1-p)^m(1-\alpha p)\geq\frac{1}{2}(1+\frac{\gamma}{\sqrt{4+\gamma^2}})$, which is equivalent to the condition

$$(1-p)^m(1-\alpha p)\leq\frac{1}{2}(1-\frac{\gamma}{\sqrt{4+\gamma^2}}), \tag{18}$$

where $\frac{1}{2}(1-\frac{\gamma}{\sqrt{4+\gamma^2}})\leq 1$.

Theorem 3's proof, then, also establishes the existence and originality of the solution p_0 equations $(1-p)^m(1-\alpha p)=\frac{1}{2}(1-\frac{\gamma}{\sqrt{4+\gamma^2}})$, with $p\geq p_0$ is inequality (18), and $p<p_0$ is inequality opposite to (18). The proof of theorem 4 follows consequently and from theorem 3.

The following theorem is proved in paper [12] (is used in the article with symbols).

Theorem 5. The maximum value of *ES* on the set D_4 equal

$$\max_{X\in D_4}\{ES_p[X]\}=\mu+\{d(y_p)+\frac{1}{1-p}(\pi^{(4)}_{\max}\circ d)(y_p)\}\sigma,$$

where quantile of the maximum distribution $F^{(4)}_{SL,\max}(x)$ of the standardised stop-loss of order (see [29]) is derived from the following equations:

Case 1: if $p\geq 1-P(\bar{c})$, then $P(y_p)=1-p$,

Case 2: if $p<1-P(\bar{c})$, then $P(y_p)=p$,

where $P(x)$ is determined from (18),

$$d(x)=\frac{1}{2}\frac{\{\phi(x,\psi(x))-x\}\{x+\psi(x)\}+2x\{\psi(x)-x\}}{\{\phi(x,\psi(x))-x\}+\{\psi(x)-x\}},$$

$$\phi(u,v)=\frac{\gamma-u-v}{1+uv},$$

$$\pi^{(4)}_{\max}(d(x))=\begin{cases}P(x)(d(x)-x)-d(x), x<\bar{c}\\ P(x)(x-d(x)), x\geq\bar{c}\end{cases}$$

Proceed to a description of the maximum values of the respective $ES^{(t)}$ risk measures at any real value $t\geq 1$ (see [18, 19]).

Theorem 6. The maximum value $ES^{(t)}$ on a set of random variables D_4 is defined as follows: imagine the real number *t* as $t=m+\alpha$, where *m* — natural number, and α — real number within $0<\alpha\leq 1$.

$$\max_{X\in D_4}\{ES^{(t)}_p[X]\}=\mu+\{d(y_{1-(1-p)^m(1-\alpha p)})+\frac{1}{(1-p)^m(1-\alpha p)}(\pi^{(4)}_{\max}\circ d)(y_{1-(1-p)^m(1-\alpha p)})\}\sigma,$$

where $d(y_p)$ — where quantile of the maximum distribution $F^{(4)}_{SL,\max}(x)$ of the standardised stop-loss of order (see [12]) is derived from the following equations.

Even if p_0 — is unique solution to the equation $(1-p)^m(1-\alpha p)=P(\bar{c})$.

Then:

Case 1: if $p\geq p_0$, then $P(y_{1-(1-p)^m(1-\alpha p)})=(1-p)^m(1-\alpha p)$,

Case 2: if $p<p_0$, then $P(y_{1-(1-p)^m(1-\alpha p)})=1-(1-p)^m(1-\alpha p)$.

Verification. Given the formula linking $ES^{(t)}$ risk measures to the usual *ES* risk measure, $ES^{(t)}_p[X]=ES_{1-(1-p)^m(1-\alpha p)}[X]$, we understand that to obtain theorem 2, it is sufficient in theorem 1 to replace *p* by $1-(1-p)^m(1-\alpha p)$.

Then case 1 is realized with the confidence probability values satisfying the condition $1-(1-p)^m(1-\alpha p)\geq 1-P(\bar{c})$, which is equivalent to the condition $(1-p)^m(1-\alpha p)\leq P(\bar{c})$. (19)

Theorem 3's proof, then, also establishes the existence and originality of the solution p_0 of equation $(1-p)^m(1-\alpha p) = P(\overline{c})$, with $p \geq p_0$ is inequality (19), and $p < p_0$ is inequality opposite to (19). The proof of theorem 7 follows consequently and from theorem 8.

CONCLUSION

Exploring the upper limits of various risk measures, including catastrophic risk measures, is of both scientific and practical interest. They are practical for quick risk assessments, which are easy to apply if the upper limits have clear and straightforward expressions. Cases when they are articulated just after the first few moments of the rule of loss allocation and do not require understanding of the law of distribution itself are particularly significant.

The paper examines the upper limits for known risk measures such as *VaR* risk measure, and the expected shortfall or imputed value at *ES* risk measure. Then the upper limits for measures introduced by the author in the scientific state of *VaR* catastrophic risks in the degree *t*, $VaR^{(t)}$ and *ES* in the degree *t*, $ES^{(t)}$.

The paper also describes the results of W. Hürlimann on the maximum values of *VaR* and *ES* risk measures, and with the application of these results the representations for maximum values of $VaR^{(t)}$ and $ES^{(t)}$ risk measures.

Using W. Hürlimann, in the paper provides an estimate of the value of economic capital by means of $ES^{(t)}$ risk measures depending on the coefficient of variation of losses in hedging losses above their lowest possible upper limits.

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The article was submitted on 16.05.2022; revised on 22.05.2022 and accepted for publication on 22.12.2022. The author read and approved the final version of the manuscript.