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C O N T E N T S

Russian Ruble Exchange Rate: Modeling of Comparative Medium-Term and Long-Term Dynamics

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ABSTRACT

The **subject** of the study is the dynamic mechanism of the formation of the exchange rate of the Russian ruble in a multi-level system of economic fundamental determinants-aggregates in the context of the independent floating rate of the national currency. The **aim** of the study is to develop the author's theoretical and methodological conceptual approach to modeling the dynamics of the equilibrium exchange rate based on international flows (IFEER) and to develop a new model of the Russian ruble exchange rate dynamics on its basis. The **methodological base** of the research includes system analysis, fundamental methods of economic theory, classical methods of mathematical analysis, and economic and statistical analysis, and the provisions of national accounting. The paper presents data on the verification of the results of modeling medium-term equilibrium dynamics. At the same time, the author pays considerable attention to the mathematical modeling of the long-term dynamics of the ruble exchange rate in comparison with the medium-term equilibrium dynamics and the mathematical analysis of internal functional relationships in modern conditions, which determines the **scientific novelty and relevance** of the study. Based on the conducted mathematical modeling, the author **concludes** about the trends of a stronger ruble exchange rate in the long run, while maintaining the current long-term trends.

Keywords: mathematical modeling; Russian ruble exchange rate; balance of payments; nonlinear long-term dynamics

INTRODUCTION

Exchange rates in modern open economies are parallel or secondary macroeconomic policy objectives to be adjusted. At the same time, due to the systemic impact on other economic variables, they act as key instruments of foreign exchange and monetary policy. This is aimed at transferring the real sectors of the economy to a sustainable growth trajectory, as well as at the transition from monetary positions to regulating balances of payments and inflation rates in countries. These questions are deeply investigated in the works of D. E. Sorokin, S. V. Shmanev, I. L. Yurzinova, A. K. Bedrintsev [1, 2], L. A. Strizhkova [3], Ya. M. Mirkin [4] and others.

The ruble exchange rate at the microeconomic level is one of the most important factors that have a significant impact on the motivation of economic entities through the mechanism of forming international relative competitive advantages, on international trade flows and by creating favorable investment climate within the country for capital flows. At the same time, and importantly, these economic aggregates are the determining factors in the dynamics of the exchange rate.

After the completion of the almost complete liberalization of the exchange rate and the transition of the Bank of Russia to the inflation targeting regime according to the classification of the International Monetary Fund, the regime of the Russian ruble exchange rate became de facto characterized by an independent floating rate of the national currency. Even in these conditions, this classification type of the exchange rate regime is also characterized by the high importance of the exchange rate policy of the Central Bank and close attention to the dynamics of both the nominal and real exchange rates.

Mathematical methods are widely used in modeling exchange rates in the works of R. Dornbusch [5], J. Frenkel [6], A. Stockman [7], R. Mundell [8], M. Mussa [9], M. Obstfeld and K. Rogoff [10] et al (including from the point of view of portfolio balance in the works of R. Driskill [11], L. Taylor [12]), domestic scientists S. Yu. Glazyev [13], A. Yu. Kuzmin [14, 15] et al. In particular, R. V. Ivanov [16] draws attention to the use of mathematical methods for modeling the valuations of financial instruments considering the currency component.

However, aspects of the long-term dynamics of exchange rates seem to be insufficiently studied. At the same time, it is necessary first of all to pay attention to the fundamental factors of dynamics, which is emphasized in the studies of J. Williamson [17], C. Engel, N. Mark and K. West. [18], L. Killian [19], P. Clark and R. MacDonald [20] et al.

This paper presents a systematic approach aimed at studying the behavior of the Russian ruble, and is based on the concept of modeling exchange rates based on the International Flows Equilibrium Exchange Rate (IFEER) developed by the author to model comparative medium-term and long-term dynamics.

CURRENCY DYNAMICS MODELING: IFEER'S CONCEPTUAL FRAMEWORK

From the point of view of long-term modeling, the following approach deserves attention. One of the cornerstone equations of an open economy concerns the balance of payments equilibrium. At the same time, it is assumed that there will be no interventionist actions on the part of the monetary authorities in the regulation of floating exchange rates. This equation is expressed in local currency:

$$(eE - I) = (K^- - eK^+).$$

On the left is the current account balance, on the right is the capital account balance, e — exchange rate, E — exports of goods and services, I — imports of goods and services, K^-, K^+ — capital outflow and inflow, respectively.

Having selected and carried out mathematical transformations, we get the national currency rate:

$$e = (I + K^-) \big/ (E + K^+).$$

This approach has several disadvantages. The exchange rate here is determined from a macroeconomic point of view. However, it practically does not have a base in the foreign exchange market in the form of real transactions. Moreover, in the world practice of national accounting, when using economic and statistical information to calculate macroeconomic aggregates at the balance of payments level, different values of national currencies can be used for exactly a certain period of time. Russia is no exception here.

Initially, all actual market transactions at nominal exchange rates $e_i, i \in (1, N)$ in the domestic foreign exchange market that have occurred during a specified period of time are considered.

Let us denote e_i, D_i, R_i in i-the operation: the nominal exchange rate, the amount in a certain foreign currency and the amount in the national currency, respectively.

These variables are related by the ratios: $e_i D_i = R_i$ and, therefore, $e_i = R_i / D_i$.

Moreover, the contribution of each transaction is different. It depends on the volume of the transaction. It should be noted that a significant part of transactions on the Russian market is carried out in US dollars. At the same time, conversion operations in other currencies, such as the euro, Canadian dollar, British pound sterling, are directly linked to the current exchange rate through a system of cross rates on both the international and national markets. Thus, for the purposes of modeling, the US dollar and its direct quotes against the Russian ruble are further considered as a foreign currency.

To study the medium-term and long-term dynamics of the Russian ruble exchange rate, it is proposed to determine the exchange rate e as the average weighted by volumes in foreign currency value of the exchange rates N of market transactions $e_i, i \in (1, N)$ conducted for a certain period of time:

$$e = \sum_{i=1}^{N} \frac{D_i}{\sum_{j=1}^{N} D_j} \times e_i . \qquad (1)$$

It can then be obtained by summing over i:

$$e = \sum_{i=1}^{N} \frac{D_i}{\sum_{j=1}^{N} D_j} \times \frac{R_i}{D_i} = \sum_{i=1}^{N} R_i \Big/ \sum_{j=1}^{N} D_j .$$

The final formula disaggregating flows across the balance of payments accounts can be represented as

$$e = \frac{\sum R^{CA} + \sum R^K}{\sum D^{CA} + \sum D^K} , \qquad (2)$$

Where the CA and K indices, refer, respectively, to funds flowing through the current account and the capital account. The actions of the monetary authorities in the form of foreign exchange interventions will be considered in aggregates with K.

For convenience we denote:

$$\sum R_i^{CA} = I \quad \sum D_i^{CA} = E,$$

$$\sum R_i^K = K^-, \sum D^K = K^+.$$

Then in the dynamic aspect (2) will be as

$$e_t = (I_t + K_t^-) \big/ (E_t + K_t^+),$$

where E — supply from the export of foreign currency; I — demand in national currency from imports for foreign currency; K^-, K^+ — the value, respectively, of the outflow and inflow of capital between countries for the time period t.

It should be emphasized that functional dependence (2) is natural from an economic point of view:

$$e = e^{*(-1)} = f_e(I^{\uparrow}, (K^-)^{\uparrow}, E^{\downarrow}, (K^+)^{\downarrow}).$$

Hereinafter, the upper sign "↑" or "↓" for this factor means that the function is strictly increasing or decreasing, respectively.

For example, in our case, in terms of partial derivatives:

$$\frac{\partial f_e(I\ ,K^+,E\ ,K^-)}{\partial K^+} < 0.$$

MODELING THE DYNAMICS OF THE RUBLE EXCHANGE RATE: BALANCE OF CURRENT OPERATIONS

Consider a dynamic two-period model in periods $t-1$, t. Within this framework, the volume of currency E in dollar prices during the period t, delivered to the domestic foreign exchange market in the form of proceeds from the export of goods and services:

$$E_t = P_t^* k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\delta} (e_{t-1}^R)^z, \qquad (3)$$

where $k_E = const$; Q is the level of real gross domestic product (GDP as a representative of total production); P_t^* — the level of average actual export prices; P_{t-1} — the level of consumer prices index (CPI); and the indices $t-1$, t indicate successive simulation periods, x and δ — are the adjustable model parameters. Let us discuss further the properties of the parameters x and δ.

The Z-score is the rate of reaction to changes in the terms of trade. Within the framework of this model, the volume of currency supplied to the domestic market in period t is directly determined by the physical volume of exports in actual export prices P_t^* for the same period. At the same time, the volume itself also depends on the terms of trade, which are represented by a value

$e_{t-1}^R = e_{t-1} \dfrac{P_{t-1}^*}{P_{t-1}}$ in the form of an adjusted

nominal exchange rate for the ratio of internal and external prices, and is determined by the decisions of exporters in the previous period $t-1$. This dependence was studied in detail in various aspects in the author's work [21], where it found its empirical confirmation in different periods of time.

A part of dependence (3) $k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\delta}$ asserts that physical exports are part of the total output, which is averaged in a dynamic sense — the exponents Q_t are represented by weights:

$$\frac{1}{x+1} + \frac{x}{x+1} = 1.$$

The exponent $\delta \geq 0$ reflects the "slightly larger" growth in exports over imports, with non-negativity constraints as a function of total output. This is due to limited domestic demand and, therefore, the need to realize the growing total production volume precisely through exports. At the same time, the method of averaging the total output itself will not have a significant effect on the modeling result due to the insignificance of the volatility in the medium term of the variable Q in comparison with possible dynamic changes in other macroeconomic determinants used in modeling.

At the same time, dependence (3) also has a natural functional character from an economic point of view in relation to the entire system of the main listed factors of currency formation:

$$E_t = f_{E_t}(P_t^{*\uparrow}, Q_t^{\uparrow}, Q_{t-1}^{\uparrow}, e_{t-1}^{R\uparrow}).$$

In the economic scientific literature, a fact is known: the choice of export pricing in the currency of the consumer or producer will have a significant impact on the transmission mechanism for the transmission of exogenous shocks as a whole to the exchange rate. It should be emphasized that the real pricing mechanisms for the export products of Russian companies based on the prices of the main world commodity exchanges denominated in US dollars (in this case, in foreign currency) are of particular importance from the point of view of the modeling performed.

When modeling the dependence of imports of goods and services, let us assume that residents direct to consumption of imports in period t a part of their income, represented by both current income and income in the

previous time period $t-1$ in domestic prices P_t. The initial functional dependence has the following form, considering the reaction y to a change in the terms of trade of the previous period:

$$I_t = P_t \, k_I (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})(e_{t-1}^R)^y, \tag{4}$$

where $z - y = x$. In fact, within the framework of this model, the indicators z and y in formulas (3) and (4) determine the indicator x, introduced earlier in the same formulas.

МОДЕЛИРОВАНИЕ ДИНАМИКИ MODELING THE DYNAMICS OF THE RUBLE EXCHANGE RATE DYNAMICS: CAPITAL FLOWS AND OPERATIONS WITH FINANCIAL INSTRUMENTS

In modern conditions of medium-term and long-term changes in the current account balance of the country's balance of payments, capital movement plays a significant role, being one of the most important factors in the behavior of the ruble exchange rate, which clearly has a great influence on the results of formula (2).

However, the problem of this difficult to predict and rather an unstable determinant of the formation of the exchange rate will be solved at the formal logical level within the framework of the model under consideration by putting forward a number of hypotheses about the dynamics of capital flows.

For the functional dependence of capital outflow, we will accept the hypothesis — this is a part of the average total income of microeconomic agents inside the country in domestic prices P_t, withdrawn for the purpose of savings abroad, considering the relative international competitive advantages of the previous period:

$$K_t^- = P_t \, k_{K^-} (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})(e_{t-1}^R)^y. \tag{5}$$

With regard to the amount of capital inflows, we will accept the following hypothesis: this is a function that increases in terms of the real aggregate product since international investors and speculators want to buy part of it at domestic prices P_t and under the terms of trade. The latter is explained by the fact that with an increase in the USD/RUR exchange rate and a fall in the national currency, investment conditions for non-residents are improving.

Therefore, the dependence of the capital inflow must satisfy the following condition:

$$K_t^+ = f_{K_t^+}(P_t^{*\uparrow}, Q_t^{\uparrow}, Q_{t-1}^{\uparrow}, e_{t-1}^{R\,\uparrow}).$$

Based on this, we assume:

$$K_t^+ = P_t^* k_{K^+} (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\theta}(e_{t-1}^R)^z, \tag{6}$$

where θ — an adjustable parameter.

An increase in capital inflow in the form of dependence (6) with GDP growth to a more than proportional (indicator θ in $k_{K^+}(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\theta}$ in a case $\theta \geq 0$) degree is associated with a general improvement in the investment climate in Russia with an increase in economic growth and an inflow of direct and portfolio investments and the expected positive effect of import substitution.

Substituting formulas (3)–(6) into (2), we obtain:
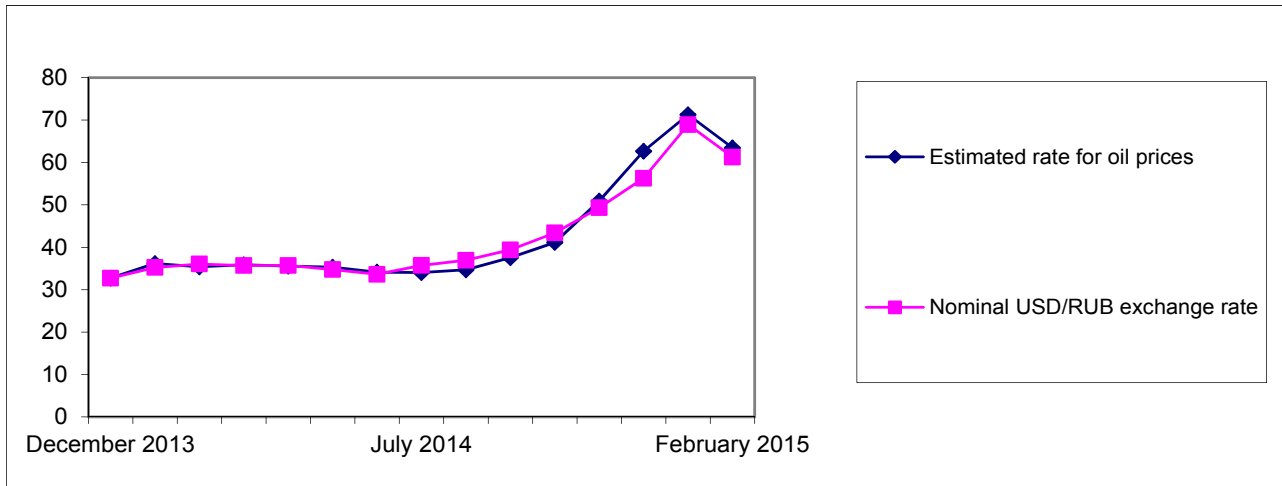
Fig. **Estimated and nominal US dollar/ruble exchange rates in 2013–2015**
Source: author's calculations, monthly data.

$$e_t = \frac{k_I P_t (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})(e_{t-1}^R)^y + k_{K^-} P_t (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})(e_{t-1}^R)^y}{P_t^* k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\delta}(e_{t-1}^R)^z + P_t^* k_{K^+} (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\theta}(e_{t-1}^R)^z} =$$

$$= \frac{P_t (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})(e_{t-1}^R)^y (k_I + k_{K^-})}{P_t^* k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\theta}(e_{t-1}^R)^z (k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta} + k_{K^+})} =$$

$$= \frac{P_t (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})(k_I + k_{K^-})}{P_t^* (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\theta}(e_{t-1}^R)^x (k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta} + k_{K^+})} =$$

$$= \frac{P_t (k_I + k_{K^-})}{P_t^* (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\theta}(e_{t-1} P_{t-1}^* / P_{t-1})^x (k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta} + k_{K^+})} = \quad (7)$$

$$= \frac{(k_I + k_{K^-})}{(P_t^* / P_t)(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\theta}(e_{t-1})^x (P_{t-1}^* / P_{t-1})^x (k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta} + k_{K^+})}.$$

Using the properties of the indicators $\delta \approx \theta$ and the greater dynamic stability of the averaged term $(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta}$ in comparison with the volatility of internal and external prices, in the medium term, we set the term as constant k':

$$\frac{(k_I + k_{K^-})}{(k_E (Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta} + k_{K^+})} = (k')^{x+1} = const.$$

We rewrite (7) as

$$e_t(e_{t-1})^x = \left(k'\frac{P_t}{P_t^*}Q_t^{-\theta/x+1}\right)\left(k'\frac{P_{t-1}}{P_{t-1}^*}Q_{t-1}^{-\theta/x+1}\right)^x.$$

After re-designating the exponent $\theta' = \theta/x+1$ and the time division of the variables involved in the process, we dynamically extend the model to a multi-period case and obtain the time dependence of the ruble exchange rate on the system of the main accepted fundamental internal and external economic determinants:

$$e(t, Q(t), P(t), P^*(t)) = e_t =$$
$$= k^/\frac{P_t}{P_t^*}Q_t^{-\theta/x+1} = k^/\frac{P_t}{P_t^*}Q_t^{-\theta'}. \tag{8}$$

For the purposes of model verification, one of the most suitable is the period of the financial crisis of 2014–2015, which is associated with the significant rapid depreciation of the ruble.

In this study, we will use the methodology and results of the author's work [22] (initial data have been updated). The consumer price index is used as the determinant of the *P* model, the real GDP index is used as the determinant of *Q* (according to the Federal State Statistics Service[1]), the price of the Intercontinental Exchange Brent crude oil is used as a determinant P_t^* (according to Bloomberg, information terminal).

The *Figure* (the author's calculations, monthly data) shows the dynamics of the calculated exchange rate of the ruble according to the main research formula (8) compared with the nominal exchange rate of the US dollar to the ruble at the end of the period (according to the data of the Bank of Russia[2]). As a result of numerical simulation by the least squares method with normalization of the nominal header, the parameter value is set $\theta' = 0,45$.

The average value of the normalized deviations and the average of the absolute normalized deviations of the nominal and calculated rates were 3 and 0.3%, respectively, which confirms the high quality of the model (8).

MODELING RUBLE EXCHANGE RATE: LONG-TERM DYNAMICS

For the purpose of this study, it is necessary to make the following assumption — in the long term, the coefficient k_E in the functional dependence (3) ceases to be a constant and becomes a dynamic function $k_E(t)$, which is important for further modeling in the long term:

$$E_t = P_t^* k_E(t)(Q_t^{\frac{1}{x+1}}Q_{t-1}^{\frac{x}{x+1}})^{1+\delta}(e_{t-1}^R)^y. \tag{9}$$

Let us discuss further the properties of the introduced function $k_E(t)$. Over the past three decades, changes in world prices for Russian export goods have had an extremely significant impact on the entire macroeconomic dynamics. And it is very important that this remains in the long term one of the fundamental basic drivers of Russia's macroeconomic

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[1] URL: https://rosstat.gov.ru/folder/10705 (accessed on 11.02.2021).

[2] URL: http:// www.cbr.ru/statistics (accessed on 11.02.2021).

dynamics. Indeed, it is at this stage, in addition to our country, that real opportunities arise for restructuring the entire export structure for the coming years.

It should be noted here that the author, assessing this scenario as very likely, belongs to that part of the expert economic community that considers changes in the structure of Russian exports towards an increase in sales of intermediate products and its real diversification as an international competitive advantage of our country in the long term. When implementing this strategy, it is necessary to consider the global trends in the excess of the growth rates of prices for intermediate goods over the growth rates of prices for raw materials. In the long term, this will undoubtedly lead to a significant increase in the volume of currency in dollar prices, which will enter the domestic foreign exchange market in the form of receipts from the export of goods and services.

All of the above allows us to consider formula (9) exactly in the variant of imposing a constraint $k_E^{/}(t) > 0$. There is a strict increase in the function $k_E(t)$ with respect to t.

Likewise, in the long term, the investment climate in Russia is bound to improve. This should lead to a significant increase in capital inflows due to an increase in direct and portfolio investments that will flow to the domestic foreign exchange market, and allows one to consider formula (6) in the version of a strict increase $k_{K^+}(t)$ with respect to t and setting a limitation here $k_{K^+}^{/}(t) > 0$.

Therefore, the dependence of capital inflows must satisfy the following condition:

$$K_t^+ = f_{K^+}(k_{K^+}(t)^{\uparrow}, P_t^{*\uparrow}, Q_t^{\uparrow}, Q_{t-1}^{\uparrow}, e_{t-1}^{R\uparrow}).$$

Accordingly, based on this:

$$K_t^+ = P_t^* k_{K^+}(t)(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\theta}(e_{t-1}^R)^z. \tag{10}$$

Substituting formulas (4), (5), (9), (10) into (2), similarly to calculations (7), we obtain:

$$e_t = \frac{P_t(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})(k_I + k_{K^-})}{P_t^*(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{1+\theta}(e_{t-1}^R)^x (k_E(t)(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta} + k_{K^+}(t))} =$$

$$= \frac{P_t(k_I + k_{K^-})}{P_t^*(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\theta}(e_{t-1} \frac{P_{t-1}^*}{P_{t-1}})^x (k_E(t)(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta} + k_{K^+}(t))}. \tag{11}$$

Next, we introduce the function $K(t)$:

$$\frac{(k_I + k_{K^-})}{(k_E(t)(Q_t^{\frac{1}{x+1}} Q_{t-1}^{\frac{x}{x+1}})^{\delta-\theta} + k_{K^+}(t))} = (K(t))^{x+1}. \tag{12}$$ Formula (11) considering (12) in this case is

transformed: $e_t(e_{t-1})^x = \left(K(t) \frac{P_t}{P_t^*} Q_t^{-\theta/x+1} \right)\left(K(t) \frac{P_{t-1}}{P_{t-1}^*} Q_{t-1}^{-\theta/x+1} \right)^x.$

Let us extend the model to a multi-period case and, after temporarily dividing the variables, we obtain a dynamic dependence of the ruble exchange rate over time on the main fundamental external and internal macroeconomic factors:

$$e_t = e(K(t), Q(t), P(t), P^*(t)) =$$

$$= K(t) \frac{P_t}{P_t^*} Q_t^{-\theta/_{x+1}} = K(t) \frac{P_t}{P_t^*} Q_t^{-\theta'} . \qquad (13)$$

As a result, it is important to note the key properties of the function $K(t)$ in formula (13): due to $\delta \approx \theta$ (since the "additional" inflow of capital for GDP growth should primarily serve the growth of exports of goods and services) sufficient stability in comparison with other members $(Q_{t-1}^{x/_{x+}} Q_t^{1/_{x+1}})$ a strict increase in internal functions $k_E(t)$ and $k_{K^+}(t)$ guarantees a strict decrease in the key function $K(t)$ (12) with respect to t: $K'(t) < 0$.

As a consequence, this indicates a tendency for the ruble to strengthen in the long term as compared to the equilibrium medium-term dynamics.

CONCLUSIONS

The ruble exchange rate is one of the most important factors that have a significant impact on the motivation of economic entities through the mechanism of forming international relative competitive advantages, on international trade flows, and by creating a favorable investment climate within the country on capital flows.

It is important to note that these economic aggregates are the determining factors in the dynamics of the exchange rate itself. At the same time, after the completion of the almost complete liberalization of the exchange rate and the transition of the Bank of Russia to the inflation targeting regime according to the classification of the International Monetary Fund, the regime of the Russian ruble exchange rate de facto began to be characterized by the independent floating of the national currency.

The above aspects determined the course of mathematical modeling of the ruble exchange rate and led to the development of the author's conceptual approach to modeling the dynamics of the equilibrium exchange rate based on international flows equilibrium exchange rate (IFEER).

Considerable attention is paid to the mathematical modeling of the long-term dynamics of the ruble exchange rate in comparison with the medium-term equilibrium dynamics and the mathematical analysis of internal functional relationships, on the basis of which a conclusion is made about the tendencies of the strengthening of the ruble exchange rate in the long term.

The paper presents data on the verification of the results of modeling medium-term equilibrium dynamics. At the same time, economic verification of internal relationships and model results in the long term will require further accumulation of economic statistics and may become the subject of future research.

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Analysis of the Dynamics of IPO Transactions in the Banking Sector

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ABSTRACT

IPO (initial public offering) is a widespread financing instrument in the world, however, the scientific community pays little attention to the dynamics of IPOs in the banking sector. The **aim** of the study is to critically analyze the dynamics of IPO transactions of credit institutions on the horizon from January 1, 2000, to December 31, 2020. The research **methodology** includes analytical methods for collecting and processing information, comparative and graphical analysis of the database collected by the author and consisting of 305 IPOs of banks from 2000 to 2020. The study compares the dynamics of IPO transactions of credit institutions from developed and developing countries, identifies characteristics inherent in each market, and explains the differences in market dynamics. The study reveals clustering in the IPO market of credit institutions and compares clustering with the general market of initial public offerings. It is shown that lending institutions around the world have actively attracted funds through IPO, having placed their shares for a total of $ 218 billion. The bulk of the funds were attracted by banks from emerging markets, primarily from China. During this period, there were 3 IPO waves on the banking IPO market, characterized by a significant increase in placement volumes and profitability on the first day of trading. This clustering in the IPO market of credit institutions was not typical only for the banking sector but coincided with the global growth in the number of transactions and IPO yields. The author **concludes** that the placement of shares of credit institutions during the hot market period is the most promising in terms of the volume and dynamics of raising funds; the IPO market of credit institutions retains high growth potential, primarily in Asia and the CIS.
Keywords: Initial Public Offering (IPO); IPO of commercial banks; IPO cycles; clustering

INTRODUCTION

Banks are financial intermediaries in the economy; the stability of the country's economy and the possibility of sustainable economic development in general depend on their financial position. The banking sector is fundamentally important for the day-to-day functioning of the economy, and a crisis in the banking sector can have irreparable consequences for macroeconomic stability due to the action of a financial accelerator [1] and, moreover, can lead to a global economic crisis, as happened in 2008.

Due to its importance to the economy, the banking sector is most heavily regulated by supervisors, primarily central banks. The Basel Committee on Banking Supervision at the Bank for International Settlements provides recommendations on the regulation of capital adequacy ratios for banks. Central banks and

relevant regulators take these recommendations into account when shaping supervisory policies domestically. Requirements for reserve funds have doubled in 15 years, and additional coefficients have appeared to protect against cyclical fluctuations of the economy, which, in turn, further limits the ability of banks to increase their loan portfolio [2].

A long period of tightening requirements for the capital adequacy of banks, as well as the need to increase equity capital to create a loan portfolio, are forcing credit institutions to look for new sources of financing. In this situation, the attraction of additional funds by banks through the initial public offering of shares on the stock exchange is a logical decision. Raising additional resources through the placement of shares on the stock exchange has an advantage over the placement of bonds, since this type of financing

is not borrowed and is not considered as a bank's obligation when calculating capital adequacy ratios, and also does not imply a mandatory return of borrowed funds.

In addition to the need to comply with capital adequacy standards, banks can raise funds through an IPO (initial public offering) to strengthen their market positions through mergers and acquisitions, entering new markets of presence and developing their branch network. The IPO mechanism makes it possible to privatize the state's share in a credit institution, as was the case in Russia in 2007 during the "people's IPOs" of Sberbank and VTB, as well as a number of Chinese banks, and, in addition, effectively monetize the share of the bank's existing shareholders. Another motivation for the bank's IPO is to raise funds for the development of financial technologies.

The banking sector is cyclical and correlates with economic growth in the country, which is confirmed by the research of U. Albertazzi, L. Gambacorta [3]. The measures to regulate the banking sector, as well as the regulatory approach proposed by the Basel Committee, in turn, are aimed at reducing the cyclical factor in the banking sector by creating additional reserves.

Banks' profits depend on the interest rate in the country and on the growth of lending. During the period of economic growth, the demand for loans grows, which positively affects the growth of banks' profits. During crises, banks, as a rule, cut back on lending, as the financial position of borrowers deteriorates significantly, which leads to a drop in the growth rate of the loan portfolio. However, the government's stimulating policy aimed at leveling the crisis in the economy by lowering the key rate and additional measures to support banks, such as placing deposits in accounts and reducing the reserve rate, also increases the banks' resilience to cyclical fluctuations in the economy [4].

This paper presents a critical analysis of the dynamics of the IPO market of credit institutions. The scope of the analysis is 20 years, from January 1, 2000 to December 31, 2020. The sample included IPOs of banks in the amount of more than $ 20 million, for which data on the dynamics of the share price on the first day of the placement were available. The database is compiled on the basis of the information portals CapitalIQ and PREQVECA.

A number of economists, such as N. Liang [5], M. Dicle [6], W. Mehmood [7], K. Song and others [8–26], have devoted their works to the problems of studying the IPO market, but the issue of IPO in the banking sector has received little attention in the scientific community, despite the importance of this sector to the economy.

ANALYSIS OF IPO DYNAMICS IN THE BANKING SECTOR

The database compiled by the author includes 305 IPO transactions of credit institutions completed from 2000 to December 2020. The total amount of funds raised during the IPO of banks is $ 218 billion (*Fig. 1, 2*).

It should be noted that the market clearly shows three IPO waves, characterized by a large volume of placement of shares, as well as a higher yield of placements on the first day of trading. It is noteworthy that these IPO waves coincided with the general growth of IPO transactions in the indicated years and are not typical only for the banking sector. This fact correlates with the results of a study by J. Helwege, N. Liang that clustering IPOs in certain industries is not typical for a "hot" or "cold" market, and during a "hot" market, companies from different industries tend to place their shares on exchange [5]. In total, there were three IPO waves during this period: 2005–2007, 2010–2011, 2014–2017 [6].

The average IPO size of credit institutions over 20 years amounted to $ 711 million, and the average value was $ 150 million. At the same time, the average transaction size in emerging markets significantly exceeded the average amount of funds raised by credit institutions from developed countries — $ 1.1 billion versus $ 309 million. Moreover, the average profitability of the first day of trading is also higher for banks from developing countries — 34% versus 5%. The number of transactions worth more than $ 1 billion in emerging markets was 29 versus 10 in developed ones.

Higher IPO returns in emerging markets are not unique to the banking sector. According

Fig. 1. **IPO volume in banking and median first-day return**

Source: (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (дата обращения: 21.03.2021) / (accessed on 21.03.2021).

to research by W. Mehmood, R.-M. Rashid, A. H. Tajuddin, the first-day return of the IPO of companies from developing countries, on average, exceeded the profitability of IPOs of companies from developed countries [7]. According to research by K. R. Song and Y. Lee, the average IPO dynamics for companies from developed countries was about 15%, and for companies from developing countries — 60%. It should be noted that the greatest dynamics was shown by the shares of companies in the Asian region [8]. The results of these studies are also confirmed by data on IPOs of banks (*Fig. 3*).

Geographically, the bulk of fundraising during IPO came from China (*Fig. 3*) — local banks in aggregate attracted about half of the total volume of the banking IPO market, while 51 transactions were carried out, which is 16% of the total volume of transactions in the sample (*Fig. 4*). Chinese banks have had a significant impact on the banking IPO market, but it is worth noting that the dynamics of placements by both Chinese banks and banks in the rest of the world coincided with the worldwide waves of IPOs observed in the market. There are differences in the dynamics of placements within the waves, but the bulk of the funds raised fell on the hot IPO markets (*Fig. 5*).

The Chinese economy is characterized by high growth rates, and banks have been actively raising funds by placing shares on financial markets. Chinese banks carried out record

transactions not only for the banking sector, but also for the entire IPO market at that time — the Industrial and Commercial Bank of China and the Agricultural Bank of China raised more than $ 19 billion each during the placement of shares. The average IPO size in China during this period was $ 2 billion, and the average value was $ 700 million, which is significantly higher than the market average for this period. It should be noted that the yield on the IPO of Chinese banks also significantly exceeded the yield on the IPO of credit institutions in the rest of the world — the average and median yield was 24% and 14%, respectively (*Fig. 6*).

The entry of Chinese banks to the stock exchange was preceded by a long process of reforming and restructuring credit institutions. After China's accession to the WTO in 2002, the Chinese government embarked on a policy of bank liberalization. The aim of the state banking policy was to improve the efficiency of banks in terms of making a profit and reducing the level of problem loans. Many banks had a high percentage of overdue loans on their balance sheets, the volume of which could reach 11–15% of assets. Most of the bad loans were transferred to specially created bad asset funds, and the banks were capitalized at the expense of government reserves and the issuance of government bonds. The Chinese government used the IPO instrument as an effective way to reduce the state's share in the capital of credit
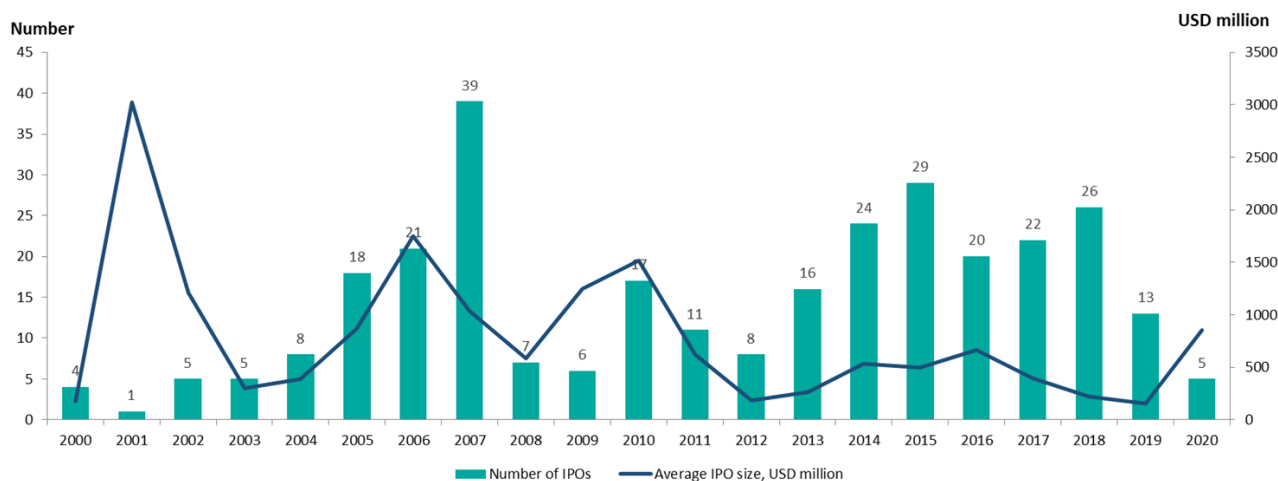
Fig. 2. **Number of IPOs in banking**

Source: CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).
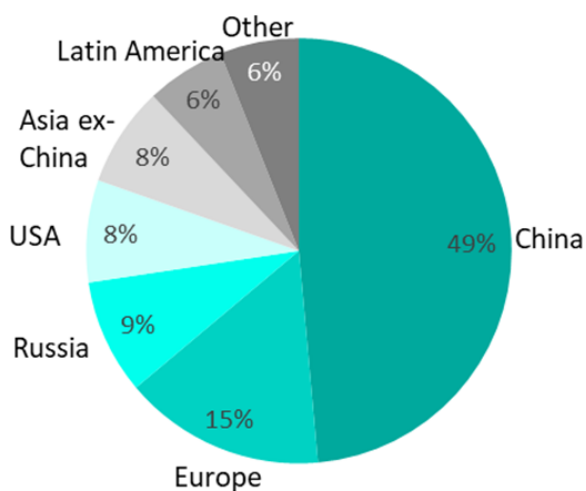
Fig. 3. **Share of IPO market in banking by country in 2000–2020**

Source: built by the author based on data from CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).
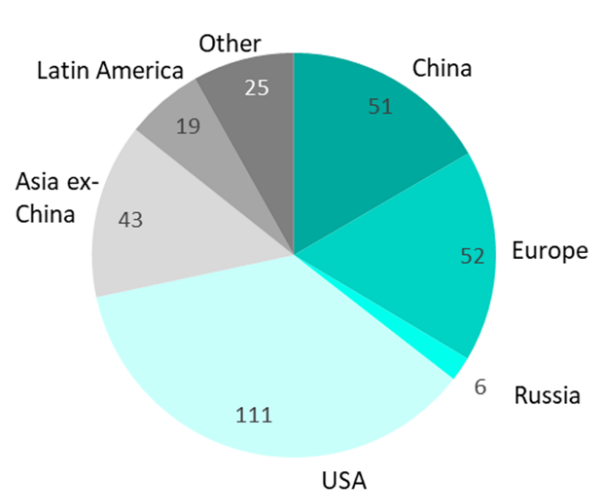
Fig. 4. **Number of IPOs in banking by country in 2000–2020**

Source: built by the author based on data from CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).

institutions. This process took place within the framework of liberalizing the local market and reforming the financial sector to increase its stability and transparency. Another factor that increased the attractiveness of banking sector shares for investors, as well as the transparency of the financial system, was the introduction of Basel II standards that were relevant for this period [9–11].

The demand for shares of Chinese credit institutions during the IPO was mainly represented by local investors and financial institutions and significantly exceeded the supply — the order books were often re-signed several times, and often several dozen times [11]. It should be noted that such high indicators of profitability on the first day of trading in shares of Chinese banks are explained by the specifics of the local market and are characteristic not only of the banking sector [12].

In terms of the number of IPOs, the USA is in first place, but in terms of the total volume of

USD million

Fig. 5. **IPO volume in China and the rest of the world**

Source: built by the author based on data from CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).

attracted funds, the USA is in fourth place. The major US banks, as those in Europe, were listed on the stock exchange before 2000, but the US banking system is characterized by a significant number of relatively large regional banks that actively listed their shares on the stock exchange. The most liquid financial market and relatively low transaction costs when entering the stock exchange also contributed to the attraction of financing through the IPO instrument [13].

However, the average IPO size in the United States is one of the lowest — $ 153 million, and the median value is only $ 55 million, which is 3 times less than the world average. The average return on the first day of trading in bank shares on the US stock exchange was 4%. It should be noted that in the United States, the number of IPOs, as a result of which, at the end of the first day of trading, the shares of the issuing bank fell below the offering price, is quite large — 26 transactions (23% of all transactions), and the average drawdown was 21%. It is noteworthy that US banks entered the IPO market quite confidently, regardless of the state of the market cycle (*Fig. 7*). Only two US banks raised more than $ 1 billion in their IPO: CIT Group placed $ 4.6 billion in shares in 2002, and Eastern Bankshares raised over $ 1.7 billion in 2020.

European credit institutions held a significant share of the bank IPO market during this period, despite the fact that the main largest placements

of shares of European banks took place before 2000 (BNP in 1993, Banca Nazionale del Lavoro in 1998, Credit Lyonnais in 1999). In aggregate, European banks attracted $ 33.5 billion, the average and median transaction value amounted to $ 643 and 316 million, respectively, which is close to global indicators and significantly exceeds the indicators of the United States (*Fig. 8*). The banking system in Europe is less concentrated than in China, and is also characterized by a fairly large number of regional banks.

Russian banks raised a total of $ 19 billion, the bulk of which was raised in 2007, when shares of Sberbank, VTB and Bank St. Petersburg were placed. This year, Russia accounted for about 20% of all raised funds in the total volume of the banking IPO market. These placements were quite successful, given the fact that on the first day of trading the price of shares of credit institutions was higher than the offering price, but the yield was still below the world average for this period. In the aftermath of the financial crisis, only one bank, with the main business in Russia, held an IPO worth more than $ 1 billion — in 2013, Tinkoff raised $ 1.08 billion by listing its shares on the London Stock Exchange. The last IPO in the Russian banking sector during this period occurred in 2015, when MKB Bank placed its shares in the amount of $ 237 million (*Fig. 9*).
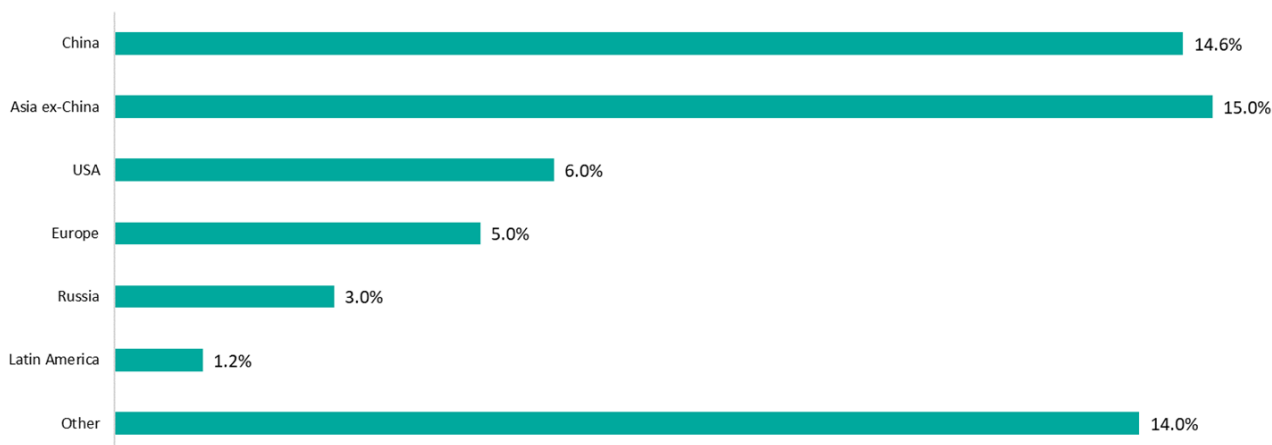
Fig. 6. **Median first-day return on IPOs in banking**

Source: built by the author based on data from CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).
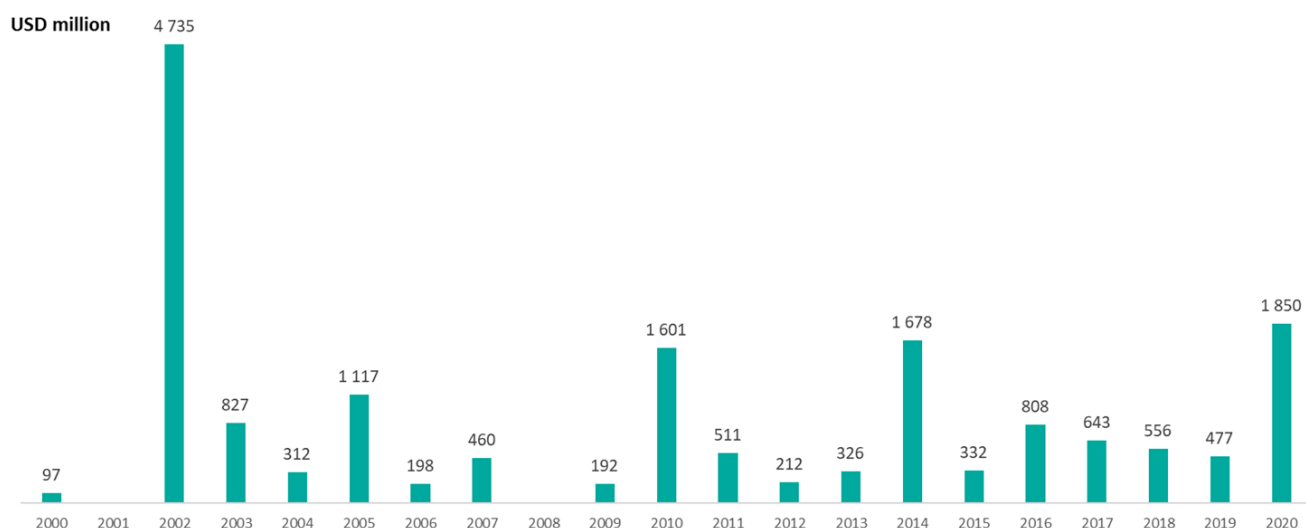
Fig. 7. **IPO volume in the USA**

Source: built by the author based on data from CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).

Only 6 Russian banks were listed on the stock exchange during the analyzed period, and 88% of all raised funds fell on two banks: Sberbank and VTB. It should be noted that practically all placements of shares of Russian credit institutions were successful, and banks were able to attract the declared funds. Despite the lower profitability on the first day of trading compared to world values, the average profitability in Russia was 4.17%, the median was 2.89% versus 21% and

6.8% globally, respectively. At the end of the first trading day, shares of only one bank fell

below the placement price — quotes of NOMOS-Bank (Otkrytie FC Bank) lost 0.5%.

In addition to Chinese banks, credit institutions from other countries of the Asian region and, above all, from Japan, showed high activity in IPOs (*Fig. 10*). During this time, Japanese banks held 9 IPOs, placing their shares for a total of $ 12 billion. It is worth noting that the average IPO size of Japanese banks was quite high — $ 1.3 billion, and the median value was $ 480 million. The placement was carried out by banks, the main shareholders of which were American private equity funds — these funds

USD million
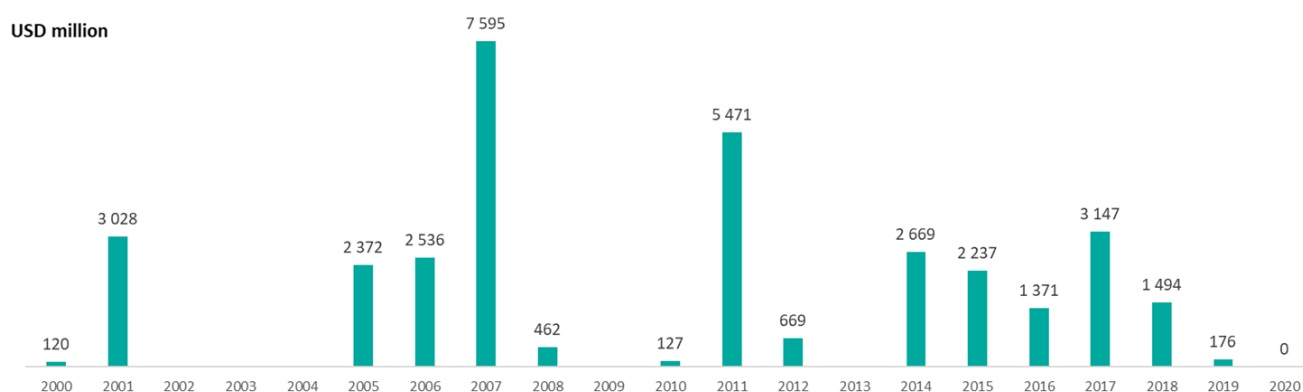
Fig. 8. IPO volume in the EU

Source: built by the author based on data from CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).

USD million
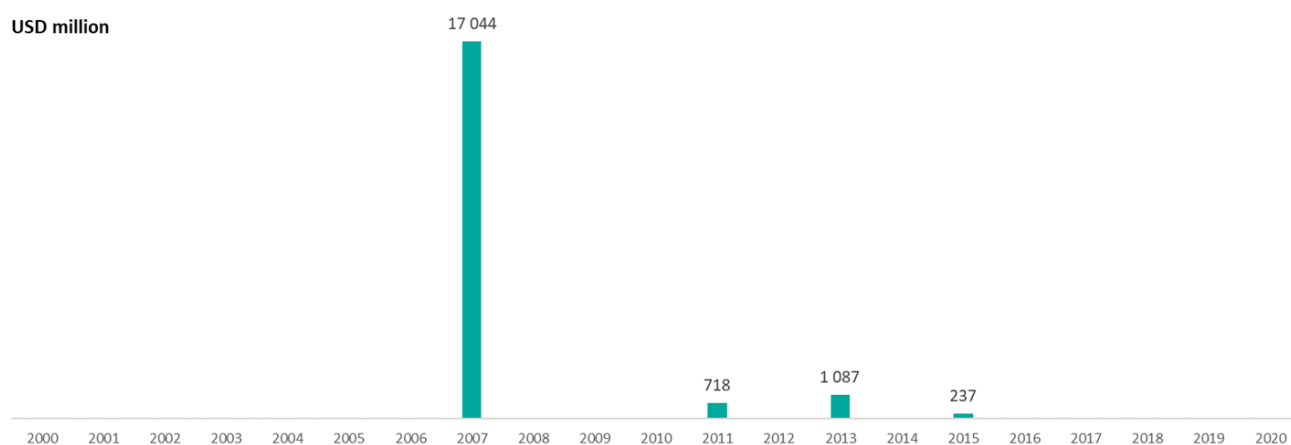
Fig. 9. IPO volume in Russia

Source: built by the author based on data from CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).

bought controlling or block stakes in Japanese banks that were on the verge of bankruptcy, and, after a deep restructuring, carried out an IPO.

Indian bank IPOs were low compared to the global average, averaging $ 171 million. During this period, a total of 12 banks listed their shares on the stock exchange, while the IPO activity of Indian banks has increased significantly over the past 5 years. Research by A.B. Sinha, B.M. Singh M. Singh [14] also points to an increase in the number of IPOs in India over the past few years. The authors associate this phenomenon with the achievement of new record values of indices in the Indian stock market and high rates of economic growth. Notably, while activity in the IPO market has been declining since 2017,

the local Indian market has seen an increase in the number of IPOs. India's banking sector has significant IPO potential given the fact that only 5 of the 10 largest banks by asset size listed their shares on the stock exchange, as well as the significant growth of the banking sector in recent years and the continuing development prospects. In total, banks in the Asian region, excluding China, raised $ 16.6 billion through IPOs over 20 years (*Fig. 10*).

HOT IPO MARKETS

There are several parties involved in the IPO process, each of which strives to realize its goals. The task of the issuing company is to maximize the funds received from the sale of

USD million
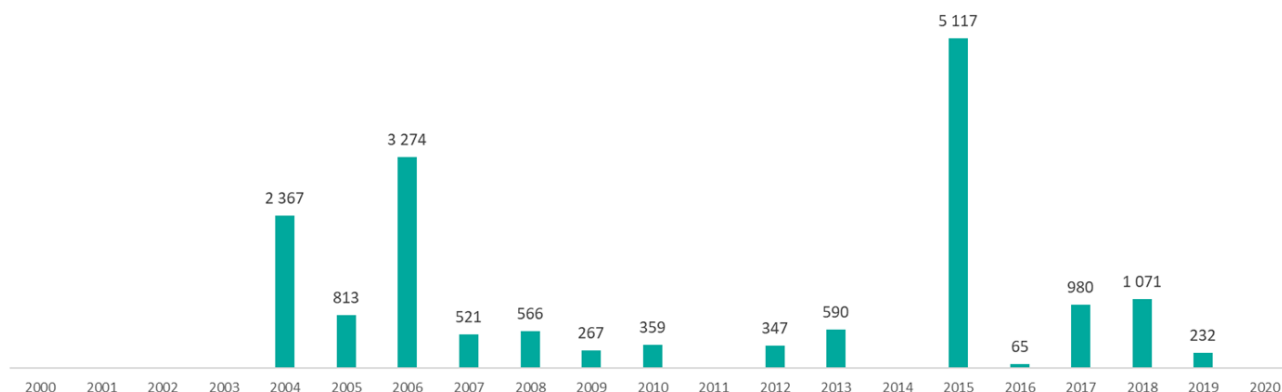
Fig. 10. **IPO volume in Asia ex-China**
Source: built by the author based on data from CapitalIQ, PREQVECA. URL: www.capitaliq.com (accessed on 05.04.2021); URL: http://www.preqveca.ru/placements/ (accessed on 21.03.2021).

its shares to a wide range of investors. Despite the potential conflict of interest, the goal of the underwriter is largely the same as that of the issuing company, as the underwriter's income depends on maximizing the demand and price of the company's shares. From the point of view of the issuing company and the underwriter, a successful IPO will consist of a full offering of the shares being traded in accordance with a valuation that suits the issuing company's shareholders. For an investor, the main goal of participating in an IPO is to generate income from the purchase of company shares. The rise in the value of shares during trading will be one of the main factors determining the success of an IPO for an investor. In other words, a successful IPO is characterized by a balance in achieving the goals of all parties involved.

During a hot market, the chances of achieving the goals of all parties are highest, as these periods are characterized by high demand for offered shares from investors, due to which a full placement of the company's shares is achieved. The high profitability of the company's shares on the first day of trading attracts special attention from both all parties involved in the IPO of shares and the scientific community [15].

It is customary to associate high stock returns on the first day of trading not only with the high interest of investors in the company's shares, but also with the deliberate underestimation of the issuing company during the IPO to ensure a full placement of the sold shares. Despite the fact that the high profitability of shares on the first day of trading can be interpreted as lost funds of the issuing company, such placements are considered successful, since during the IPO the entire volume of the placed shares is sold, and investors receive income from participation in the placement that meets the interests of all interested parties.

Many authors in the process of researching the problems of the IPO market use the concept of "hot" and "cold" IPO markets, but it should be noted that the definition of "hot" markets differs from one researcher to another and often the authors use their own methodology. As a rule, by "hot" IPO markets, researchers mean a situation in which the price of shares of companies on the first day or month of trading is characterized by high growth, and the number of companies entering the stock exchange increases significantly in a short period of time. These periods are characterized by increased investor risk appetite, as well as increased demand for shares of issuing companies. Given the cyclical nature of IPO markets, this period represents an upswing in the IPO wave followed by a downturn or cold market. The cold market is characterized by low returns on the first day of trading, as well as significantly fewer IPOs.

R.G. Ibbotson and J.F. Jaffe define a "hot" market as a situation in which the average return in the first month of trading in a listed stock is abnormally high relative to the market as a whole. It should be noted that the profitability of

"cold" markets, according to the authors' methodology, does not have to be negative [16].

K. Penzin distinguishes three cycles in the IPO market, depending on the price dynamics on the first day of trading [17]:

• hot IPO market — the opening price is more than 15% higher than the offering price;

• warm IPO market — the opening price is less than 15% higher than the offering price;

• cold IPO market — the opening price is lower than the offering price.

In this paper, the term "hot" IPO market refers to a market situation in which the IPO volume and median return on the first day of trading increase significantly compared to the previous period.

The first IPO wave was observed in 2005–2007, this period was a record one in terms of the amount of funds raised not only for the banking sector, but also for other industries. This period was due to the high-risk appetite of investors against the background of positive expectations from the growth of the world economy [18, 19]. The median return on the first day of trading on shares of credit institutions increased over this period to 10.2% versus the median value over 20 years of 6.8%.

Half of the volume of funds attracted to the banking sector during this period was accounted for by banks from China, which together attracted $ 50 billion. It is worth noting that it was during this period that the largest placements of shares of Russian banks took place: the IPO of Sberbank and VTB for a total of $ 17 billion.

Despite the hot IPO market during this period, the dynamics of share prices of Russian banks on the first day of trading on the stock exchange after the placement turned out to be worse than the market — the median yield on placements of Russian banks was 4%, which is lower than the median yield on IPOs of credit institutions for this period of 10%.

This IPO wave is characterized by the fact that 80% of transactions during this period were carried out by credit institutions from emerging markets. The median first day IPO return for transactions in emerging markets in 2005–2007 was also significantly higher than the median return on IPOs of banks from developed countries —

14.3% versus 7%. It is noteworthy that during this period 10 banks from Brazil placed their shares, and in 2007 there were 9 placements, given that in 20 years only 12 Brazilian banks entered the stock exchange. However, despite the large number of placements by Brazilian banks, these IPOs cannot be called successful, since the yield on the majority of placements on the first day of trading was negative, and the median yield was 0%.

After the 2008 financial crisis, the number of IPOs by credit institutions dropped significantly, and it took the market several years to return to pre-crisis levels. However, it should be noted that, despite the low total volume of attracted funds, the initial public offering of the bank's shares, carried out in 2008–2009, was generally successful — out of 13 transactions during this period, only 3 placements were completed in the negative zone on the first trading day.

Research by R. Li, W. Liu, Y. Liu, S.-B. Tsai, as well as the works of C.-Y. Hsu, J. Yu, S.-Y. Wen confirm the fact that the profitability of companies' shares on the first day of their placement on the stock exchange fell significantly after the financial crisis of 2008, and the recovery of the IPO market took about 3 years [20, 21].

The second IPO wave took place in 2010 and lasted only a year. The volume of funds raised and the number of transactions increased several times compared to previous years, but almost 75% of all funds raised this year fell on the placement of the Agricultural Bank of China, which attracted $ 19.2 billion. It should be noted that this wave was also not typical only for the banking sector: the data collected in the work of U. Güçbilmez show a significant increase in IPO transactions in other sectors around the world in the period 2010–2011 [22].

This market recovery was fueled by the global economic recovery after the 2008 financial crisis, as well as the delay in going public for companies planning an initial public offering before the crisis. During this period, major global stock indices recovered and reached new records, as well as increased risk appetite for investors, which increased the chances of companies to successfully list shares on the stock exchange. However, events such as the military conflict in Libya, the EU debt crisis amid problems in Greece, and the

accident at a nuclear power plant in Japan increased volatility and negatively affected the market, which led to a change in investor sentiment and the end of a hot period on the IPO market. The cold IPO market lasted until 2014 and was characterized by a significant drop in both the total volume of transactions and the average size of IPO transactions in the banking sector. The downturn also coincided with a long-term decline in commodity prices, which dampened investor risk appetite [23, 24].

The third IPO wave took place in the period 2014–2017. This IPO wave is characterized by lower volumes of funds raised compared to the hot market in 2004–2007 — in total, during this period, banks attracted $ 49 billion. As in previous periods, the bulk of the funds raised fell on China — in total, local banks attracted $ 22 billion. The data collected by M. Á. Acedo-Ramírez, A. C. Díaz-Mendoza, F. J. Ruiz-Cabestre [23], as well as L. V. Tokun, A. G. Berg [25] indicate that there was a hot market in the world between 2014 and 2017.

This IPO wave was fueled by a general raise in the stock market after the downturn seen in 2012–2013. The hot market kicked off with a successful $ 25 billion IPO in the world of China's Alibaba, followed by a general surge in IPO activity. Statistics also show that the majority of placements during this period were in the Asian markets, with the largest growth in the markets of China and India [26].

Despite the hot IPO market, this period was characterized by a significant number of geopolitical risks in both Europe and the United States and the Middle East, which often led to the postponement of IPO transactions and increased volatility in stock indices. Factors such as the first drop in China's GDP growth below 7% in 20 years, the UK's exit from the EU, a significant drop in oil prices, and the US presidential election had a significant impact on the market during this period. The anticipation of a slowdown in global economic growth led to stagnation in the stock market and a decrease in the number of IPOs.

From 2017 to 2020, there was a decrease in the volume of placements of shares of credit institutions in monetary terms, despite the continued high number of transactions. This decline

was also largely due to geopolitical factors, primarily the UK's exit from the European Union and investors' fears about the prospects for further growth of the EU economy.

Banks from China continued to dominate the banking IPO market, with a total of 16 placements in Chinese banks totaling $ 9.2 billion over this period. During this period, credit institutions from the United States became more active in the IPO market, the number of placements of which amounted to 27, but the average size of transactions also remained relatively low — $ 130 million.

The aggravation of the epidemiological situation due to the spread of COVID-19 around the world and the introduction of widespread quarantine measures led to a decrease in IPO transactions. Despite the difficult situation in the world, in the second half of 2020, against the backdrop of growing liquidity in the stock market as a result of significant injections from regulators, there was a recovery in stock indices, as well as two banks from China and the United States successfully completed major share placements worth $ 1.7 billion each.

As the economy recovers and inflation accelerates around the world, central banks are expected to begin phasing out their monetary stimulus programs, leading to higher interest rates, which in turn could have a positive impact on banks' profit [27].

It is worth noting that most of the largest banks in developing countries have also had IPOs over the past 20 years, but there is still a lot of potential for placing shares of banks from the Asian region. In addition, financial technologies are now actively developing, and startups from this sector are direct competitors of traditional banks, since they often have banking licenses. The placement of shares of companies in this sector may become the next stage in the development of the IPO market for credit institutions.

In Russia, only 6 banks placed their shares on the stock exchange, of which 3 credit institutions are among the top 10 largest banks in terms of assets, which indicates that the potential for IPO transactions is preserved, given the high level of development of the banking sector in the country.

One of the possible options for the development of the banking IPO market in Russia may be the listing of banks that have undergone the reorganization of the Central Bank.

CONCLUSIONS

Raising funds through IPO transactions is one of the most attractive sources of financing for credit institutions in the face of tightening capital adequacy requirements and the need for additional funds to increase the loan portfolio.

Emerging market banks attracted the most funds during the period under review during the initial public offering — $ 156 billion. Emerging markets showed high rates of economic growth, which led to a high need for additional financial resources of credit institutions. In addition, leadership in raising capital from emerging market banks is also due to the fact that major large banks in the US and Europe held IPOs before 2000.

The largest volume of funds raised fell on the Chinese banking sector — local banks attracted a total of $ 106 billion. During this period, there was an active process of liberalization of the Chinese financial sector, and China used the IPO mechanism as an effective way to increase the efficiency and transparency of the country's banking system, as well as reduce the share of state participation in the economy. Despite the fact that the largest banks in China have already conducted IPOs, this market retains its potential due to the rapid growth of the financial sector and the presence of a large number of large regional banks. Even during the crisis, Chinese banks held a leading position in the banking IPO market.

The yield on placements by credit institutions from emerging markets was also higher than that of banks from developed countries — the median return on the first day of placement for emerging markets was 10% versus 5.5% for developed countries. Chinese banks also posted the highest first day IPO returns, with a median first day yield of 14.7% over that period.

During this period, 3 IPO waves took place on the IPO market of credit institutions, which were characterized by higher volumes of placement of shares, as well as higher profitability on the first day of placement. It should be noted that these IPO waves were typical not only for the banking sector, but for the entire IPO market as a whole, which confirms the theory of J. Helwege, N. Liang about the absence of clustering in certain industries during formation of the hot IPO market. Banking IPOs strongly correlate with the general sentiment in the IPO market, and clustering of IPOs in certain periods was not observed only in the banking sector during the study period.

The placement of the bank's shares during the hot market period is more promising from the point of view of the successful completion of the transaction, given the fact that the profitability and volume of placements in these periods increase significantly, which confirms the conclusions of R.G. Ibbotson, J.F. Yaffe [16] that the issuing company receives the greatest income from the sale of shares in the period following a period of low profitability in the market, that is, during a hot market. The median profitability of the banking sector in the hot market is 8.3% versus 4.5% in the cold market, equal to $ 112 million.

Over the past 20 years, most of the largest banks in the Asian region have listed their shares on the stock exchange, but there is still great potential for IPOs by lending institutions from the CIS, India, as well as a number of fast-growing countries in the Asian region. Fintech companies, which often become direct competitors of banks, can also become a growth point for the IPO market of credit institutions.

Further prospects for working on this topic include analyzing the valuations of credit institutions when placing their shares on the stock exchange at the P/B (Price-to-book value) multiple and comparing this indicator depending on the market period. This analysis will test the hypothesis that an IPO during a hot market period is more promising from the perspective of the company's current shareholders, as the likelihood of a successful IPO with higher multiples during this period increases after an overall market assessment.

Another development of this topic is the analysis of SPO (Secondary Public Offering)

transactions of credit institutions. SPO analysis will test the hypothesis that already listed banks will continue to offer their shares as a financing instrument for their activities after the IPO, and will also test the correlation between SPO volumes and the market phase.

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State Ownership and Firm Performance: A Performance Evaluation of Disinvested Public Sector Enterprises

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ABSTRACT

The Indian government devised a flexible method to modify the performance of public sector firms through disinvestment in the 1990s to boost commercial strength and bridge the budget deficit. The disinvestment policy intends to reduce the government's involvement in the country's economic activities to encourage the private sector. The **research aim**s to empirically examine the financial and operating performance of thirty-two Central public sector enterprises (CPSEs) in India. Further, the paper intends to study the other firm factors that influence the performance parameters. The Wilcoxon signed-rank test and random panel regression model are the **methods** employed to analyze the data statistically. The **results** show that the profitability of disinvestment has not brought significantly much improvement post-privatization in PSEs. In contrast, the productivity of employees has improved. Dividend payout ratio and no. of employees have shown improvement after five years of disinvestment, and leverage has insignificantly declined. In addition, state ownership shows a significant negative relationship with the performance variables. It implies that higher the equity shareholding of the government (state ownership) in the CPSEs, would negatively hamper the performance of firms. On the other hand, GDP and firm size are positively affecting the profitability and productivity of employees. The study **concludes** that the government is required to bring down the equity shareholdings in CPSEs, directing more efforts towards strategic disinvestment. Government should choose strategic disinvestment rather than partial and small-scale disinvestment because neither will offer good results. The decline in leverage shows the availability of cheaper sources of finance. Furthermore, it has been suggested that government interference in operational and administrative functions should be given the least priority.

Keywords: panel data; firm performance; privatization; disinvestment of enterprises; profitability indicators; sources of funding; state ownership

INTRODUCTION

Central public sector enterprises (CPSEs) have played a critical role in helping India's economy grow after independence and in resolving the country's socio-economic challenges. Though, the performance of the public sector has always been criticized owing to their low profitability and capacity not being fully utilized. High mounting revenue expenditure left the government with no surplus to spend on the capital expenditure. From 1988–1989, the public sector suffered a total loss of 1906.51 crores [1]. Due to the microeconomic inefficiencies, periodic inflation and balance of payments imbalances led the government towards a grave position

[2]. The government was forced to adopt new economic policies regarding PSEs to save the Indian economy from financial disaster caused by unconstrained expenditure, cumulative debt burden, unfavorable balance of payment, and underperformance.

Disinvestment was adopted as part of economic reforms aimed at improving the performance of government-owned businesses (PSEs), managing the fiscal deficit, promoting a market economy rather than a command economy, and stimulating international and local capital [3]. The Indian government adopted disinvestment as a means of resolving such a dire scenario. Disinvestment implies dilution of state equity shareholding in the firms.

Privatization has become a significant global phenomenon, affecting both developed and developing countries. Under the current Indian disinvestment policy, partial and strategic disinvestment are followed. In the case of disinvestment through minority stake sales, i.e., partial disinvestment, the government transfers the shareholding up to 49 percent and remains the majority stakeholder. On the other hand, the government moves 50% or more of the shareholding and transfer of management control under strategic disinvestment. India has followed the path of partial disinvestment since 1992, several public sector enterprises have been disinvested, and some others privatized over the years [4].

From 2000 onwards, there has been a change in the disinvestment policy from passive disinvestment (partial disinvestment) to active disinvestment (strategic disinvestment). As of 2018, there are more than two hundred operational public sector enterprises [5, 6]. When there is a transition from public ownership to private ownership via disinvestment, it is crucial to study how the financial and operational performance of CPSEs is affected in this transition. However, most of the studies in the Indian context have focussed mainly on partially disinvested PSEs. This study adds to the literature by studying both partially and strategically disinvested PSEs for eighteen years through univariate and panel data analysis. The primary objective of the study is to compare the pre and post disinvestment performance of PSEs. The study further analyses the factors other than state ownership that impact the profitability and operating efficiency of PSES as shown in *Figure*.

The Wilcoxon signed-rank test shows how the disinvestment has not brought much significant change in the profitability parameters. In contrast, the productivity of employees has improved. Dividend payout ratio and no. of employees have shown improvement after five years of disinvestment, and leverage has insignificantly declined. The panel data analysis reveals that state ownership has a negative relationship with profitability and operating efficiency parameters. It confirms with the studies such as [6–8] that

higher state ownership is detrimental to the organization's health.

On the other hand, the better economic growth of the country positively influences the performance of firms. Although, the leverage of CPSEs has reduced, which is a good indicator that there is less dependency of disinvested firms on government borrowings. Lower the leverage, better the financial and operating performance of the public sector enterprises. It is also shown that there is a positive impact of firm size measured by the log of total assets on the profitability and operating efficiency of the firms. This finding aligns with most past research findings, which claim that the largest privatized firms earn more profit due to economies of scale [8, 9].

For a better explanation, the study's framework has been divided into five portions, one of which being the current one. The second section contains a review of the literature. In section three, the research approach employed in the study is described. The findings and discussion are discussed in Section 4. Finally, in part five, the study's conclusion and recommendations are presented.

REVIEW OF PAST STUDIES

Many extensive studies have been undertaken worldwide to check the influence of Privatization on government-owned enterprises' financial and operational performance after Privatization, and the literature has produced mixed results.

Overall, India's privatization process was a series of policies designed to reduce the size of the state sector, increase the involvement of the private sector, and adhere to the logic of the market in making economic decisions [10]. When Privatization took on its present state, it may be traced back to the early 1980s, when several British public sector firms were sold off for profit. In the years that followed, France privatized many public sector enterprises (PSEs), including over 20 by the mid-1980s. Leading European economies, on the other hand, did not begin Privatization until the 1990 s [11].

A study investigated public, private, and mixed-owned enterprises' profitability and productivity measures [12]. The analysis

concluded that the private sector outperformed the public sector after accounting for sector and country variations. The performance of state-owned enterprises and private entities was compared by using a sample of 23 comparable airlines of varying ownership categories for 1973–1983 [11]. The results found a significant relationship between ownership and productivity growth. Productivity growth rates were ambiguous in the short run but showed an increase of 0.05% in the long run. The Boardman-Vining analysis was enlarged to include 1139 firm-years from Fortune 500 companies during 20 years. According to the data, private companies are much more profitable than state-owned ones. They opine when there is a change in ownership from public to privately owned firms, it offers a variety of benefits to the organization [13].

Studies by researchers [5, 6, 8, 14] found that post-privatization firms' efficiency improved significantly. They argued that Privatization enhances a firm's efficiency by removing political interferences and redirecting its focus to the economic goal of optimizing returns over time. On the contrary, there are studies that state that Privatization does not have a significant impact on the firm's performance [5, 14–16]. They contended that the real issue in the public sector is not just of inefficiency, but pricing and collection of user fees; unless these issues are resolved, public sector performance is unlikely to improve.

The privatization process should not be taken for granted merely by changing the ownership; it should be followed by reforms in the capital sector and restructuring corporate laws and regulations [16].

The study investigated the economic effects of privatization and ownership transfer on the performance of 1184 Chinese firms [17]. They found that a combination of state and private ownership, i.e., partial privatization, is the best-performing ownership model for Chinese firms. Overall, the most appropriate choice for reforming SOEs is ownership transformation, which effectively increases performance and attracts private capital to state-owned enterprises. The impact of state ownership on efficiency was examined on a sample of 114 largest Russian companies [18]. The study considered the direct and indirect impact of state ownership separately. It was found that, there was no discernible link between profitability and performance qualities in these businesses. Increases in direct government ownership lead to decreased labour productivity and profitability, according to the study; the influence of indirect government ownership, on the other hand, appears to be more convoluted.

To investigate the relationship between ownership structure and performance for a sample of 1034 firms for 2000–2004. The results concluded that private block-holdings are beneficial to firm value. Further, the firms without or with low state participation, private block-holdings may hamper the firm value of such smaller firms [19]. In addition, a negative association is found between state ownership and corporate value, corporate increases when the government transfers more than 45 percent shares [20].

The mixed empirical results could be attributed to various model assumptions, firm performance metrics, time period and sample selection techniques. For example, studies [12, 15] have relied on OLS techniques and non-parametric tests to study financial performance. They used two-stage least-squares analysis to analyze balanced panel data [19]. In addition, all non-financial PLCs were considered in the study [8]. On the other hand, the study employed the fixed-effect panel model for the time period 2006–2014 [19].

They concluded that more significant degrees of government ownership have a more negative influence on performance in the competitive sector than lower levels [21]. Private firms, central public sector enterprises (CPSEs), and CPSEs with limited state shareholding outperform those with significant state shareholding.[1] The extent of government ownership is to blame for CPSEs' poor performance. Governance difficulties are particularly relevant in nations with insufficient

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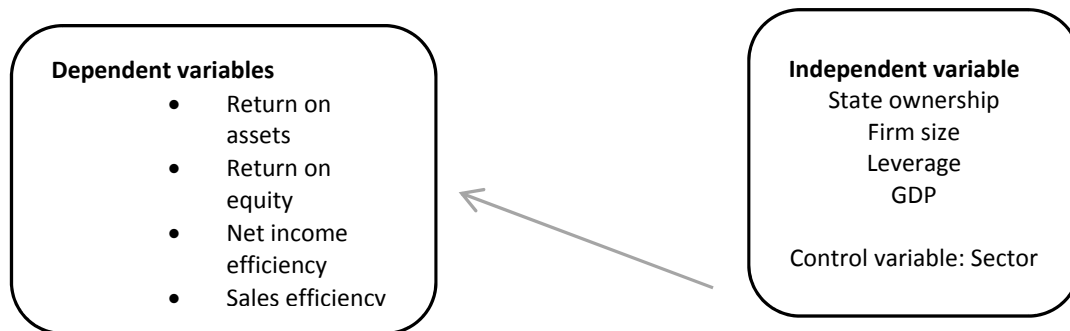
Fig. **Research framework used in the study relating to financial and operating performance variables and control variables for the disinvested PSEs**

Source: based on reviews of literature, a research framework developed by the authors.

investor protection, privatization boosts profitability, efficiency, and productivity [23].

Several studies have attempted to study the impact of Privatization on firm performance. However, the relationship between state ownership and performance is yet to be answered. State ownership is used as a proxy variable to represent the effect of Privatization [7, 8, 23, 24]. Studies done in the past have primarily focussed on studying the immediate impact of Privatization using non-parametric tests. Apart from this, other factors such as firm size, leverage, GDP and sector influence the performance of firms. Therefore, this study examines the financial and operating performance of disinvested firms in India, focusing on more than one and a half-decade periods.

RESEARCH METHODOLOGY

The disinvestment, on the other hand, began in 1992. Therefore, the study considers a sample of those disinvested PSEs that have got disinvested after 2000 since the period 2000 onwards marks the strategic disinvestment era. Forty-three non-financial PSEs have been disinvested. The sample size for this research was thirty-two PSEs. The twelve companies were excluded due to a lack of data and mergers. The period of the study is 2001–2018. The research is based on secondary information. The information was gathered from various sources, including capital line and the Department of Public Sector Enterprises website. The Panel data regression analysis is carried out using STATA 14. The study has adopted the following random panel regression model based on the Hausman test results (*Table 3*).

The author examines the financial performance over 11 years using various ratios. The year of disinvestment is set to zero, indicating that the year of disinvestment is not considered. Before and after disinvestment, the mean values of each CPSE for each variable ranged from (−5 to −1) to (+1 to +5). Wilcoxon signed-rank test has been applied to examine the financial performance of the divested firms based on five years before and after disinvestment. However, Wilcoxon signed-rank test does not capture the factors (such as GDP, size, risk, leverage, sector) that may influence the financial performance of firms. Fixed/random panel regression was applied to analyze data and affirm the results achieved through a non-parametric test.

$Perf_{it} = \alpha + \beta_1 stateownership_{it} + \beta_2$ Firm Specific Variables$_{it} + \varepsilon_{it}$

a = Intercept/Constant

b1, b2, b3, b4......... bn = slopes/coefficients of regression

X1, X2, X3, X4,......Xn = Independent variables that influence the performance of the dependent variable

€n = Error terms or residuals having a normal distribution with a mean of 0 and constant variance of σ^2.

Variables
Dependent variables
Profitability

Return on assets: The return on assets (ROA) is a metric that evaluates the income earned by a company's assets. This metric measured

how effectively the organization is leveraging its total assets to generate profits. It was computed by dividing EBIT by the firm's total assets [25].

Return on equity: It assesses how well the company manages the money it receives from shareholders. In other words, it reflects the company's profitability in terms of shareholder equity. It was computed by dividing earnings after taxes by shareholder's fund [26, 27].

Operating efficiency

Net income efficiency: It was computed as earnings after taxes divided by the number of employees [28].

Sales efficiency: It was computed as net sales divided by the number of employees. Excise duty, commission, rebates, and discounts are not included in net sales [6].

Independent variable

State ownership The percentage of state ownership owned by the government after disinvestment/privatization. Similarly, it was found that enterprises with less than 50% state ownership outperform others in terms of financial performance [17]. On the other hand, a high percentage of state ownership results in worse efficiency due to soft cover-age, debt elimination, and other factors [9]. The study plans to test this again in these situations, thus predicting a negative relationship between the variables of State and PER.

Firm size: It is thought that too large enterprises may not perform well due to corruption or difficulty controlling and operating PSEs. It is calculated as a logarithm of total assets [20].

Leverage: The amount of debt a company has an impact on its performance. Total debt/total equity is how it is determined [29, 30].

Economic growth: Gross domestic product (GDP) is considered to measure the impact of economic growth. The GDP impacts every part of the firm's production and business process, including material prices, labor costs, and sales [23]. As a result, it is postulated in this research model that economic expansion has a favorable impact on firm financial performance.

Table 1

VIF table

Variable	VIF	1/VIF
State ownership	1.01	0.9235
Firm size	1.07	0.9319
leverage	1.12	0.8817
Economic growth	1.32	0.7262
sector	1.05	0.8312
Mean	1.10	

Source: author's compilation, STATA 14 software.

Control variable:
Sector: Dummy variable. 0 considered for the service sector and 1 for the manufacturing sector [31].

FINDINGS AND DISCUSSION

Variance Inflation Factor has been calculated to check for multicollinearity (*Table 1*). VIF falls between 1.01 and 1.32, and the mean is 1.10. Since the VIF value is less than 10, there is no multicollinearity [32]. Finally, autocorrelation was checked using Durbin-Watson. The Durbin-Watson test is used to determine the independence of error terms or residual autocorrelation. There appears to be autocorrelation of residuals in the established regression models because the calculated Durbin-Watson value (4.251) is greater than the necessary benchmark value (3.00).

To see if there was any heteroskedasticity in the data, the Wald test was used. The findings corroborated autocorrelation and heteroskedasticity. For this, **Robust panel regression results are shown** (*Tables 4 and 5*).

Several researchers have employed the OLS technique to measure the impact of state ownership/privatization on firm performance. However, this technique overlooks the problem of heterogeneity of the data. Therefore, the study employs an appropriate panel data regression model to address this issue (fixed effect panel or random effect panel).

Wilcoxon signed-rank test analysis: Pre and Post impact of disinvestment on profitability and operating efficiency

Performance Indicators	N	Mean (Median) Before Disinv.	Mean (Median) After Disinv.	Mean Change	Z statistics	Sig (Two-Tail)
Profitability						
Return on Assets	32	0.2412(0.2021)	0.2217(0.1951)	−.019(0.007)	−0.507	0.144
Return on Equity	32	0.1561 (0.1366)	0.1421(0.1235)	−.014(0.0131)	−0.633	0.527
Efficiency						
Net inco. Effic.	32	0.6623 (0.6323)	1.0521(0.9925)	0.3898(0.3602)	−1.011	0.001*
Sales Efficiency	32	0.7821 (0.7978)	1.5123 (1.012)	.7302(0.2142)	−1.202	0.003*
Payout						
Dividend Pay-out Ratio	32	20.311 (19.5231)	22.711 (21.3151)	2.4 (1.792)	−1.647	0.04**
Leverage						
Debt to equity ratio	32	0.0039 (0.0011)	0.0019 (0.0008)	−.002(0.0003)	−1.408	0.259
Employment						
Total no. of employees	32	14261 (8235)	11721 (6329)	−2540 (1906)	−2.062	0.029**

Source: author's compilation.

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

The dynamic panel regression model provides robust standard error estimates and controls the heteroskedastic distortions [33]. Further, the panel data estimation is the best technique to capture the time and cross-sectional variance

Wilcoxon signed-rank test analysis

The Wilcoxon signed-rank test (shown in *Table 2*) shows that ROA and ROE have decreased after disinvestment. Before disinvestment, the mean (median) ROA and ROE were 0.2412 (0.2021) and 0.1561 (0.1366), respectively, while after disinvestment, they were 0.2217 (0.1951) and 0.1421 (0.1235). However, because the P-value is more than 0.10, the decline is statistically insignificant.

On the other hand, the mean (median) of net income productivity improves from 0.6623 (0.6323) to 1.0521 (0.9925) after five years of disinvestment with a p-value of 0.001. Similarly, Sales productivity appears to be improving, as the mean (median) value rises from 0.7821 (0.7978) to 1.5123 (1.012) after disinvestment, with a p-value of 0.03. In addition, the mean (median) dividend payout ratio of all firms increased from 20.311 (19.5231) to 22.711 (21.3151) after disinvestment, implying a 2.4-point increase in mean (median) (1.792). At the 1% level, this finding is deemed to be statistically significant.

Furthermore, with a p-value > 0.10, the mean (median) debt/equity ratio falls from 0.0039 (0.0011) before disinvestment to 0.0019 (0.0008) after disinvestment. The mean (median) of the total number of employees, on the other hand, fell from 14261 (8235) to 11721 (6329), a change of −0.2540. (0.1906). The finding is statistically significant.

Panel data regression results

The results of the GLS dynamic model to study the impact of state ownership and other variables are presented in this section. *Table 3* provides the chi-square statistics results, suggesting that the suitable model

Table 3

Hausman statistics

Dependent variables	χ2	P value	Appropriate Model
ROE	4.51	0.4731	Prob ≤ χ2 Random effect panel model
ROA	2.72	0.2231	Prob ≤ χ2 Random effect panel model
Sales efficiency	1.51	0.8187	Prob ≤ χ2 Random effect panel model
Net income efficiency	1.22	0.3122	Prob ≤ χ2 Random effect panel model

Source: author's calculation, STATA 14 software.

Table 4

Impact of state ownership on the profitability of disinvested PSEs

Variables	ROA (Model 1)			ROE (Model 2)		
	Coeffi.	Rbt S.E	P-value	Coefficients	Rbt. S.E	P-value
State	−1.011	0.001	0.002*	−0.721	0.003	0.013**
Firm size	0.212	0.646	0.022**	0.0021	0.0061	0.000*
Leverage	−3.22	0.086	0.000*	−2.175	0.132	0.121
GDP	1.79	0.021	0.021**	0.884	0.0211	0.111
sector	−0.436	0.052	0.251	−0.144	0.0612	0.091***
Adj.Rsquare(b/w)	0.6321			05825		
rho	0.6545			0.6223		

Source: author's calculation, STATA 14, Dependent variables, return on assets, and return on equity showing statistical significance at 1%, 5%, and 10% as *, **, and *** respectively.

Table 5

Impact of state ownership on the efficiency of disinvested PSEs

Variables	Net income efficiency (Model 3)			Sales efficiency (Model 4)		
	Coeffi.	Rbt S.E	P-value	Coefficients	Rbt. S.E	P-value
State	−0.012	0.012	0.001*	−0.035	0.0012	0.002*
Firm size	0.0221	0.0032	0.081***	0.053	0.0047	0.655
Leverage	−0.321	0.0010	0.001*	−.0109	0.0025	0.637
GDP	0.0812	0.030	0.121	.1861	0.045	0.000***
sector	−0.0035	0.0158	0.132	−.0241	0.0251	0.001*
Adjusted R-square	0.6045			0.5711		
Rho	0.6278			0.6023		

Source: author's calculation, STATA 14, Dependent variables, net income efficiency and sales efficiency showing statistical significance at 1%, 5%, and 10%.

is the random effect model because the χ2 is insignificant in all four models. The firms' profitability is represented by the first two dependent variables, whereas sales efficiency and net income productivity are used to describe the efficiency per employee.

Table 4 represents the results for model 1 and model 2. The impact of state ownership and other variables on return on assets and equity has been empirically tested. The results indicate there is a negative impact of state ownership on the profitability parameters. Regarding the effect of state ownership, on return on assets, since the beta coefficient of state ownership is –1.011 and the P-value is equal to 0.001, less than 1 percent (P-value 0.001 < 0.01). It can be concluded that state ownership has brought a significant negative impact on firms' return on assets. In other terms, lower state ownership or a greater extent of disinvestment is better for profitability. Privatization involves dilution of state shareholding in the public sector enterprises. As the government loses its shares in the firm, the results indicate profitability improves.

Further, the study examines the impact of variables other than state ownership that influence the firms' profitability (*Table 4*). The firm-specific variable's effect has also been analyzed for the profitability of the firms. The firm size, leverage, and GDP of the firm significantly influence the return on assets of PSEs. The negative beta coefficient of leverage shows that one unit change in the leverage ratio leads to a –3.22 change in return o assets. Firm size measured by the log of total assets has a coefficient of 0.212, P-value is 0.022, less than 5 percent (P-value 0.022 < 0.05). In contrast, the country's economic growth positively affects the firms' return on assets, β = 0.0812 with p-value equals 0.021 (P < 0.05). The performance of the manufacturing sector is having an insignificant negative impact on the ROA of the PSEs.

State ownership and return on equity exhibit similar results as obtained in model 1. State ownership has a negative impact with β = –0.721, significant at 5 percent, and P-value equals 0.013 > 0.01. The negative impact of state ownership on ROE is validated by this negative impact as evidenced by beta value. Coming to the firm-

specific variables, firm size is reported to impact return on equity positively. This finding aligns with most past research findings, which claim that the largest privatized firms earn more profit due to economies of scale. Firm size has a beta coefficient equal to 0.0021, significant at a confidence level of 99 percent (P-value < 0.001). GDP also positively influences the firms' return on equity, with β = 0.884, insignificant at 90 percent confidence level (P-value > 0.10). In contrast, leverage has a negative impact on ROE.

Table 5 reports the panel data regression results, showing the impact of state ownership on the productivity of the disinvested firms. Productivity has been measured with net income efficiency and sales efficiency — the results obtained in models 3 and 4 are similar report findings to models 1 and 2. There is a negative relationship between state ownership and net income efficiency. The P-value is 0.001, less than 1 percent, with a beta coefficient equal to –0.012. The negative coefficient and the significant P-value rejects the null hypothesis that state there is no significant impact of state ownership on the productivity of disinvested PSEs. The variables that significantly impact the net income productivity of disinvested public sector enterprises are size and leverage. The p-values are 0.081 (P < 0.10), 0.001 (P < 0.01), significant at a confidence interval of 90 percent and 99 percent, respectively. The beta coefficients of size and leverage are reported as β = 0.0221 and –0.321, respectively. Similarly, regression analysis shows a negative beta coefficient of state ownership to sales productivity. The β coefficient is –0.035 significant at 99 percent confidence interval (P-value < 0.01). Firm size, leverage, GDP, and sector also influence the sales productivity of the disinvested firms. The positive β coefficient shows a positive impact except for leverage, and the sector with β coefficients are –.0109 and –0.0241. The former is insignificant as P-value > 0.10 and the latter is significant with a P-value of 0.001.

CONCLUSIONS

Wilcoxon signed-rank test analysis reveals that disinvestment has not significantly improved ROA and ROE parameters even after five years

of disinvestment. The fundamental reason for this is because the Indian government has traditionally placed a high value on partial disinvestment. However, even though the strategy has switched from partial to strategic disinvestment, the process has been prolonged.

The results further show that the operational efficiency of disinvested PSEs has significantly improved. The improvement could probably be due to the reduction of employees. The government had introduced a voluntary retirement scheme for the employees.

Dividend payout ratio and no. of employees have shown improvement after five years of disinvestment, and leverage has insignificantly declined. The decline in leverage is because of the availability of a cheaper source of finance.

The results exhibit a negative relationship between state ownership and performance (ROA, ROE, net income efficiency, and sales efficiency parameters. The findings show that the higher the level of state ownership, the worse the performance of such disinvested PSEs. All agree that the smaller the state ownership, the better the performance of public businesses [8, 9, 24, 34].

Property rights and agency theory explain why there is a negative link between state ownership and firm performance. Higher state ownership would mean more engagement of state agents, which would negatively affect firm performance. State agents are more concerned with their interests than with the firm's performance. In addition, firm performance is hampered by increased bureaucratic control.

However, the change in ownership from public to private does not guarantee performance improvement. Other institutional changes must accompany it. The transition from public to private ownership impacts a company's performance by increasing its economic efficiency. However, ownership alone will not increase a company's success.

To ensure that CPSE performance improves as a result of changing ownership from public to private, public authorities must implement other reform measures such as increasing financial and managerial autonomy, executing performance contracts, listing on stock exchanges and implementing corporate governance principles among others [5].

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International Experience of Long-Term Budget Projections: National and Subnational Levels

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ABSTRACT

The **subject** of the research is the approaches used in foreign experience in the formation of forecasts of budget parameters for the long term. The study **aims** to determine the quality criteria for national and regional long-term budget projections based on the best practice of developed countries. In foreign practice, the question of choosing preferable solutions for long-term budget projections remains open. In Russian studies, some of the above issues are highlighted as of the first decade of the 2000s and require updating, and the foreign regional experience on the use of the long-term budget forecasting lacks detailed analyses. This substantiates the **relevance** of this study. The **novelty** consists in highlighting the list of "best practices" in implementing long-term fiscal projection for the national and subnational levels based on the study of the experience of foreign countries. To achieve this goal, the author uses **methods** of a comparative analysis of international experience in building budget forecasts, system analysis, and analogy. As a **result**, a list of criteria that meet the good practices of developing long-term budget forecasts has been formed. It is proposed to determine the forecasting horizon within 30–50 years, generate forecasts annually or with a specified frequency if there is a mechanism for updating them. The authors conclude that developing forecasts on a scenario basis using the principle of continuity in relation to the estimates obtained and forecasting methodology, as well as assessing the sensitivity of budget parameters to exogenous factors and budget sustainability are necessary characteristics of long-term budget projections. **Prospects** for the study consist in studying methodological solutions for forecasting budget parameters and developing tools for the regions of the Russian Federation for calculating indicators of long-term budget projections.
Keywords: long-term budget projections; fiscal sustainability; international experience; subnational budgets

INTRODUCTION

The world's leading economies recognize the importance of assessing the prospects for the development of public finances in the long-term perspective. Long-term budget projections make it possible to trace the prospects of the current fiscal policy from the point of view of the sustainability of the budget system in the future in the context of certain demographic trends [1]. In this regard, in world practice, the majority of documents containing long-term budget projections include the analysis of fiscal sustainability. The long-term budget projection is based on the assumptions that the main trends in terms of demographic characteristics, micro- and macroeconomic indicators will continue. If the long-term forecast shows the sufficiency of budget revenues to address priority tasks and the absence of a "pyramidal" increase in the deficit and public debt, then the current fiscal policy is recognized as sustainable. Otherwise, it can be concluded that the existing approaches need significant adjustments [2].

Long-term budget projections are a relatively new tool that has been actively used around the world since the 1990s. In Russia, the first long-term budget projection was approved by the Government of the Russian Federation in 2019. International organizations have not yet formulated comprehensive and detailed recommendations on documents containing forecasts of the state of public finances for a long period. Determination of more general solutions or individual successful "point" mechanisms is carried out through a comparative analysis of the experience of different countries and the selection of best practices based on expert opinion.

Long-term forecasting is primarily associated with the function of the central government. At the same time, demographic issues are relevant to all levels of government, making this fiscal policy instrument suitable for use at the subnational level. The formation of such documents by region allows determining the risks that may arise as a result of changes in socio-economic conditions while maintaining the current policy, as well as, if necessary, adjusting budget decisions.

In foreign practice, the topic of forecasting long-term budget parameters has been thoroughly elaborated for the national level, which cannot be said about the regional aspect of long-term budget projections.

The experience of the subnational level is hardly mentioned in scientific works, without considering the content of the relevant documents, approaches to their development, and the relationship with national long-term projections. This gap is partly due to the lower prevalence of long-term fiscal projections at the regional level due to the lack of regulation by the central government. Nevertheless, individual cases allow tracing the possible directions of using the tool under consideration at the regional level.

The works of domestic scientists describe international experience [3–5] and consider some methodological aspects of constructing such projections [6]. The base of the research, as a rule, is the article by B. Anderson and J. Sheppard [7].

The problem of the sustainability of public finances associated with long-term budget projections is considered in dissertations with proposals for possible assessment methods for Russia [8, 9].

The problem of forming long-term budget projections at the subnational level of government has been studied to a lesser extent. Articles by G. Ya. Shakhova with co-authors [10] and A. Deryugin with co-authors [11], dissertation by M. V. Semibratskii [12] are devoted to the construction of such a document by the Russian regions, however, the corresponding foreign practice is hardly presented. At the same time, some countries have accumulated experience in long-term forecasting of the state of regional finances, the analysis of which can be useful for finding solutions to problems urgent for Russian practice.

This article is an attempt to fill the gaps in the study of the problems of forecasting the state of public finances in the long term and to lay the foundation for the development of recommendations for improving Russian practice. The study aims to determine the

quality criteria for national and regional documents of long-term budget projections based on the best practices of developed economies. Through comparative analysis, the use of grouping methods, and analogy, the generally accepted and "best" solutions are identified both in the ideology of developing such documents and their integration into the budget process and in methodological decisions.

The results obtained can become a starting point for further research in the context of the issues raised in relation to Russia, where long-term budget projections are developed at the federal and regional levels every 6 years for a period of at least 12 years based on the forecast of socio-economic development. Despite the influence of legislative norms on the need to develop a forecast from 2015, the first long-term budget projection was approved by the Government of the Russian Federation after 4 years[1] and was not updated after that, although such a mechanism is provided.[2] At present, almost all regions of the Russian Federation have adopted long-term forecasts of budget parameters. These documents focus on forecasting budgetary expenditures and revenues, leaving aside the question of readiness to meet future demographic and macroeconomic challenges while maintaining current policies.[3] As a result, the budget projection looks like an attempt to calculate the exact values of budget indicators for almost two decades without assessing budget sustainability, which is inconsistent with world practice.

Long-term budget projections in domestic practice are still on the path of integration into the budgetary and political process. Thus,

the calculated values of budget expenditures and financial support of state programs for forecasting the federal budget for the long term were not used in the subsequent budget cycle. In its current form, the long-term budget projection tool is divorced from reality: federal and regional projections, together with long-term socio-economic projections, are not updated considering the changed external and internal conditions, including the coronavirus pandemic and anti-crisis state policy. A common feature of sub-federal projections — limited disclosure of the methodology for calculating the parameters of the budget system in the long term — reduces the transparency of forecasting. The lack of a quantitative assessment of the impact of individual exogenous factors (the so-called sensitivity analysis in world practice) on the forecast values of budget parameters narrows the idea of the risks of sustainability of the budget system.

NATIONAL LONG-TERM FISCAL PARAMETERS PROJECTIONS

Long-term budgetary projections and related analytical tools have a relatively short history. Since the mid-1990s the practice of using this tool has expanded significantly and at present most OECD countries have such projections [13]. The forecast horizon ranges from 25 years in South Korea to 75 years in the United States[4] и Канаде, and Canada, and for most countries it is 40–50 years. When forecasting, countries tend to stick to rolling estimates. Forecasting up to a fixed year[5] is carried out by the European Commission for the European Union[6] and its member states both in a separate series of documents on population aging (Ageing reports) and in the annually published debt sustainability reports and overviews of the EU member states stability program.

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[1] Government Decree of the Russian Federation of March 29, 2019 No. 558-r "On approval of the budget projection of the Russian Federation for the period up to 2036". SPS ConsultantPlus.

[2] Paragraph 3, clause 3, art. 170.1 of the Budget Code of the Russian Federation. SPS ConsultantPlus.

[3] Ministry of Finance of Russia. Analysis of the current practice of forming budget projections of the constituent entities of the Russian Federation. 2020. URL: https://minfin.gov.ru/ru/perfomance/budget/policy/?id_57=132277analiz_deistvuyushchei_praktiki_formirovaniya_byudzhetnykh_prognozov_subektov_rossiiskoi_federatsii (accessed on 28.04.2021).

[4] The Financial Report of the United States Government, prepared by the United States Department of the Treasury.

[5] From 2021, long-term projection is carried out until 2070.

[6] Specifications on the implementation of the Stability and Growth Pact and Guidelines on the format and content of Stability and Convergence Programmes. European Commission. URL: https://ec.europa.eu/info/sites/default/files/code_of_conduct_en1.pdf (accessed on 03.05.2021).

Long-term budgetary projection documents are prepared annually in the EU (by the union and member states in accordance with the EU regulation), UK, USA, Canada. In some developed countries, such documents are published at intervals of 3–5 years (Australia, New Zealand, Norway, EU in the case of an ageing report) or on a specific schedule (South Korea, Japan). There is no formal mechanism for unscheduled adjustments to the current projection, but the decision to update the projection outside the accepted schedule can be made "in manual mode" depending on the current situation. Thus, in Canada in 2020, for the first time, an update of the national fiscal sustainability report[7] was published according to a previously established schedule, which considered the consequences of the pandemic and the government's anti-crisis measures.

Regulation of long-term budgetary projections is reduced to the consolidation of general issues: the purpose, the person in charge, the frequency of publication of the document. The methodology and details of the formation of a long-term budgetary projection are not regulated by laws or departmental acts. Disclosure of information on the approach to forecasting certain parameters is distributed directly in the document of long-term budgetary projections. Methodological aspects are also highlighted in the analytical materials of the responsible authority.

In exceptional cases, different departments prepare several long-term projections. The Congressional Budget Office annually publishes the Long-term Budget Outlook[8] for the next 30 years — the dynamics of demographic, economic, and budget parameters, describing several alternative scenarios. The 25-year projections are incorporated by the Office and the Budget into the annual budget message of the President of the United States. The longest-term projections — for the next 75 years — are prepared annually by the country's Ministry of Finance and assess fiscal sustainability.

Long-term projections of fiscal parameters are most often the function of the fiscal policymakers [Australia, USA (State Budget Statement), New Zealand, UK, Norway, etc.]. In the United States (Long-term Budget outlook) and Canada, the Legislative Budget Office is responsible for developing such projections. Documents containing long-term projections of the state of fiscal parameters are not subject to approval by the legislature, but, as a rule, are submitted to it for consideration.

The documents developed in foreign countries devoted to the analysis of fiscal sustainability are similar in content. These are complex reports for a selected period of time with an analysis of the obtained results of forecasting demographic and economic parameters and projections of the state of public finances based on them. Based on the calculated projection values of budget parameters for the long term, an assessment of budget sustainability is carried out. An important result of forecasting and the accompanying study of the obtained values is a list of risks that are present for the sustainability of government finances. In other words, the purpose of such documents is to identify possible financial challenges that the government may face in the long term, given current policies, an aging population, and dynamics of macroeconomic indicators.

It is important to note that long-term projections in foreign countries do not take the form of setting annual targets or thresholds for budgetary expenditures or revenues for the next decades. The projection results can be presented as aggregated directions of expenses for several points of the selected long-term period. The greatest detail of the projections is presented in the form of a functional classification of expenditures, the smaller is the division into expenditures, the dynamics of which is due to demographic changes, and all other expenditures. Considerable attention is paid to the block of demographic and economic parameters, as well as the analysis of budget

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[7] Fiscal sustainability report 2020: update. Office of the Parliamentary Budget Officer. Nov. 2020. URL: https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/RP-2021–033-S/RP-2021–033-S_en.pdf (accessed on 02.05.2020).

[8] The 2021 Long-term budget outlook. Congressional Budget Office. URL: https://www.cbo.gov/system/files/2021–03/56977-LTBO-2021.pdf (accessed on 30.04.2021).

parameters that depend on the aging of the population.

In most countries, long-term projections are done for the general government budget. Australia, New Zealand, the USA, and the UK build such projections for the central government budget. There is also a separate projection for the state of the pension system (for example, in Canada, Norway, UK, Australia). The Government of Canada pays special attention to subnational finance and in the national report presents a projection for all regions of the country, as well as formulates conclusions and recommendations regarding the fiscal sustainability of the Territories.[9]

The approaches to the projection of the long-term fiscal parameters can be divided into two groups: the top-down approach and the bottom-up approach. With the first approach the long-term projections are carried out based on the current goals of budgetary policy (most often, the level of expenditures to GDP, taxes to GDP and government debt to GDP), based on the need to achieve which, the necessary indicators of expenditures or revenues are determined considering possible changes in demographic indicators. According to the second approach, budget parameters are modeled on the basis of the predicted values of demographic and economic parameters, as well as the assumption of the invariability of government policy. There are no restrictions on income, expenses, or budget deficits. As a result, the obtained values of budgetary indicators and indicators of budgetary sustainability are analyzed with modeling of changes in exogenous factors. Long-term projections can be based either on one approach (for example, in Australia, EU, USA, New Zealand, projections are based on a bottom-up approach) or on a combination of the above (UK, Norway).

Long-term budget projection documents are associated with estimates of budget parameters for the medium term. The selected

long-term time horizon is divided into two segments: the coming years and the remaining period for which separate projections are made. The values of the budget parameters in the first segment are duplicated from the actual medium-term budget projections, which, as a rule, are prepared together with the draft budget for the next year. For the second segment, direct forecasting of the values of budget indicators is carried out using the selected prerequisites and the results of calculations of demographic and economic factors. For example, in Canada, the first-time span is 4 years, and the remainder is from 5 to 75 years. In Australia and the United States (Long-term Budget Outlook), medium-term projections are made for a 10-year period and long-term projections are for the remaining years of the 40-year and 30-year periods, respectively.

Budget parameters projection is carried out using economic and mathematical modeling. In global projection practice, as a rule, dynamic general equilibrium models or modeling of the values of fiscal parameters based on their growth rates in the long term are used. The second approach is less formalized, the main task is to select and justify the rate of growth of budget characteristics in the long term. As a rule, the choice is based on an expert opinion on the advisability of using a particular modeling method.

Of all the variety of solutions found in the world practice of long-term projections, the following are the most common.

Budget expenditures are projected separately from expenditures, the volume of which depends on the age structure of the population and all other expenditures that are not affected by the aging of the population. The first includes spending on education, health care, social security (pensions, health insurance, social benefits). The projections of the listed costs depend on the obtained values of demographic indicators in the long term. For all other areas, growth is usually assumed to be proportional to GDP growth.

For budget revenues, the assumption is made that they are constant in relation to GDP

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[9] Fiscal sustainability report 2020: Update. Office of the Parliamentary Budget Officer. Nov. 2020. URL: https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/RP-2021–033-S/RP-2021–033-S_en.pdf (accessed on 02.05.2020).

in the long run, which is determined on the basis of historical values.

The most commonly used forecasting is based on the calculation of the base budget. The projection of fiscal parameters (budget revenues, expenditures, deficit/surplus, public debt) is constructed for a given planning period using a set of assumptions regarding demographic, economic parameters, and the invariability of the current fiscal policy. The last condition implies, in particular, the preservation of the existing tax rates, social transfers (relative to the level of wages), the provision of public services (defense, law enforcement agencies, public administration, etc.). The base budget calculated in this way is used to simulate various scenarios of changes in economic and demographic parameters.

The scripting approach used in many countries can take many forms. A long-term forecast document can be constructed directly for several scenarios — a set of variants of the dynamics of individual exogenous demographic and macro indicators. For each scenario, the predicted values of the resulting parameters and the probability of its implementation are determined. Scenarios can also be used for selected indicators, for example, budget expenditures, budget balances, and public debt depending on the age structure of the population. In this case, the document is formed on the basis of the initial conditions (or the most likely scenario), and when predicting individual indicators of the state of government finances, several options for their values are given, depending on the scenario for some external factor. Another variant of the scenario approach is the assumptions regarding the implementation of a certain set of political decisions. In this case, a long-term projection document is formed according to the indicated scenarios for the implementation of reforms. This practice is rare, for example in Australia when developing a long-term projection for 2015.[10]

An analysis of the sensitivity of the constructed projections of budget parameters to certain exogenous factors can be considered a component of the scenario approach. It consists of a quantitative assessment of the impact of changes in the values of certain demographic and macroeconomic indicators on the projection of fiscal parameters. The values obtained from the analysis, by analogy with the elasticity, show fluctuations, for example, in the indicators of the primary deficit, the fiscal gap when certain exogenous factors change, as a rule, by 1%. All other external variables are considered unchanged. Thus, sensitivity analysis allows calculating the consequences of a change in one particular factor on the resulting budget parameters. This makes it possible to form a vision of the consequences of shocks of certain factors for government finances, as well as to determine the exogenous variables most affecting fiscal sustainability. At the same time, the results of the sensitivity analysis are not related to each other for different external factors, and additional calculations are required to calculate the effect of simultaneous changes in several of them.

Assessing fiscal sustainability is practically an integral part of long-term projections.[11] The method of assessment depends on what is meant by the sustainability of government finances in each particular country. A common definition: fiscal sustainability is the government's ability to finance priority programs, as well as service its debt obligations without critical adjustments to the balance of revenues and expenditures [14]. Also, sustainable development should exclude the situation of increasing debt at a higher rate than the growth of the ability to service it.

The theoretical foundations of methods for assessing fiscal sustainability are laid in the works of J. Horne [15] and O. Blanchard [16]. Evaluation is often carried out through the calculation of the fiscal gap indicator, in which, by means of an intertemporal budget constraint, the indicators of budget revenues

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[10] Intergenerational Report 2015. Treasurer of the Commonwealth of Australia. URL: https://treasury.gov.au/sites/default/files/2019–03/2015_IGR.pdf (accessed on 01.05.2021).

[11] For example, Australia's long-term report does not provide a calculation of fiscal sustainability indicators, and the analysis of the results of long-term projections indirectly affects the problem of fiscal sustainability.

and expenditures are linked for a selected time interval.

The calculation of the fiscal gap (Δ) is carried out according to the following formula[12]:

$$\Delta = \dfrac{D_t - \prod_{i=1}^{k}\left(\dfrac{1}{1+i_{t+i}}\right) \times d^* \times \overline{Y_{t+k}} - \\[2ex] -\sum_{i=1}^{k}\prod_{j=1}^{i}\left(\dfrac{1}{1+i_{t+j}}\right) \times \overline{PB_{t+i}}}{\sum_{i=1}^{k}\prod_{j=1}^{i}\left(\dfrac{1}{1+i_{t+j}}\right) \times \overline{Y_{t+i}}},$$

where D — the size of the public debt; i — the interest rate of debt service; d^* — the ratio of government debt to GDP at the end of the period; PB — the value of the primary budget balance; Y — projected values of GDP; k — the projection period.

The desired level of debt burden (d^*) is usually taken as the ratio of the current level of government debt to GDP. For example, in the UK this level is 75% of GDP,[13] in Canada — 28,5% of GDP.[14]

The result of calculating the budget deficit is a specific target value by which it is required to change the indicator of the budget deficit by making budget decisions in terms of increasing revenues and/or reducing expenditures in the short term.

The EU uses the S 2 indicator, specially designed to assess long-term fiscal sustainability, the value of which corresponds to the required annual adjustment of budget parameters over a selected period of time to stabilize the public debt-to-GDP ratio, considering the "price" of population aging. The higher the value of S 2 (it is assumed that the cutoff value is 6% of GDP), the higher

the threat to the sustainability of the budget system and, consequently, the need to adjust expenditures or revenues.[15]

In the context of a large number of uncertainties and prerequisites taken in the development of long-term budget projections, the issue of flexibility of the planning documents for the long-term period deserves special attention. Demographic and economic shocks of long-term projections have become relevant in connection with the 2020 crisis caused by the pandemic of a new coronavirus disease and a decrease in energy prices. The negative socio-economic consequences, together with large-scale anti-crisis packages at the national and subnational levels, increased the burden on budgets and led to an increase in debt obligations at all levels of the budget system. At the same time, most countries where long-term budget projections are not published annually did not update their current estimates, despite the crisis (with the exception of Canada). Australia has postponed the publication of the next projection for a year, despite the statutory schedule for the submission of the document.

Long-term budget projection documents are developed according to the principle of continuity. In case of significant changes in the forecast values, the next document provides an appropriate justification. The most common reasons for adjusting previously published forecast values include a modification of the assessment methodology, a change in the calculation base (the use of more relevant statistical data), and crisis phenomena. An important characteristic, in this case, is the coherence of the developed forecasts and the transparency of the reasons for their change.

A tool that can have a potentially positive impact on the quality of published forecasts is to consolidate the responsibility of the agency that makes the forecast. In New Zealand, this decision is legislative in nature: the head of the Treasury is obliged to sign a section with the

[12] Fiscal sustainability report 2020. Office of the Parliamentary Budget Officer. 2020. URL: https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/RP-1920–029-S/RP-1920–029-S_en.pdf (accessed on 05.05.2021).

[13] Fiscal sustainability report 2020. Office for Budget Responsibility. United Kingdom. 2020. URL: https://obr.uk/fsr/fiscal-sustainability-report-july-2020/ (accessed on 06.05.2021).

[14] Fiscal sustainability report 2020. Office of the Parliamentary Budget Officer. 2020. URL: https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/RP-1920–029-S/RP-1920–029-S_en.pdf (accessed on 05.05.2021).

[15] Fiscal Sustainability Report 2018 // Institutional paper 094. European Commission. 2019;094:1–212. URL: https://ec.europa.eu/info/sites/default/files/economy-finance/ip094_en_vol_1.pdf (accessed on 11.05.2021).

responsibility of the department for the fact that the work in the preparation of the report on the long-term state of government finances is performed at a high professional level.

In the UK Fiscal Resilience Report, the management of the Office of Responsible Fiscal Policy indicates that it takes full responsibility for the forecasts, analyzes, findings, and recommendations presented. However, there is no mention of how this responsibility can be exercised in the listed countries.

The role of long-term budget projections in global practice, as a rule, is reduced to analytical. This is partly facilitated by the development of forecasts outside the executive branch of government, the rare publication of documents of long-term budget projections, the preparation of independent studies and reports that are not included in the budget process. On rare occasions, the government appeals to long-term estimates when making decisions.

In Australia, long-term budget estimates were used to illustrate the impact of decisions made to reform health, education, welfare, and social support in 2014–2015. The results of forecasting several scenarios for the implementation of reforms acted as an additional argument in favor of the option chosen by the government.

FORECASTING SUBNATIONAL FINANCES FOR A LONG-TERM PERIOD

The use of a long-term budget projection tool at the subnational level is less common than at the national level. The preparation of long-term budget projections occurs in a few regions of Australia and Canada. As a kind of subnational experience, one can consider the practice of EU member states in preparing long-term budget projections and analyzing the state of fiscal sustainability. The experience of long-term forecasting at the subnational level in the listed countries is individual and is conditioned, among other things, by national practice. In this regard, the case-based approach to the study of foreign experience seems to be justified.

Note that, with the exception of the EU member states, central governments do not establish regulatory requirements for the formation of documents for long-term budget projections by lower levels of government. The regions independently regulate the need to develop such documents. In general, the main vector of using the long-term budget projection tool is set by the central government.

Australia

New South Wales is the only region in Australia that publishes long-term budget projections. The purpose, content, publication schedule (every 5 years) and the period for which projections are made (40 years), as well as forecasting methodology, largely duplicate the decisions of the federal government for the Intergenerational report. Within the framework of the document, the Ministry of Finance of the region is considering the following issues: demographic changes, the future state of the region's economy, the state of government finances (with a separate analysis of infrastructure costs), upcoming challenges to the balance and sustainability of the state budget.[16] In contrast to federal practice, the state's report calculates the value of the fiscal gap, on the basis of which a conclusion is made about the sustainability of regional finances. It is important to note the connection between regional long-term projections and the federal projection. For example, the calculation of the forecast of future regional budget revenues from federal taxes is based on the projection of the Australian government of the volume of total tax revenues from these taxes.

The document with long-term budget projections is provided as part of the draft budget documents. There is no mechanism for unscheduled adjustments to existing projections. There is no practice of publishing updates to the current report until the year the next document is prepared. Projections are formed according to the principle of continuity, although comparison with previous projections is carried out only for certain indicators, for

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[16] NSW Intergenerational report 2016. Budget paper № 5. URL: https://www.treasury.nsw.gov.au/sites/default/files/2017–01/Budget_Paper_5_-_Intergenerational_Report_2016_-_full_report.pdf (accessed on 11.05.2021).

example, for the budget deficit. So, in 2012, the projection of the budget deficit for the long term was estimated at 2.8% of the GRP, and the actual value — 3.4% of the GRP. This change is due to the decisions of the federal government to reduce funding for health care costs, which significantly increased the burden on regional budgets.

The Ministry of Finance does not include information on the forecasting methodology in the document, but this information is presented in the analytical documents of the department. The long-term projection is based on a baseline scenario, although a scenario is presented that lacks the healthy population aging to illustrate the impact of population aging on the fiscal balance. For the budget deficit indicator, the results of a sensitivity analysis to changes in factors such as net population migration at the national level, labor force participation, labor productivity, and efficiency of public service delivery are presented.

There is no information on the use of the results of long-term projections in the process of budgetary or strategic planning.

Canada

A distinctive feature of long-term projections in Canada is the analysis of the state of regional budgets for each constituent entity of the federation in the national Fiscal Sustainability Report. The Budget Office of the Parliament, which prepares this document, considers the issue of inter-budgetary relations and calculates the forecast values of fiscal parameters, as well as the indicator of the fiscal gap for each region over a 75-year horizon. Thus, in the country, the budgetary sustainability of all subjects of the federation in the long term is assessed in a centralized manner, which is advisable in the absence of such an analysis at the subnational level.

The Province of Ontario is the only region where long-term budget projections are being implemented: by the Ministry of Finance since 2005 as part of a document analyzing the state of the regional economy in the long term, by the Committee on Budgetary Responsibility of

the Legislative Assembly of the region since 2017 in the form of an independent document.[17] The basic provisions for the development of the first of the listed documents have been normatively regulated, while the second is being developed within the framework of the general provisions on the functioning of the Committee. The frequency of publication of the document of the Ministry of Finance is linked to the regional general elections, 2 years after which the minister is required to provide an assessment of the state of the economy and demographic characteristics and their potential impact on government finances of the province in the next 20 years. The frequency of preparation of long-term projections of the Committee is not regulated, but, based on current practice, it is 2 year.

Unlike the federal experience, as well as decisions of other countries, the long-term report of the Ontario Treasury does not contain forecast values of budget indicators.[18] Instead of calculated projections for the next 20 years, general directions of changes in regional finance (dynamics of demand for public services, growth of budget revenues, budget balance, public debt), as well as factors affecting this, are formulated. The specification of risks, as well as recommendations for changing the current budgetary policy, are not included in the document. According to the content, the long-term report of the Ontario Ministry of Finance is a long-term socio-economic forecasting document with a detailed analysis of demographic and economic characteristics using a scenario approach.

The Committee's long-term budget projection is more consistent with world practice. The document is being developed for a fixed period until 2050. The current version is built for two scenarios: baseline and alternative, which are highlighted on the

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[17] Long — term budget outlook. Fiscal implications of the government's program transformation: 2020–2050. Financial Accountability Office of Ontario. 2019. URL: https://www.fao-on.org/web/default/files/publications/EC 1905%20LTBO/LTBO%20Fiscal_2020.pdf (accessed on 13.05.2020).

[18] Ontario's long-term report on the economy. Ministry of finance. 2020. URL: https://files.ontario.ca/mof-long-term-report-book-2020–06–03-en.pdf (accessed on 14.05.2021).

basis of successful long-term maintenance of the achieved medium-term goals that have been set to significantly restrain the growth of budget expenditures in key areas (health care, social security, education). The Committee calculates budget revenue figures (for the baseline scenario only) broken down into three components: provincial tax revenues, federal transfers, and miscellaneous revenues. Cost projections are performed for total program costs, and separately for health, education, miscellaneous, and infrastructure costs for baseline and alternative scenarios. Forecasting methodology disclosed by the Committee in the document.

The Committee focuses on analyzing the results of the baseline and alternative scenarios in terms of indicators of the provincial budget deficit and the dynamics of the level of the public debt of the region but does not calculate indicators of fiscal sustainability. Compared to the long-term projection of the Ministry of Finance, the projection of the Committee is more devoted to assessing the future state of regional finances and is consistent with national and world practice. We also note that the budget projection of the Committee is formed according to the principle of continuity in terms of using the scenario approach and comparing the projection results in the document for 2017 and 2020. In both reports, the criterion for identifying scenarios is a package of budget reforms announced by regional authorities. As in the case of the federal budget projections in Australia, the Committee's projection serves as a certain argument in favor of the implementation of the regional authorities' plans for budget reforms.

The Ontario case is a prime example of how the region is adopting its own vision for long-term projections and fiscal sustainability analysis. The regional executive power does not concentrate on quantitative estimates of the future parameters of the regional budget but formulates general conclusions about the directions of changes in regional finances in connection with the projected changes in the demographic profile of the region and the economy. This solution simplifies the analysis

of the state of regional finances but reduces the practical value of conclusions about long-term trends and issues that may arise. This deficiency is compensated by the developed projections within the legislative branch of government, as well as national projections of the budget parameters of the regions.

European Union

For EU member states, the format, content and frequency of submission of long-term budget projections are determined by supranational regulation by the European Commission. The experience of, for example, Germany and Sweden is interesting, where, in addition to the EU requirements for the analysis of fiscal sustainability within the framework of the annually published Stability Programmes, there is a national practice of long-term budget projections. The listed countries are preparing national documents of long-term budget projections, which are more detailed in comparison with the Stability Programmes.

EU member states, following EU regulation, provide information on the long-term sustainability of national finances until 2070 in the annually published Stability and Convergence programmes. Due to this, the period of long-term fiscal projections and analysis of sustainability at the level of each country is synchronized with the forecast period of the higher level of regulation.

Updating country projections is being implemented according to the publication schedule of the annual Stability Programmes, before which no changes were made to last year's report. Moreover, in the context of the coronavirus pandemic, in accordance with the EU recommendations, the member states of the Union were exempted from the requirement to publish a long-term assessment of fiscal sustainability as part of the Stability Programmes for 2020 and had to focus on the medium-term consequences of the crisis and the accompanying anti-crisis policy. The sustainability programmes prepared in 2021 include information on long-term trends, but in a less detailed format than the pre-crisis programmes.

The Ministry of Finance in *Germany* periodically (on average every 4–5 years) prepares a report on the sustainability of public finances.[19] Contrary to common practice, the last three long-term reports in Germany are not carried over. Long-term budget projections are based on the period for which the population is projected (50 years). As such, the Sustainability Reports for 2011, 2016 and 2020 include projections to 2060. The forecast is based on the country's consolidated budget under two scenarios: optimistic and pessimistic, depending on the long-term dynamics of demographic and economic factors. Medium-term projections of budget parameters for the first 4 years of the 50-year projection period are integrated into the long-term report.

Fiscal sustainability is assessed by calculating the S 2 indicator. The Ministry of Finance is conducting a sensitivity analysis and impact assessment for S 2 due to changes in factors such as fertility, life expectancy, unemployment rate, etc. Based on the forecast results and conclusions regarding the sustainability of public finances in the long term, the report formulates proposals for fiscal measures. social security policy and improvement.

In *Sweden*, the National Institute for Economic Research (NIER), subordinate to the Ministry of Finance, is responsible for the annual preparation of fiscal sustainability reports. The purpose of developing long-term projections is to identify imbalances in the budgetary system at an early stage for necessary adjustments to fiscal policy. Projections are carried out on a scenario basis, calculations are given for 5 alternative scenarios, for example, the absence or slower improvement in the quality of social services, removal of the prerequisite for healthy aging of the population and later retirement, etc.[20]

In general, the document is prepared for the period up to 2100 however, most projections of the dynamics of budget indicators are presented until 2050. Comparisons are made with previous projections, as well as projections prepared by other institutions (for example, the Ministry of Finance). Fiscal sustainability is assessed by calculating the S 2 indicator.[21]

Sweden is good practice when it comes to using the results of long-term projections in the political and budgetary process. The rationale for the chosen value of the fiscal rule in relation to structural surplus during the business cycle[22] or its change[23] is mainly based on the government's ability to respond to long-term demographic challenges. For example, the introduction of the target surplus in 2000 was dictated, inter alia, by the need to achieve long-term sustainability of public finances and respect for the principle of generational equity.

CONCLUSIONS

Based on the results of the analysis of foreign experience in long-term budget projections, we will formulate some solutions that are recommended in order to improve the quality of the relevant documents:

• the planning horizon for the national level can be chosen by analogy with the most widespread in the world practice — 30–50 years, for the subnational level, a similar or smaller (within 20 years) projection horizon seems to be optimal;

• projection is carried out on a sliding basis;

• the mechanism of integration of medium-term projections into documents of long-term budget projections is used. It is worth

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[19] Report on the Sustainability of Public Finances 2020. Federal ministry of finance, Germany. URL: https://www.bundesfinanzministerium.de/Content/EN/Standardartikel/Press_Room/Publications/Brochures/2020–06–25-Sustainability-Report-2020.pdf?__blob=publicationFile& (accessed on 12.05.2021).

[20] The Long-Term Sustainability of Sweden's Public Finances/ The National Institute of Economic Research. 2015;43. URL:

https://www.konj.se/download/18.2de531e0151549bd6822b9af/1448875883622/The-long-term-sustainability-of-swedens-public-finances.pdf (accessed on 14.05.2021).

[21] Fiscal frameworks and fiscal sustainability in Nordics/ Calmfors L. Nordic Council of Ministers. 2020:1–176. URL: http://dx.doi.org/10.6027/Nord2020–004 (accessed on 14.05.2021).

[22] The Swedish Fiscal Policy Framework. Ministry of Finance, Sweden. 20211. URL: www.government.se/sb/d/14625/a/164299 (accessed on 13.05.2021).

[23] A new surplus target. The Swedish Economy. The National Institute of Economic Research. 2016. URL: https://www.konj.se/download/18.4ff3f2ff156ddcbd8252ef0a/1472651484546/A-new-surplus-target.pdf (accessed on 13.05.2021).

considering the practice of some developed economies, where medium-term projections prepared within the framework of the budgetary process are developed for a 10-year period;

• documents of long-term budget projections include a comparative analysis of previously made projections. Any changes from previous projections are justified in the document. Thus, the continuity of the developed projections is ensured, as well as the basis for assessing the projection quality is formed;

• the general approach and projection methodology, as well as their changes in comparison with previously published projections, are disclosed in the long-term projection document. Such a solution increases the transparency and quality of projection documents. There is a widespread practice of publishing basic information about the assumptions used and adjusting them as part of projection documents. Specification of the calculation methodology can be implemented in the methodological materials of the responsible executor;

• the most common frequency of publication of long-term budget projections is annual. Such a solution, firstly, makes the long-term projection tool more flexible; secondly, it eliminates the need to introduce a mechanism for unscheduled adjustments to the published projection; thirdly, it makes it possible to timely illustrate the current demographic, economic, and political changes;

• development of a scenario-based projection. This solution allows outlining the directions of changes in the main fiscal indicators under certain conditions. The identification of scenarios should be carried out according to the same principle in the documents of long-term projections to ensure the comparability of forecasts, and their number should be limited;

• analysis of the sensitivity of the constructed projections to fluctuations in the values of determining factors of a demographic and economic nature. Evaluation of changes in fiscal parameters in response to changes in exogenous variables makes it possible to determine the limits within which budget parameters may be located, including in the event of shocks;

• ensuring the responsibility of the department — the developer of the long-term projection document for the quality of forecasts. To this end, it is important to introduce monitoring and evaluation of long-term budget projections according to criteria such as the feasibility and accuracy of forecasts, compliance with legal regulations, transparency of projection methodology, continuity of forecasts, and justification of any changes and adjustments. If the projections do not meet the listed criteria, then a public report of the department with appropriate explanations should be provided;

• using the results of long-term projections in the development and selection of political decisions. The rationale for certain reforms should include the long-term impact on the state of public finances, including their sustainability. The successful practice of long-term projections is found in Australia, Germany, and Sweden. It is not recommended to use the planned reforms as a criterion for identifying scenarios, since such an approach is not relevant in the framework of several consecutively published projection documents and will lead to incomparability of the latter;

• inclusion in long-term budget projections of an assessment of fiscal sustainability, for example, by calculating the size of the fiscal gap at the end of the projection period. Concluding that the fiscal system is unstable in the long term, the document includes conclusions on the necessary changes in fiscal policy.

The listed solutions can be considered as characteristics of the quality of documents for long-term budget projections. Changing existing practices, considering the mechanisms listed above, will facilitate the introduction of long-term projections as an active tool in fiscal policy at all levels of government, instead of the current function of a source of additional information, weakly related to policy decisions.

Considering the best solutions from world

practice listed in this article, in further work it is advisable to formulate directions for adjusting the Russian approach to long-term budget projections at the federal and regional levels. To change the role of the instrument, it is proposed to focus on the vision of developed countries: long-term budget projections allow analyzing socio-economic trends, assessing the implementation of external and internal risks, and calculating the consequences of political decisions in projection onto the budgetary system. A long-term budget projection is not a plan for the values of long-term budget parameters, but a complex, analytically developed document showing the impact of future demographic and economic trends on the state of public finances. The main purpose of forecasting is to identify potential risks to the balance and sustainability of the budget system, which should be considered when making political decisions.

Proposals for improving long-term projections in Russia include expanding the projection horizon to at least 30–40 years at the federal level and up to 20 years at the regional level with a revision of the frequency of publication of projections in favor of more frequent development of a document. Such a change requires expanding the strategic planning horizon, on the basis of which budget projections are developed. The documents should be formed on the basis of continuity, and not from scratch, and compared with previously published budget projections, followed by substantiation of discrepancies in the values obtained. Developing a forecasting quality control mechanism will also help change the instrument's role in fiscal policy. In connection with the generally recognized high uncertainty of long-term projections, it is important to assess the impact of changes in external factors on the parameters of the budget. The introduction of the global assessment of the sensitivity of budget projections into Russian practice will make it possible to determine exogenous factors, the shocks of which will most strongly affect the state of the budget system.

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Priority Development Areas as a Tool for Enterprises Support in Russian Monotowns

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ABSTRACT

This paper **aims** to estimate the effectiveness of the Priority Development Areas (PDA) program in Russian monotowns at the firm level. Using data from the SPARK-Interfax database on Russian companies in 2014–2018, the authors estimate the effect of the PDA residency on the firms' revenue growth in monotowns in Russia. The authors test two hypotheses. First, the status of the PDA resident is obtained by firms that have been successful in previous periods. Second, the PDA resident status does not have a positive effect on firm growth. To measure the treatment effect, the authors use the nearest neighbor propensity score matching **method**, which allows drawing conclusions about causality, as opposed to the ordinary least squares (OLS) method. The regressions consider the firm size, industry, and geographic location of the city. According to the **results** of the study, both hypotheses are confirmed. Resident status is determined by the gains in the company's revenue for the two previous periods (the coefficients are significant in all specifications at the 5% level). The influence of residency on the firm's revenue growth is neglected (becomes insignificant) when comparing enterprises with the same pre-2015 trends. Thus, the authors **conclude** that the success of the PDA program in Russian monotowns in terms of business support is questionable. The findings of the study are valid for enterprises established before 2015.

Keywords: monotown; city development; priority development area; spatial development; industry structure; nearest neighbor propensity score matching; SPARK; firm size

INTRODUCTION

A dilemma between equalization of territories and stimulating growth in the most developed regions arises when implementing a spatial policy[1] [1–3]. Both goals are outlined in the Strategy for the Spatial Development of Russia until 2025,[2] where also mentioned the problem of the development of single-industry towns (monotowns).

Many monotowns are facing the problem of excessive monopolization associated with the presence of a city-forming enterprise. This situation complicates the implementation and development of any other entrepreneurial activity [4]. Low-diversified cities, on the one hand, ensure the realization of comparative advantages and contribute to the growth of the country's economy (the so-called Marshall-Arrow-Romer effect takes place) [5, 6]. On the other hand, narrow specialization reduces the resistance of the urban economy to external shocks (the so-called Jacobs effect arises) [5, 7, 8]. Since 2016, Priority Development Areas (PDA) have been created in monotowns to ensure favorable conditions for accelerated socio-economic development. PDA residency gives businesses an advantage in paying taxes at reduced rates.[3] One of the goals of the PDA program in monotowns is to diversify the economy, stimulate the development of businesses that do not belong to city-forming enterprises.

According to the report "Analysis of the practice of applying preferential regimes, which are in force on the territory of the Russian Federation, in terms of their effect on economic growth and compliance with the stated goals" of the Accounts Chamber of the Russian Federation (2020)[4] monotowns for the period of 2014–2018 are characterized by a decrease in entrepreneurial activity, which means losing one of the growth points of the city.

Following the report of the Accounts Chamber, we note that there are no efficiency indicators of PDA in monotowns, so the development of monotowns is assessed ambiguously.

At the same time, when carrying out the analysis, it is important to note that not all enterprises of a monotown become PDA residents. In this regard, a more detailed analysis at the level of the individual resident and non-resident firms is more relevant than estimating the growth of total factor productivity at the city level, as authors in [9, 10] do. Therefore, we attempt to study the effects of the presence of Priority Development Areas to find out whether the status of a PDA resident has a positive effect on the growth of the firm.

PDA IMPACT ASSESSMENT IN THE SCIENTIFIC LITERATURE

The study [11] presents an estimation of the socio-economic development of cities in the Central Black Earth economic region of Russia, considering two indicators of the city's mono profile: the share of a city-forming enterprise in city-wide production volume, as well as the share of employed at the city-forming enterprise.

Government support for business, aimed at increasing productivity and employment in certain territories, is used in many countries around the world. However, accurate micro-econometric estimates of the effect of this support are rarely found in the economic literature. In [12], various criteria

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[1] World Investment Report 2019: Special Economic Zones. 2019:127–206. URL: https://unctad.org/system/files/official-document/wir2019_en.pdf (accessed on 19.05.2020).

[2] Decree of the Government of the Russian Federation of February 13, 2019, No. 207-r "On approval of the Strategy for the spatial development of Russia until 2025". URL: http://static.government.ru/media/files/UVAlqUtT08o60RktoOXl22J jAe7irNxc.pdf (accessed on 02.09.2020).

[3] More details on monogoroda.rf. URL: http://xn-80afd4affbbat. xn — p1ai/work/products/project-office/toser/ (accessed on 02.09.2020).

[4] Report of the Accounts Chamber 2020 "Analysis of the practice of applying preferential regimes in force on the territory of the Russian Federation, in terms of their impact on economic growth and compliance with the stated goals". URL: https://old.ach.gov.ru/activities/control/%D0%9E%D1% 82%D1%87%D0%B5%D1%82%20%D0%BF%D0%BE%20%D0 %BF%D1%80%D0%B5%D1%84%D0%B5%D1%80%D0%B5%D 0%BD%D1%86%D0%B8%D1%8F%D0%BC%2020200330%202. pdf (accessed on 02.09.2020).

are used to select regions for a program to support manufacturing employment. The region selection criteria for the program change every 7 years, therefore, on the next change, the previous criteria were used as instrumental variables for the new selection criteria for participation in the programs. Using instrumental variables, authors identified a positive effect of the program on employment and investment, but not on total factor productivity (TFP). Estimates of the OLS model underestimated the effect of the program because it was originally targeted at lagging businesses and regions. However, the effect of such a program was found only for small firms; there was no effect of the manufacturing employment support program for large enterprises. It was also found that the increase in employment in the sectors included in the support program was due to a decrease in unemployment (and not due to interregional labor migration or migration between enterprises of the same region). The benefit of one new job place creation is estimated at $ 6,300. This result means that subsidies are efficient compared to the cost of paying them.

The European Union actively uses targeted support programs for enterprises and regions. In Italy, the state support program was aimed at providing problem regions with transfers for infrastructure modernization, and then at creating incentives for hiring additional employees. This policy was analyzed in [13]. Similar support measures were carried out in Sweden, France and Germany and were the examined in the study [14].

The government targeted measures to support enterprises and territories were also implemented in Asian countries. Special economic zones were created in China, the effect of which on the local economy was studied, for example, in the research by J. Wang [15]. The author estimate the effect of special economic zones (SEZ) on the total factor productivity (TFP). The author uses the method of propensity score matching: the changes between the municipalities that received the status of a special economic zone in earlier rounds, and those that received this status in later waves are compared. In this matching, the control variables used are: initial output, the number of students per capita, distance to coast, highway density, proximity to an airport or port, post offices and telecommunications per capita, deposits and loans per capita, wages, property prices, and historical trends in total factor productivity. J. Wang found that regions with a special economic zone status attract direct foreign investment, but this do not crowd out investment from residents. However, the effects are heterogeneous: for zones created earlier the benefits of municipalities are larger than for zones created later. It should be noted that the special economic zone does not cover the entire territory of the municipality in China. One municipality may have several special economic zones. It was found that municipalities with multiple SEZs experienced larger effects than those with only one SEZ.

In [16], the so-called synthetic control is used to estimate the long-term effect of earthquakes on TFP. Calculations are made for the provinces of Italy. Control variables are GDP per capita, investment per capita, the share of university graduates in the workforce, population density, the share of industries, and the quality of institutions.

In the study [17], factor analysis is carried out, which does not directly estimate the effect on the TFP, but indirectly — through the output. Estimates are based on quarterly data for Malaysia and answer the question to what extent various factors affect output. The following parameters are used as control variables: physical capital (gross capital as a share of GDP), labor force (number of employees), real flows of foreign direct investment, admission to universities (as an indicator of human capital), as well as the product of indicators "direct investment" and "university applicants" as a measure of absorption of investments in human capital.

The general methodological base for all studies on the impact of budget support measures on indicators of development of a territory (city) is a matching of territories (cities) that received and did not receive support. The following groups of indicators are used as control variables or comparative characteristics: human capital (share of university graduates in the labor force), (foreign) investment (as a share of GDP), population (labor resources, number of employees), wages, housing prices in the city, the quality of the institutional environment. They use total factor productivity, wages or investments, and the growth rate of the gross urban product as a dependent variable characterizing urban development.

For a more detailed analysis, it is necessary to compare the enterprises that received and did not receive the status of a PDA resident in case not all enterprises of the city are included in the PDA program. In the foreign literature, a number of studies explore the problem of favoritism in determining preferences for enterprises [18–21]. In this article, based on the analysis of pre-trends, we will also test the hypothesis that initially more successful enterprises receive the status of a PDA-resident.

Thus, we can draw the following conclusions based on the literature review:

• a simple comparison of the indicators of participants in a particular business support program before and after participating in it is a poor way to measure the effectiveness of this program since it does not distinguish the actual contribution of the program among all possible factors affecting the dynamics of business development;

• it is necessary to select a control group that would show the contribution of other significant factors, while the selection of firms in the control group or in the impact group should occur, if not by chance, then at least independently of other factors that are significant for business dynamics.

DATA AND MODEL

All calculations are based on the SPARK-Interfax database for Russian firms, which in-cludes information on more than 400 thousand enterprises for 2014–2018 according to 8 sections of OKVED (A, B, C, F, G, I, P, Q). We also used data on monotowns in Russia, in which the Priority Development Areas (hereinafter referred to as "PDA")[5] were created and the register of PDA residents of monotowns.[6]

The PDA status of enterprises was determined by the objects of the second level of the OKATO (administrative division, districts, cities), which corresponded to the monotowns list.

All estimates are made only for PDA-registered companies. Using the Google API, the coordinates of the PDAs and all firms at their legal addresses (at the location of tax payment) were obtained and then compared with each other. In addition, to create an indicator of the distance from Moscow and from regional centers (considering their spatial influence [22]), their coordinates were obtained, and then the distances from each PDAs to the nearest regional center and Moscow were measured.

All indicators are taken in real terms to account for inflation so that the growth of firms' incomes can be estimated. As a measure of inflation for the mining and manufacturing industries, we used the producer price indices of the mining and manufacturing industries, respectively. For construction, the producer price index for construction products is used. For all other industries, the consumer price index for goods and services was used. All indicators are taken from the Rosstat website.

In this article, we test two main hypotheses:

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[5] A complete list of Priority Development areas: federal and regional special economic zones (SEZ), priority development areas (PDA) in monotowns, in the Far East and other municipalities of the Russian Federation. URL: https://xn--dtbhaacat8bfloi8h.xn-p1ai/toser-all (accessed on 20.04.2020).

[6] A complete register of areas of advanced social and economic development residents created in single-industry municipalities of the Russian Federation. URL: http://old.economy.gov.ru/minec/activity/sections/econReg/monitoringmonocity/2019041502 (accessed on 16.07.2020).

• hypothesis 1 — the status of a PDA resident a priori is obtained by more dynamic firms in previous periods;

• hypothesis 2 — the status of a PDA resident does not have a positive effect on the company's growth.

Both hypotheses are closely interrelated since the non-randomness of the resident status in relation to the characteristics of the firm creates the problem of endogeneity in assessing the effect of residency [23]. If the indicators that affect the likelihood of residence are not considered or considered incorrectly, an overestimate will be received.

To consider the non-randomness of obtaining the resident status, we used the nearest neighbor propensity score matching (hereinafter referred to as "matching") [24]. All residents are an impact group, and firms operating in the PDA and not having resident status, from industries in which there are residents, are assigned to the control group.

The matching algorithm is designed in such a way that at the first step, the probability of impact (in our case, residency) is estimated depending on the selected characteristics. Further, for the probability distribution of the characteristics of the treatment group, such observations are selected from the control group so that the distribution of the characteristics of the control group is as close as possible to the distribution of the treatment group. In other words, firms with resident status are not compared with all other firms, but with purely similar firms that do not have such status. Therefore, it becomes possible to compare groups with the same probability of obtaining a resident status, thus, the quantitative effect of a resident will not be overestimated as a result of the fact that, on average, more dynamic firms received PDA resident status.

Unfortunately, exact matching is hardly possible, as it is impossible to find an exact copy for each resident due to the fact that firms have many continuous characteristics (such as revenue) that may differ slightly even if all other variables are the same (for example, belonging to a particular industry). For this reason, a likelihood (similarity) measure is calculated, which shows how certain firms with resident status have similar (including identical) firms without such status. This procedure is called matching (propensity score matching).

For matching, it is critical with which characteristics the matching is carried out according to the propensity. Therefore, before starting the algorithm for searching for similar firms, it is necessary to select the best specification for estimating the probability of residence.

We use the maximum likelihood method to estimate logistic regression (hereinafter referred to as "logit model estimation"):

$$\hat{\theta} = \underset{\theta}{\arg\max} \prod_{i=1}^{n} P\{y = y^i \mid x = x^i\}, \qquad (1)$$

where $P\{y = 1 \mid x\} = f(z) = \dfrac{1}{1 + e^{-z}}$ — the logistic function or the probability for the given characteristics $z = \theta^T x$ to be a resident, $P\{y = 0 \mid x\} = 1 - f(z)$ — the probability of not being a resident. The values $\hat{\theta}$ obtained through the maximization of the likelihood function are the estimated values of the coefficients of the indicators of the influence of a particular characteristic on the probability of being a resident.

We are forced to use the logit model instead of a simpler linear probability model, where it is enough to apply the ordinary least squares method (hereinafter referred to as "OLS"), because, in contrast to the logit model, which guarantees that the probabilities predicted within the framework of the model will lie in the range from 0 up to 1 (determination of probability), OLS allows values to be outside the range of valid values.

Thus, to obtain an unbiased effect of residency, one must first determine the best specification of the logit model according to one of the information criteria, for example, Akaike:

$$AIC = 2k - 2\ln(L), \qquad (2)$$

where k — the number of parameters in the statistical model; and L — the maximum value of the likelihood function of the model. Akaike information criterion is a relative measure of model matching. The smaller its value, the better the model relative to others, since it allows the smallest number of characteristics to obtain the greatest value of the likelihood function.

As a proxy variable for the growth of the company, we use the indicator of revenue growth. After selecting the best specification, we use the matching algorithm and compare the base OLS estimate for all observations and those obtained using matching to see the difference in effect estimates.

Hypothesis 1 is correct if some of the characteristics of firms will significantly determine the status of residence in the assessment of the logit model. Hypothesis 2 will be confirmed if the estimate of the effect of residence on revenue growth after using matching loses its significance and decreases in magnitude relative to the base OLS estimate.

ANALYSIS RESULTS

Of the 443,512 companies available in the SPARK-Interfax database, 155 residents of the PDA were selected based on the list of the Ministry of Economic Development of Russia. Further, the industries in which it is possible to obtain the status of a resident were identified: there are 27 such industries[7] in total (*Table 1*).

On the basis of 27 industries and PDA firms, 9160 firms were selected that belong to the same industries as residents, are located and operate in the PDA, but do not have the status of residents.

Table 2 shows that more than two-thirds of the firms that received the PDA resident status did not exist before 2016. For those that were created only in 2018, it is not possible to assess the impact of the residency on revenue growth, because they did not yet

have revenue in 2017. The analysis will focus on firms that existed in 2015 (41 firms). This is done to control the so-called pre-trends — trends in revenue growth over the previous two periods, since otherwise there is a risk of comparing firms that are fundamentally different in terms of competitiveness.

The fact that most of the firms that received the status of residents were created when the PDA list was formed is of interest and requires a deeper analysis. After all, this can indicate both the success of the creation of the PDA, which attracts entrepreneurs to open new businesses, and the opposite — the PDA does not support existing businesses that need help and development. But this question will remain outside the scope of our analysis since a quantitative assessment is difficult due to the lack of many characteristics required to control for such an effect.

For all further calculations, the following indicators were used:
- resident — a dummy variable for firms that had resident status in 2018;
- revenue — the firm's revenue in billions of rubles for 2018;
- revenue growth — percentage change in revenue from the previous year to the current one (from 2017 to 2018);
- distance to the capital of the region — the Euclidean distance between the coordinates of the place of observation (the city in which the firm is located) and the coordinates of the nearest capital of the region of the Russian Federation in kilometers;
- distance to Moscow — the Euclidean distance between the coordinates of the observation (of the city in which the company is located) and the coordinates of Moscow in kilometers, zero for observations outside the European part of Russia;
- large firm — a binary variable indicating a type of firm in 2018 according to the classifier of financial statements;
- medium-sized firm — a binary variable indicating a type of firm in 2018 according to the classifier of financial statements.

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[7] Hereinafter, by industries, we mean the types of economic activities in accordance with the OKVED used in statistical accounting.

Industries with residents

No.	Industries
1	Crop and livestock production, hunting and related services in these areas
2	Fishing and fish farming
3	Extraction of other minerals
4	Food production
5	Textiles production
6	Manufacture of clothes
7	Wood processing and manufacture of wood and cork products, excluding furniture, manufacture of straw products and plaiting materials
8	Manufacture of paper and paper products
9	Manufacture of chemicals and chemical products
10	Production of medicines and materials used for medical purposes
11	Manufacture of rubber and plastic products
12	Manufacture of other non-metallic mineral products
13	Metal production
14	Manufacture of finished metal products, except for machinery and equipment
15	Manufacture of computers, electronic and optical products
16	Manufacture of electrical equipment
17	Manufacture of machinery and equipment not included in other categories
18	Manufacture of motor vehicles, trailers and semi-trailers
19	Furniture production
20	Manufacture of other finished goods
21	Repair and installation of machinery and equipment
22	Building construction
23	Engineering construction
24	Wholesale and retail trade in motor vehicles and motorcycles and their repair
25	Wholesale trade, except for the wholesale trade of motor vehicles and motorcycles
26	Activities for the provision of places for temporary residence
27	Healthcare activities

Source: compiled by the authors.

Control of industry and regional affiliation [22] means the inclusion of binary variables of industries and regions in which firms are located. They can explain part of the variation, but the coefficients of each of them individually are not of significant interest for the objectives of our analysis. Therefore, to avoid a significant increase in the size of the tables shown in the article, they indicate whether there is a control for these binary variables or not.

Firms recognized as residents by years of establishment

Year	2015 and earlier	2016	2017	2018
Number of firms opened	41	12	38	64

Source: compiled by the authors.

The trend of revenue growth determines the residency (Logit estimation)

	Resident			
	I	II	III	IV
Revenue growth lag	0.004** (0.002)	0.006*** (0.002)	0.006*** (0.002)	0.006** (0.002)
Second order revenue growth lag	0.005*** (0.002)	0.004*** (0.002)	0.004*** (0.002)	0.005*** (0.002)
Distance to the capital of the region			0.002 (0.003)	
Distance to Moscow			−0.001 (0.0004)	
Industry control	No	Yes	Yes	Yes
Control for regional affiliation	No	No	No	Yes
Number of observations	5049	5049	5049	5049
Likelihood logarithm	−193.122	−156.573	−154.804	−131.167
Akaike information criterion	392.243	371.147	371.608	400.335

Source: compiled by the authors.

Note: measurements are made with a constant term, indicators with a lag are values one year earlier than the measurement period, * $p < 0,1$; ** $p < 0,05$; *** $p < 0,01$.

The lag of any indicator means the use of its value for the previous period. Accordingly, the second order lag is the use of the indicator value two periods ago.

For the estimates of the logit model (*Table 3*) and for all subsequent results, outliers were excluded for which the growth rate of revenue at least in one of the periods (2015–2016, 2016–2017, 2017–2018) was more than 500 percentage points. This allows for more universal estimates and more accurate estimates of probabilities. The results with the inclusion of outlier observations are similar, but for them it is impossible to construct visually understandable distributions and to
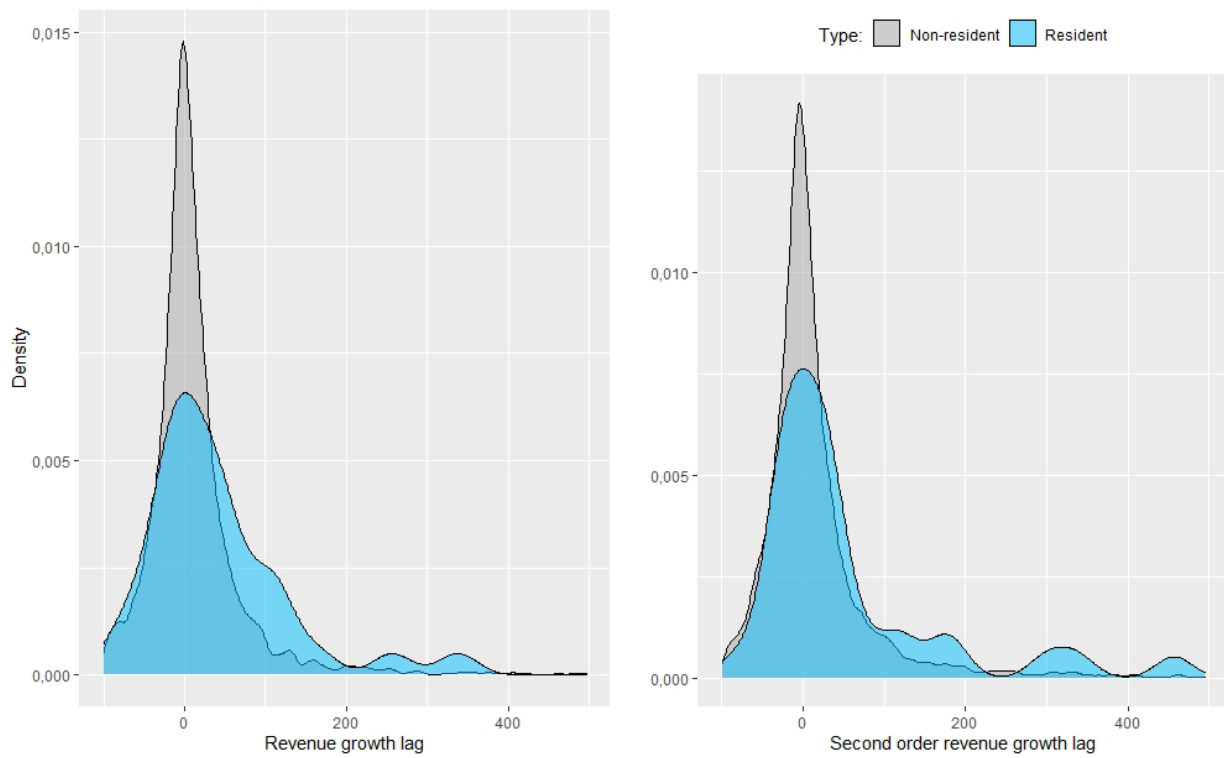
Fig. 1. **Distribution of revenue growth of previous periods for all observations**
Source: compiled by the authors.
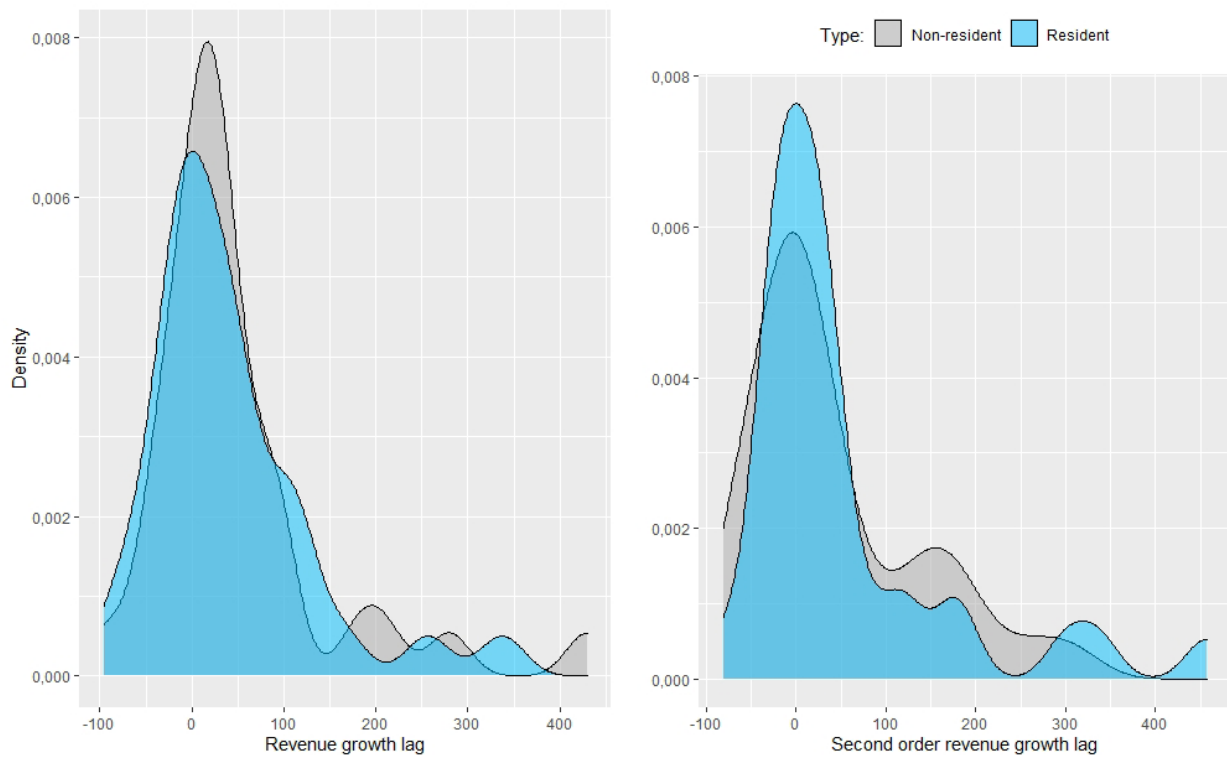
Fig. 2. **Distribution of revenue growth of previous periods after PSM**
Source: compiled by the authors.

Residence effect disappears after PSM

	Revenue growth		
	I (OLS)	**II (matching)**	**III (matching)**
Resident	39.972** (16.513)	36.927* (21.435)	23.582 (20.997)
Revenue lag	−0.028 (0.032)		−0.000 (0.000)
Distance to the capital of the region	−0.028** (0.013)		0.132 (0.148)
Distance to Moscow	−0.004** (0.002)		0.007 (0.028)
Large firm	13.647*** (3.291)		25.763 (36.984)
Medium-sized firm	9.370*** (2.987)		−15.251 (17.798)
Industry control	Yes	No	Yes
Number of observations	5049	66	66
R^2	0.016	0.044	0.410
Adjusted R^2	0.010	0.029	0.148

Source: compiled by the authors.

Note: errors are heteroskedasticity-robust (HC 1), measurements are made with a constant term, indicators with a lag are values one year earlier than the measurement period. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

interpret most of the coefficients. This leaves 33 resident firms and 5,016 non-resident firms that have operated since at least 2015 and have not increased revenues by more than 500 percentage points since 2015.

In all four specifications (*Table 3*), only the income growth values of previous periods have a significant impact on the likelihood of residence. The result is stable for different specifications: in the presence and absence of control over industry affiliation and geographic location, and the result does not change when either taking into account the distance to economic centers or simply when considering the fixed effects of the regions.

The increase in revenue over the previous two periods serves as sufficient residency statistics to allow us to argue that a particular firm is more likely to have resident status in 2018 if we know how that firm grew from 2015 to 2016 and from 2016 to 2017. The result fully justifies the fact that only firms that existed in 2015 were used for the estimates. Losing two-thirds of the sample of residents, we still get the opportunity to make accurate estimates of the effect and compare firms with similar growth dynamics.

Based on the Akaike information criterion, we can say that Specification II in *Table 3* is
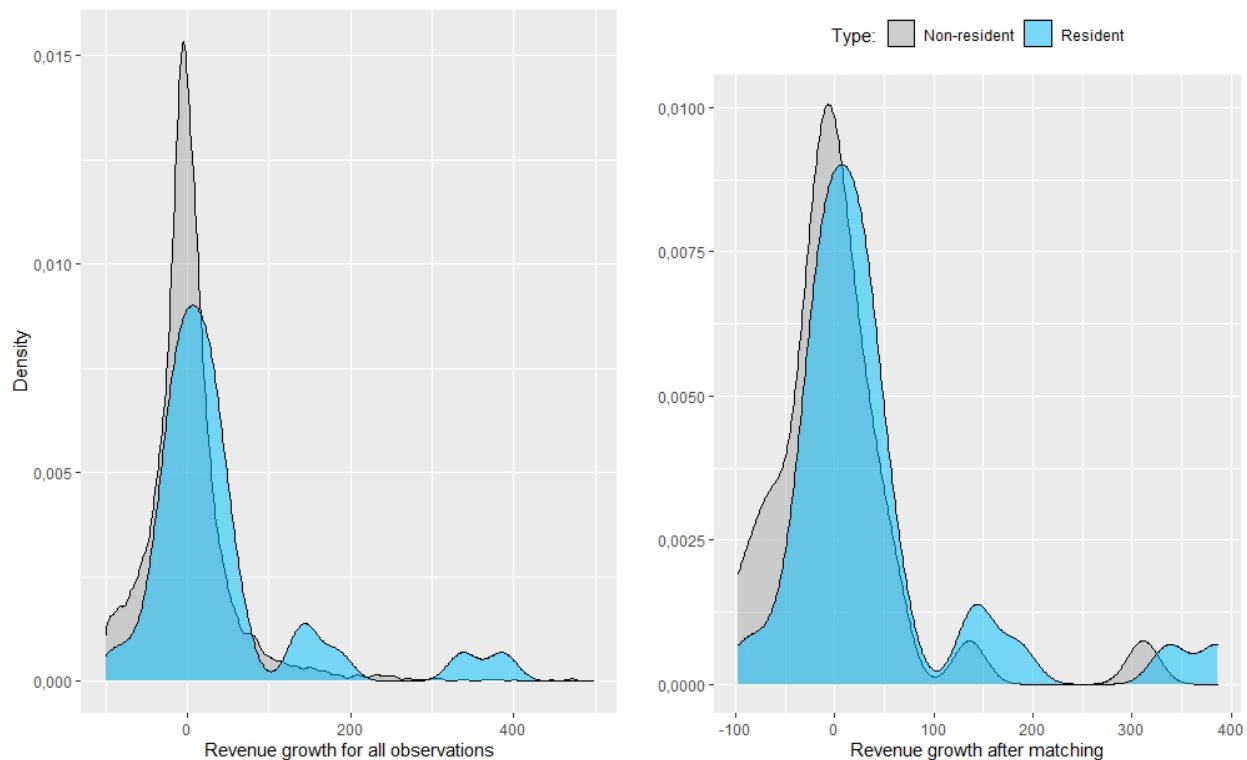
Fig. 3. **Distribution of revenue growth of previous periods after PSM**
Source: compiled by the authors.

the best because it has the smallest criterion value. At the same time, none of the industry binary variables has a significant effect, it is just that in combination with the control for industry specifics the most correct estimates of the effect of first and second order revenue growth lags are obtained.

The marginal effect of revenue growth in prior periods is small. Thus, for a company whose revenue growth in the period from 2015 to 2016, as well as from 2016 to 2017 amounted to approximately 500 percentage points, the probability of residency will be only 3.16% higher, but for a general assessment of the impact of residency on revenue growth, even such a small change in probability is important.

Figures 1 and *2* show how the matching procedure, made based on characteristics from the logistic model, which is the best according to the Akaike information criterion (Specification II from *Table 3*), makes it possible to almost completely eliminate the difference in distributions. As a result, we can say that the problem of non-

randomness of the impact has been resolved, and an unbiased estimate of the effect of resident status can be obtained.

Table 4 allows us to compare the result of estimating the effect of residency with and without the matching procedure. Simple OLS for all available observations (Specification I) gives a 5% significant positive effect of residency on revenue growth. This estimate is biased upward because even if we use OLS based on observations selected using matching without control variables, the effect will become less significant (now on 10% level) and less in magnitude.

If for the observations selected using matching we also include control over the revenue of the firm of the previous period, geographic location, size of the firm, and its industry affiliation, then the effect completely disappears. In this case, most of the variation is explained by the belonging to a particular industry. And again the details are not important, but it is essential that the significant effect of residency is no longer obtained.

Moreover, if a simple OLS has adjusted R^2 of 1%, then the OLS after matching, even without control, explains 3% of the variation. And the OLS after matching with the control from Specification III in (*Table 4*) has a rather high value of 0.148.

The change in the effect is clearly seen in *Figure 3*. If without matching, the distributions of income growth are clearly different for non-residents and residents, then the matching procedure that eliminates the effect of the pre-trends makes the distributions of growth almost the same.

CONCLUSIONS

One of the goals of implementing the PDA program in monotowns was the diversification of economies by stimulating the development of businesses that are not related to the city-forming enterprises.

However, the results of our analysis of the impact of the PDA on the development of enterprises in monotowns cast doubt on the success of achieving the goal of this program. Results of our calculations show that the status of resident in the PDA is obtained by firms that have already developed quite successfully before the launch of this state initiative.

Both hypotheses of the research were confirmed. Resident status is not accidental, it is predetermined by the growth of the firm's revenue in the two previous periods. And the influence of residency on the growth of companies disappears when comparing companies with the same pre-trends — the trends of income growth over the previous two periods.

The result obtained allows for several interpretations. It is possible that resident status is mainly granted to firms that are already developing more dynamically, to report the success of the PDA program. Alternatively, more dynamic firms may find it easier to overcome bureaucratic difficulties in obtaining resident status, which creates a self-selection effect. Most likely, the observed result contains both of these interpretations.

A separate question arises: how to consider in the analysis not only firms that existed in 2015, but also those that appeared in subsequent years? Among the residents who received the status immediately after the establishment of the company, "special" enterprises, which differ from similar ones without the status of a resident, can also be found.

A promising area of future research of the effectiveness of PDA is a more detailed analysis of the nature of granting a resident status, as well as dividing the selection effect of firms applying for the status of PDA-residents into two: the choice of representatives of state bodies and the presence of the self-selection effect.

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Suchkova O. V. — literature review, description of results, conclusions.

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Scenario Modelling of the Impact of the Dynamics of Public Debt on the Gross Regional Product of Russian Regions

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ABSTRACT

The **subject** of this research is public debt and its impact on the dynamics of the gross regional product (GRP) of Russian regions. The aim of the paper is to study and scenario forecast the dynamics of changes in the internal public debt of Russian regions and model its impact on the gross regional product. The **relevance** of the study is due to the fact that most regions in Russia are forced to increase their internal public debt to cover the budget deficit and attract additional resources to solve important problems of socio-economic development and implement strategic projects and programs. The **scientific novelty** of the research consists in the development of a methodological approach to modelling and scenario forecasting of the level of GRP of different groups of regions, taking into account the dynamics of changes in their public debt using ARIMA modelling methods and panel regression analysis. The authors apply the **methods** of panel regression analysis and ARIMA modelling. The authors theoretically substantiated that public debt has a different effect on the GRP of Russian regions, grouped the regions according to the identified trends in the dynamics of public debt (the first group — regions with the dynamics of debt reduction over the period from 2005 to 2019, the second group — with the all-Russian trend of debt reduction since 2017, and the third group — with the dynamics of increasing debt over the period under review); developed a methodological approach to modelling and scenario forecasting of the GRP level of the Russian regions, taking into account the dynamics of changes in their public debt; carried out ARIMA forecasting of the dynamics of the public debt of different groups of regions and built regression models of the influence of the dynamics of the public debt on the GRP of Russian regions within the selected groups; formed forecast scenarios for changes of the GRP level of regions, taking into account the identified dynamics of transformation of their internal public debt. **Conclusions:** public debt has a negative impact on the dynamics of the GRP of Moscow and the Moscow region and a positive effect on the dynamics of the GRP of the regions of the second and third groups. The findings of the study may be used by the federal and regional executive authorities to find ways to reduce public debt and increase the level of socio-economic development of territories.
Keywords: public debt; scenario forecasting; ARIMA modelling; panel regression analysis; gross regional product

INTRODUCTION

Public debt plays an ambiguous role in the economic development of regions. The overwhelming majority of Russian regions today are forced to increase their domestic public debt to cover the budget deficit and attract additional resources to solve acute problems of socio-economic development and implement strategically important projects and programs. Budgetary and bank lending to the regions of the Russian Federation, attracting investments in their debt securities constitute the financial basis for the economic development of these regions. Such researchers as I.V. Kisel' [1], N.N. Parasotskaya and N.D. Yakovlev [2], S. Li, P. Cao [3], R. Zhao, Y. Tian, A. Lei, F. Boadu, Z. Ren [4], A.C. Carlo [5], S.W. Yong, R. Suhaimi, S.Y. Chai [6] studied the positive impact of the public debt on the social-economic development of territories.

On the other hand, by increasing the internal public debt, the Russian regions increase the level of debt burden on regional budgets, which can lead the overwhelming majority of regions to adverse consequences — threats of loss of budgetary security. The negative effect of increasing public debt is considered in the works of L.B. Mokhnatkina [7], S. Soldatkin [8], A. Afonso, J. Alves [9], U. Panizza, A.F. Presbitero [10], G. Gagarina, L. Chainikova, L. Arkhipova [11]. S.G. Cecchetti, M.S. Mohanty and F. Zampolli, who note that after reaching a certain level, public debt begins to negatively affect socio-economic development [12]. For a number of central regions of Russia, which have a fairly high budgetary provision, the growth of the internal public debt, on the contrary, contributes to a decrease in the rate of economic development due to an increase in the cost of maintaining the accumulated debt. Such regions are trying to reduce the debt burden on the budget and increase the level of budgetary independence and autonomy. Thus, it can be assumed that public debt has either a positive or a negative impact on certain groups of regions that

differ in terms of GRP. This paper is devoted to the substantiation of this hypothesis.

Based on the importance and relevance of this problem, the main aim of this paper is to study and scenario forecast the dynamics of changes in the internal public debt of the regions of the Russian Federation and model its impact on GRP. To do this, the following objectives were set:

• theoretical analysis of approaches to understanding the role of public debt in the economic development of territories;

• study of the methodological foundations of scenario forecasting of the dynamics of public debt and modeling of its impact on the GRP of the Russian regions;

• grouping of regions according to the identified trends in the dynamics of public debt;

• ARIMA modelling the dynamics of the public debt of various groups of regions;

• construction of regression models of the influence of the dynamics of public debt on GRP within the selected groups.

Reaching these objectives allows establishing the degree of influence of the public debt on the GRP of the regions of the Russian Federation of various groups and to formulate forecast scenarios for its change, considering the revealed dynamics of transformation of the domestic public debt.

THEORETICAL AND METHODOLOGICAL QUESTIONS OF RESEARCH

N.N. Parasotskaya and N.D. Yakovlev noted the positive influence of public debt on socio-economic development [2]. In their study, they write about the expedient and reasonable use of government borrowing, since this allows budgetary maneuvers to be carried out, helps to contain the negative impact of shocks on the country's economy, and can yield positive results for the economy as a whole.

S. Li, P. Cao investigate the impact of public debt on urbanization. Empirical studies show that the debt of local authorities contributes to an increase in the

rate of urbanization, the development of infrastructure [3].

Among the researchers who focus on the positive role of public debt in socio-economic development are I. V. Kisel' [1], R. Zhao, Y. Tian, A. Lei, F. Boadu, Z. Ren [4], A. C. Carlo [5], S. W. Yong, R. Suhaimi, S. Y. Chai [6].

The negative impact of public debt on socio-economic development is presented in the study by L. B. Mokhnatkina. The attraction of sources of financing the budget deficit leads to the accumulation and growth of public debt, while the growth of public debt leads to an increase in the cost of servicing debt obligations. In conditions of austerity of budgetary funds, the accumulated public debt becomes a significant source of threat to regional economic security [7].

Foreign scientists U. Panizza, A. F. Presbitero investigate the impact of public debt on economic growth in a sample of OECD countries. The results are consistent with studies that found a negative correlation between debt and growth [10].

The negative role of public debt is considered in the works of scientists such as S. N. Soldatkin [8], A. Afonso and J. Alves [9], G. Gagarina, L. Chainikova, L. Arkhipova [11].

The authors single out another group of studies related to assessing the role of public debt. S. G. Cecchetti, M. S. Mohanty, F. Zampolli [12], A. A. Kumykov [13], S. Chen and W. Li [14] note both the positive and negative impact of the public debt on the socio-economic development of the territories. The research results obtained by S. Chen and W. Li, show that the excessive accumulation of latent public debt in the eastern region does not contribute to economic growth, while public debt in the central and western regions makes a significant contribution to local economic growth [14]. S. G. Cecchetti, M. S. Mohanty and F. Zampolli point out that after reaching a certain level, public debt begins to negatively affect socio-economic development [12]. The ambiguity in understanding the role of public debt in the economic development of territories has generated interest in this study.

In the scientific literature, there are several methodological approaches to assessing the role of public debt in the economic development of territories. A theoretical review of the works showed that to model the influence of the public debt of the regions of the Russian Federation on the indicators of their socio-economic development, the main of which is GRP, the *methods of regression analysis* are usually used: a least-squares method for spatial data and spatial regression modelling using panel data. For example, regression analysis was used in the work of K. V. Matvienko to identify the relationship between the volume of debt obligations of various types and the region's GRP, as well as the volume of the revenue side of the consolidated budget of the region [15].

A. Afonso and J. Alves used panel data methods to analyze the impact of public debt on economic growth. One of the important advantages of using panel data estimation is that it emphasizes individual heterogeneity if there are some distinctive features in the cross-sections [9].

Spatial regression methods were applied in the works of R. Zhao, Y. Tian, A. Lei, F. Boadu, Z. Ren, who investigated the correlation between local government debt and regional economic growth in 30 provinces of China. Using a Moran's scatter plot, a Local Indicator of Spatial Association (LISA) map, and a semi-parametric spatial model (SE-SDM), the authors demonstrated the impact of spatial agglomeration effect and local government debt on regional economic growth. Their semi-parametric spatial model characterizes the nonlinear relationship between local government debt and regional economic growth and allows one to estimate the size of local government debt, above which economic growth will be suppressed by crowding out private investment and cuts in public spending [4].

The methods of simulation modelling using regression analysis were applied by A. Yu. Zhigaev to build scenario forecasts of public debt for the medium term [16], S. Chen

and W. Li to study the correlation between local government debt, economic growth and other variables [14]. A multi-parameter dynamic model of Russia's external debt was also developed by S. E. Tsvirko. This model contained a number of exogenous variables reflecting the domestic and foreign policy of the state and made it possible to describe the influence of various methods of settling external debt, known in world practice, on the size of the public debt [17].

These methods make it possible not only to establish the dependence of the economic development of territories on the dynamics of public debt but also to build various scenarios for predicting its changes in the future. However, to form more accurate regression models, it is necessary to use data reflecting the same trends in the dynamics of the public debt of the Russian regions. The use of data for grouped regions with multidirectional trends in the dynamics of public debt in regression analysis will make it possible to objectively assess its impact on the gross regional product of the Russian regions. A theoretical review of the work carried out using this toolkit showed that the constructed regression models for the entire set of regions did not allow us to identify the features of the influence of public debt on the level of their economic development. In such studies, it was found that the dynamics of the growth of the public debt of the territories had both a positive and a negative impact on the indicators of socio-economic development.

To construct predictive scenarios for changes in the dynamics of economic development of regional systems using regression modeling, an important aspect is the construction of accurate forecasts of changes in the dynamics of the public debt of the Russian regions. An overview of works in this area showed that the most popular methods for predicting the dynamics of the public debt of territories are methods of extrapolation, moving averages and exponential smoothing. They were used, for example, in the work of A. Yu. Kolodyazhnaya

for forecasting the public debt of the Orenburg region [18], N. A. Tolstobrova, V. Postnikov, M. A. Kamenskikh to analyze changes in economic development indicators and study the dynamics of changes in public debt and Russia's GDP, forecasting the external and internal public debt of Russia in absolute and relative terms [19]. These methods make it possible to form short-term forecasts based on the identified trends in the dynamics of changes in the indicator. If the dynamics of the studied indicator were nonlinear, had high volatility, then the forecasts generated using these methods were not reliable enough. The most accurate forecasting method, in this case, is first or second-order autoregressive modelling, for example, ARIMA modelling.

The ARIMA modelling method was used in the work of N. V. Kovtun, O. Ya. Dolinovskaya, V. Ignatyuk to develop three types of economic and statistical models for the formation of external public debt, namely:

• autoregression models that consider seasonality and violations of a different order, which makes it possible to study in isolation the patterns of formation of the dynamics of external public debt on the principles of decomposition of a number of dynamics;

• a mixed model of autoregression with the inclusion of seasonality, random processes and factor scaling, on the basis of which it is possible to study the patterns of the formation of the debt burden, considering not only its decomposition but also taking into account the factors of accumulation, lending and consumption;

• a mixed autoregression model based on actual data on external public debt, consumption and accumulation, considering MA-, AR-processes and seasonality, which allows determining the dominant factors causing an increase in the debt burden [20].

F. Zhuravka, H. Filatova and J. O. Aiyedogbon studied theoretical and practical aspects of forecasting public debt in Ukraine. A visual analysis by the authors of the change in the size of public debt made it possible to draw a conclusion about the

deepening of the debt crisis in the country. Their methodological approach was based on an autoregressive integrated moving average (ARIMA) as the basic forecasting model [21].

This method of forecasting the dynamics of the public debt of territories, in contrast to the previous methods, is based on the results of regression modelling, considers the volatility of the dynamics of the analyzed indicator and can be used to make forecasts for the medium term. The advantage of ARIMA modelling is not only the formation of the most probable forecast, considering the established trends in the dynamics of the studied indicator, but also the corridor of its possible values, which is especially valuable for the formation of the most negative and positive scenarios.

The need to consider the specifics of the regions from the point of view of the dynamics of changes in public debt for the formation of regression models substantiating its influence on the GRP of the Russian regions, as well as the development of predictive development scenarios of Its change, considering the current trends in the dynamics of public debt, required the development of a new methodological approach. *Fig. 1* presents the algorithm for modelling and scenario forecasting of the GRP of the Russian regions, considering the dynamics of changes in their public debt.

At the initial stage of the study, using graphical methods of analysis, it is planned to assess the dynamics of changes in the total public debt of all Russian regions and their municipalities, as well as to identify regions with different dynamics of this indicator (with trends of growth and decrease in the debt burden on regional budgets). The grouping formed based on the results of the implementation of this stage of the study will make it possible in the future to assess the influence of the established trends in the change in the public debt of the Russian regions on the dynamics of the level of their GRP.

At the second stage of the study, using the methods of ARIMA modelling, it is planned to build three predictive scenarios for changes in the public debt of 85 Russian regions until 2022 within the selected groups of regional systems. The use of this method will allow us to consider the volatility of the dynamics of the indicator under study and build a more accurate scenario of the inertial forecast in comparison with the methods of extrapolation and moving averages. The advantage of using ARIMA modelling is the formation of a corridor of possible forecast values of the indicator, the extreme values of which will be used to build pessimistic and optimistic scenarios for forecasting changes in the public debt of the Russian regions.

The regression analysis carried out at the next stage using panel data for selected groups of regions with multidirectional dynamics of public debt will allow us to establish its influence on the main indicator of the socio-economic development of regions — their gross regional product. Regression modelling, in this case, acts as a tool for substantiating the hypothesis put forward about the different impact of public debt on the GRP of different groups of regions, as well as a method for constructing predictive scenarios for changes in the GRP of the Russian regions, considering the dynamics of their public debt. This study involves the use of panel least squares regression analysis with the necessary preliminary analysis of stationarity, linearity of data distribution, construction of models with fixed and random effects, panel diagnostics to select the optimal model and check statistical significance of its parameters, as well as the Gauss-Markov assumptions (autocorrelation of residuals, normality of their distribution, heteroscedasticity, etc.).

Formed regression models of the GRP dependence on the dynamics of the public debt of the Russian regions and their municipalities for the indicated groups of regions, as well as predictive scenarios for its change at the final stage of the study are the basis for constructing an inertial scenario of GRP dynamics, which assumes
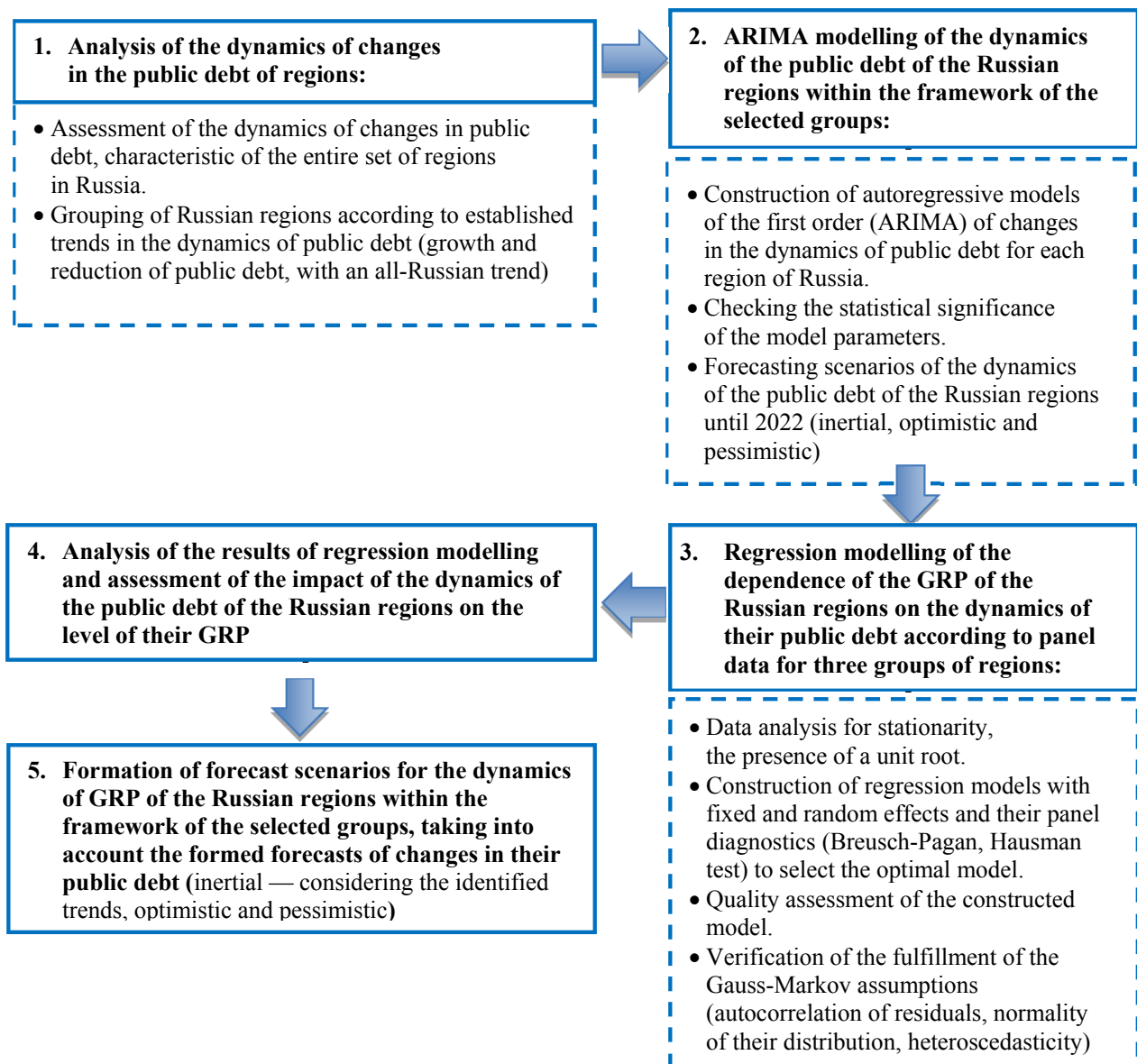
1. **Analysis of the dynamics of changes in the public debt of regions:**
• Assessment of the dynamics of changes in public debt, characteristic of the entire set of regions in Russia.   • Grouping of Russian regions according to established trends in the dynamics of public debt (growth and reduction of public debt, with an all-Russian trend)

2. **ARIMA modelling of the dynamics of the public debt of the Russian regions within the framework of the selected groups:**
• Construction of autoregressive models of the first order (ARIMA) of changes in the dynamics of public debt for each region of Russia.   • Checking the statistical significance of the model parameters.   • Forecasting scenarios of the dynamics of the public debt of the Russian regions until 2022 (inertial, optimistic and pessimistic)

4. **Analysis of the results of regression modelling and assessment of the impact of the dynamics of the public debt of the Russian regions on the level of their GRP**

3. **Regression modelling of the dependence of the GRP of the Russian regions on the dynamics of their public debt according to panel data for three groups of regions:**
• Data analysis for stationarity, the presence of a unit root.   • Construction of regression models with fixed and random effects and their panel diagnostics (Breusch-Pagan, Hausman test) to select the optimal model.   • Quality assessment of the constructed model.   • Verification of the fulfillment of the Gauss-Markov assumptions (autocorrelation of residuals, normality of their distribution, heteroscedasticity)

5. **Formation of forecast scenarios for the dynamics of GRP of the Russian regions within the framework of the selected groups, taking into account the formed forecasts of changes in their public debt (**inertial — considering the identified trends, optimistic and pessimistic**)**

Fig. 1. **Algorithm for modelling and scenario forecasting of the GRP of Russian regions taking into account the dynamics of changes in their public debt**
Source: compiled by the authors.

the preservation of both current trends in the future and an extremely optimistic and pessimistic scenarios. The predicted scenarios of changes in the public debt of the regions of the Russian Federation and the dynamics of their GRP will help to confirm or refute the hypothesis put forward.

RESEARCH RESULTS

The data of the Ministry of Finance of Russia for the period from July 2005 to December 2020 were used to study the dynamics of the public debt of the Russian regions and their

municipalities.[1] To cover the emerging budget deficit and increase budgetary provision, the regions are forced to increase the level of their public debt by issuing and selling government debt securities, obtaining budget loans, loans from credit institutions, foreign banks and international financial organizations, issuing state guarantees of a region of the Russian Federation and other debt obligations. The total public debt of all Russian

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[1] The size and structure of the public debt of the Russian regions and municipalities. URL: https://minfin.gov.ru/ru/perfomance/public_debt/subdbt/ (accessed on 01.11.2021).
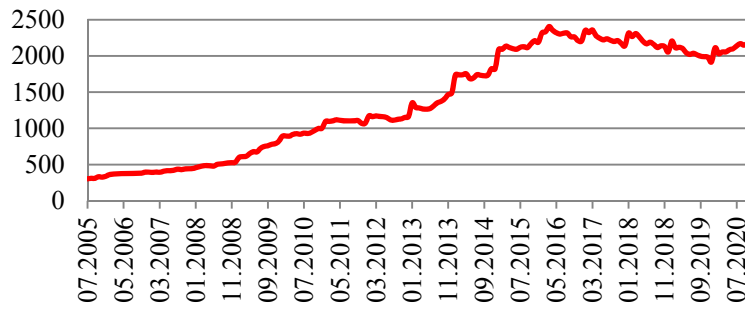
Fig. 2. **Dynamics of the total public debt of Russian regions and their municipalities from 07.2005 to 12.2020, billion rubles**

Source: compiled by the authors. URL: https://minfin.gov.ru/ru/perfomance/public_debt/subdbt/ (accessed on 01.11.2021).

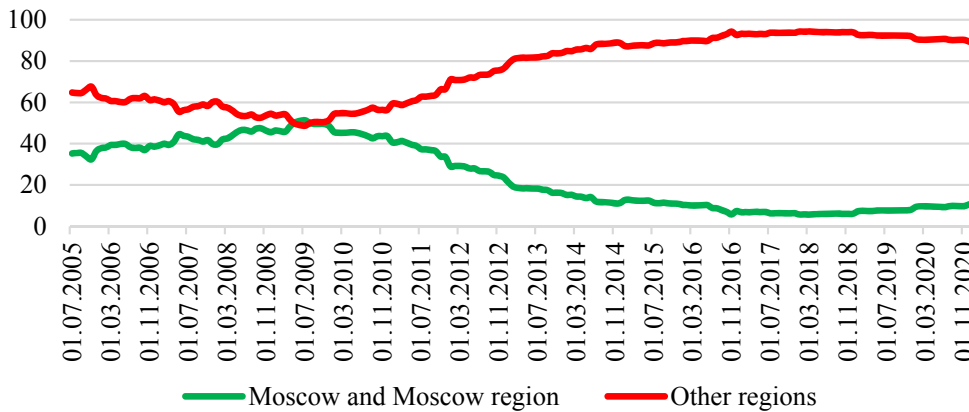*Fig. 3.* **Dynamics of changes in the share of Moscow, the Moscow region and other regions in the total public debt of Russian regions, %**
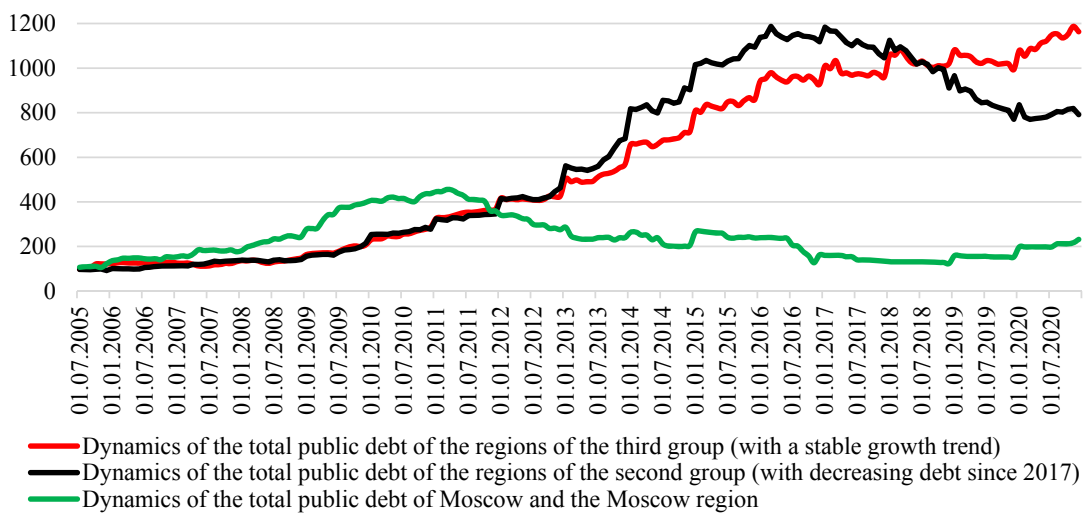
Source: compiled by the authors.

Fig. 4. **Dynamics of public debt in three groups of regions, billion rubles**
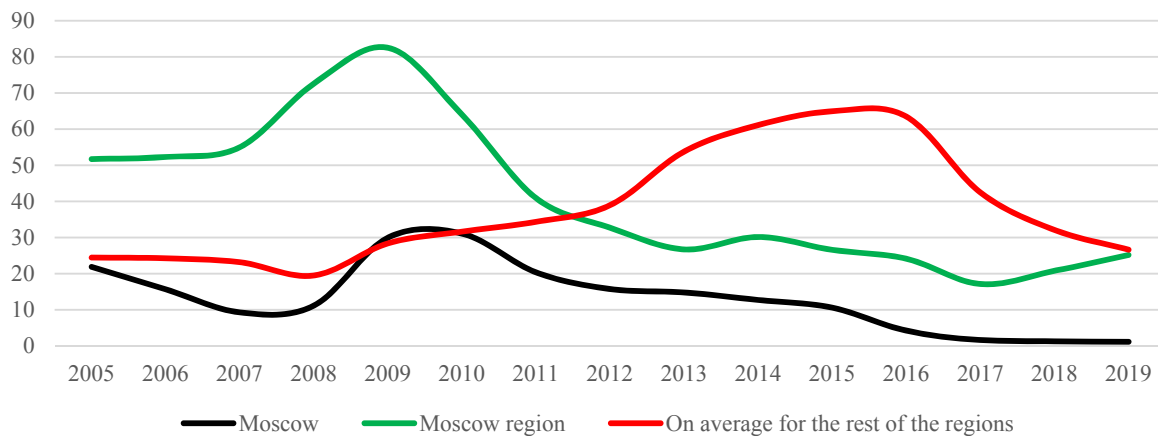
Source: compiled by the authors.

Fig. 5. **Dynamics of changes in the ratio of coverage of budgetary debt in Moscow and the Moscow region, %**
Source: compiled by the authors.

regions and their municipalities for the period under review increased by 7.2 times — from 303 billion rubles in July 2005 to 2 186 billion rubles by the end of 2020 (*Fig. 2*).

If in 2005 35.3% of the total public debt accounted for Moscow and the Moscow region, by the end of 2020 the share of these regions in the structure of public debt fell to 10.6%. The rest of the regions have been actively increasing the level of public debt over the past 15 years (*Fig. 3*). At present, these regions concentrate about 89% of the total public debt of the Russian regions. The presented figure confirms the spatial heterogeneity of the distribution of public debt of regions and their municipalities established by our previous study [22].

Over the period from 2005 to 2020, the share of public debt in the structure of total public debt for all regions of the Russian Federation increased significantly in such regions as: Krasnodar Territory (up to 4.8%), Sverdlovsk Region (up to 4.4%), Republic of Tatarstan (up to 4.4%), St. Petersburg (up to 3.9%), Krasnoyarsk Territory (up to 3.5%), Nizhny Novgorod Region (up to 2.9%), Udmurt Region (up to 2.5%), Khabarovsk Territory (up to 2.5%), Republic of Mordovia (up to 2.2%), Samara Region (up to 2.2%), Volgograd Region (up to 2.2%), Saratov Region (up to 2.1%), Tomsk region (up to 1.9%), etc.

The spatial transformation of the debt burden on regional budgets is also confirmed

by the grouping of regions formed by us according to the characteristic trends in the dynamics of their public debt (*Fig. 4*).

The study identified three groups of regions with similar dynamics of changes in public debt over the period 2005–2020. In the first group of regions, to which we include Moscow and the Moscow region, there were tendencies of decreasing public debt. The most noticeable decrease in the debt burden on the budget was observed in Moscow. This trend is natural, since the region has a fairly high budgetary provision. In the Moscow region, despite the growth in public debt that began in mid-2017, the overall debt burden on the budget decreased (*Fig. 5*). The coverage ratio of the budgetary debt of the Moscow region, which characterizes the ratio of the public debt of a region of the Russian Federation to the volume of its own tax and non-tax revenues, had a similar dynamics decline as in Moscow. At the end of 2019, this indicator for the Moscow region decreased from 82.5% as of 2009 to 25.2%. To construct the three most probable scenarios for predicting changes in the dynamics of the public debt of the regions of the first group by 2022, ARIMA modelling was used, the results of which are presented in *Table* and *Fig. 6*.

The statistical significance of the model parameters is evidenced by the P-values of the coefficients that are within the permissible values, the determination coefficients taking values close to one, as well

Results of ARIMA modelling of the dynamics of the total public debt of Moscow and the Moscow region

	Coefficient	Standard error	z	P-value
const	203 971	65 564.5	3.111	0.0019
phi_1	0.989241	0.00850885	116.3	0.0000
theta_1	0.0915908	0.00653365	4.402	0.0161
	Real unit	Imaginary unit	Module	Frequency
AR − Root 1	1.0109	0.0000	1.0109	0.0000
MA − Root 1	−10.9181	0.0000	10.9181	0.5000
R-squared	0.983361	Norm. R-squared	0.983270	
Akaike criterion	4017.428	Schwarz criterion	4030.309	
Hannan-Quinn criterion	4022.648			

Source: compiled by the authors.
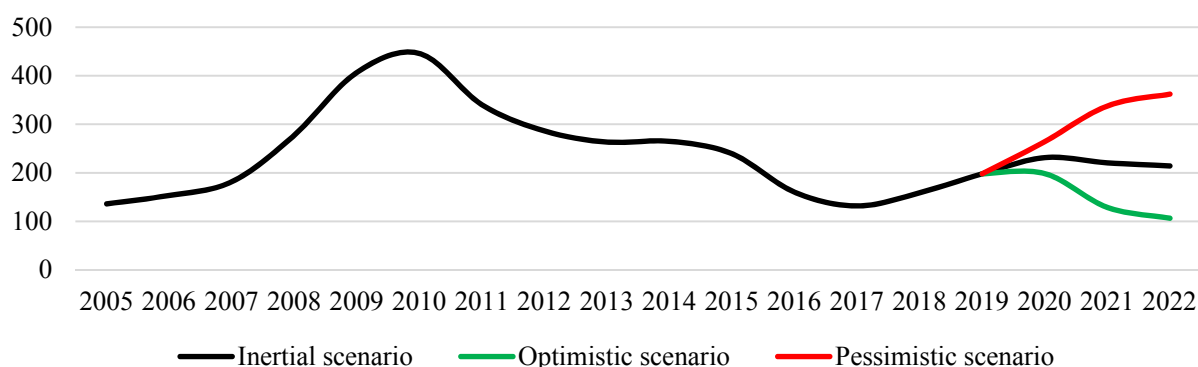
Fig. 6. **Scenarios of the dynamics of the total public debt of Moscow and the Moscow region until 2022, billion rubles**

Source: compiled by the authors.

as the information criteria Akaike, Schwarz and Hannan-Quinn. To assess the reliability of the model, tests were carried out for the presence of autocorrelation up to the 12th order (Ljung-Box Q) and the normality of the distribution of residuals. The tests carried out have confirmed the statistical significance of the parameters of this model.

According to the generated ARIMA model, the inertial scenario shown in *Fig. 6*, suggests that the noted downward trend in the public debt of Moscow and the Moscow region will continue in the short term (to 214.1 billion rubles by 2022). A more positive scenario is also possible — a decrease in the public debt of the regions to 106.3 billion rubles. Since the total public debt of the regions of the first group over the past three years has been growing, which is pronounced in the Moscow region, the scenario of a pessimistic forecast
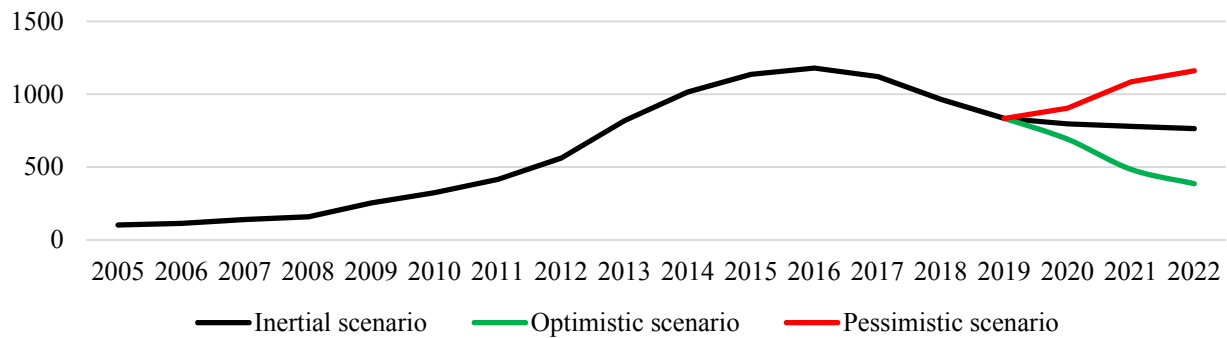
Fig. 7. **Scenarios of the dynamics of the aggregate public debt of the regions of the second group until 2022, billion rubles**

Source: compiled by the authors.

is possible — an increase in the total public debt of regions to 362.2 billion rubles. This is an extremely negative scenario of a change in the debt burden on the regional budget, formed as a result of ARIMA modelling with a 95% confidence level.

If in Moscow and the Moscow region the level of debt burden on the budget's own tax and non-tax revenues has been decreasing since 2009, in other regions of Russia it increased until 2016 (*Fig. 5*). The debt burden on the budget of these regions began to decline only in 2017. A similar trend was observed in the dynamics of changes in the public debt of all regions of the second group, to which we include the Belgorod, Bryansk, Voronezh, Ivanovo, Kostroma, Kursk, Lipetsk, Ryazan, Tver, Arkhangelsk, Volgograd, Leningrad, Murmansk, Astrakhan, Volgograd, Rostov, Samara, Orenburg, Chelyabinsk, Amur, Magadan, Kemerovo and Sakhalin regions, the Republic of Karelia, Komi, Dagestan, Bashkortostan, Chuvashia, Kabardino-Balkaria, Altai, as well as Krasnodar, Stavropol, Krasnoyarsk, Altai, Kamchatka, Primorsky Krai, Khanty-Mansi Autonomous Okrug, Yamalo-Nenets Autonomous Okrug, Nenets and Chukotka Autonomous Okrugs (*Fig. 3*). These regions are characterized by an all-Russian tendency to change the dynamics of public debt. As a result of using the ARIMA modelling tool, three forecast scenarios of changes in the total public debt of the regions of the second group until 2022 were built (*Fig. 7*).

The inertial scenario, formed with a reliability of 95%, predicts a continuation of the trend towards a decrease in the size of public debt in all regions of the second group. The total debt of the region, according to this forecast, may decrease by 2022 from 833.8 to 763.5 billion rubles. Two extremely opposite scenarios (optimistic and pessimistic), which, as the model showed, are quite realistic, allow reducing the public debt of the regions to the level of 2010 (to 385.1 billion rubles) and its growth to the level of 2016 (to 1 161 billion rubles) in the event of a deterioration in the budgetary provision of these regions.

In the regions of the third group, to which we include St. Petersburg, the Republic of Tatarstan, Sakha, Ingushetia, Karachay-Cherkessia, North Ossetia, Chechnya, Mari El, Mordovia, Udmurtia, Tuva, Khakassia, Buryatia, Adygea, Kalmykia, Crimea, Perm, Transbaikal, Khabarovsk Territories, Kurgan, Sverdlovsk, Novosibirsk, Omsk, Tomsk Regions and other regions throughout the entire period under review, there was a steady growth trend in public debt (*Fig. 4*). This group, in addition to subsidized regions with low budgetary security, also includes actively developing regions that attract budget and bank loans, investments in debt securities to solve the most important problems of socio-economic development and implement strategic projects and programs. The use of ARIMA modelling made it possible to identify three possible scenarios for further changes in the dynamics of their public debt (*Fig. 8*).
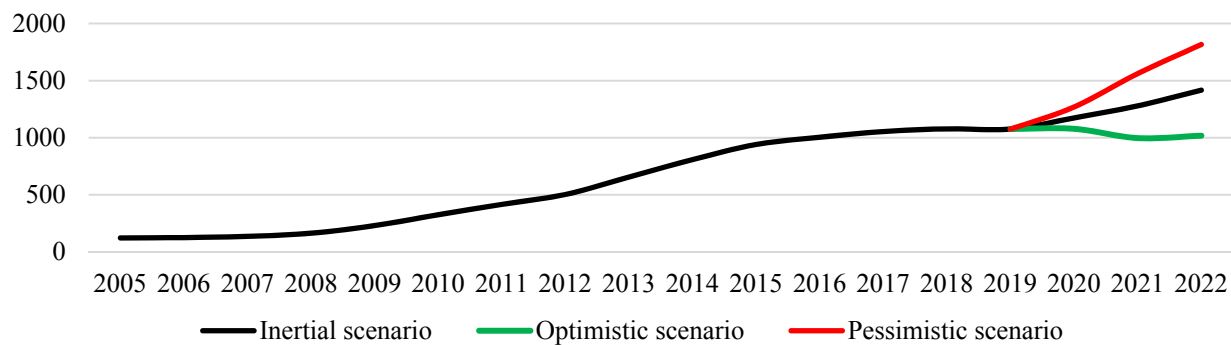
Fig. 8. **Scenarios of the dynamics of the aggregate public debt of the regions of the third group until 2022, billion rubles**

Source: compiled by the authors.

Since over the entire study period the size of the public debt of the regions of this group did not practically decrease, the most likely scenario, considering the noted rates of its change, is an increase in the total public debt of the regions of Russia of the third group for 1 416.9 billion rubles.

A more significant increase in their public debt is also possible — up to 1 816.8 billion rubles, since this group includes subsidized regions. Even an optimistic forecast, as shown by ARIMA modelling, allows maintaining the high level of public debt achieved by the regions (1 017.7 billion rubles) until 2022.

To assess the impact of the dynamics of public debt on the key indicator of socio-economic development — the GRP of the three indicated groups of regions and to further build predictive scenarios for changing its dynamics until 2022, regression modelling using panel data was used. The gross regional product was considered as a dependent variable, and the volume of public debt of the Russian regions and their municipalities was considered as the factor under study. When constructing a model for the first group of regions with a decreasing debt burden on the budget, which is formed by Moscow and the Moscow region, 30 observations were used (annual statistics of the Ministry of Finance of the Russian Federation on the size of public debt of the Russian regions for the period 2005–2019). For the second group of regions with a characteristic tendency towards a decrease in the debt burden on the budget, 585 observations have been used since 2017, for the third group of regions with a steady increase in public debt throughout the entire period under consideration — 615 observations.

Before the formation of regression models for the three types of regional systems, the data were analyzed for stationarity using the Dickey-Fuller test, for the presence of unit roots in the panel using the Chow test. The choice between models with fixed or random effects was carried out using the Hausman and Breusch-Pagan tests, the test for the statistical significance of the regression coefficients (including the Wald test), and the analysis of information criteria of Schwarz, Akaike, and Hannan-Quinn, a Durbin-Watson residual autocorrelation test, a Jarque-Bera test to evaluate the normal distribution of residuals. The Hausman and Breusch-Pagan test showed that the most accurate and adequate model for all groups of regions is the model with fixed effects.

The constructed regression models made it possible to confirm the hypothesis that public debt negatively affects the dynamics of the GRP of Moscow and the Moscow region and has a positive effect on the dynamics of the GRP of the regions of the second and third groups. The economic development of the first group of regions of the Russian Federation (Moscow and the Moscow region) is negatively affected by the processes of increasing public debt, the

The second group of regions (with a downward trend in the public debt of the Russian regions since 2017)
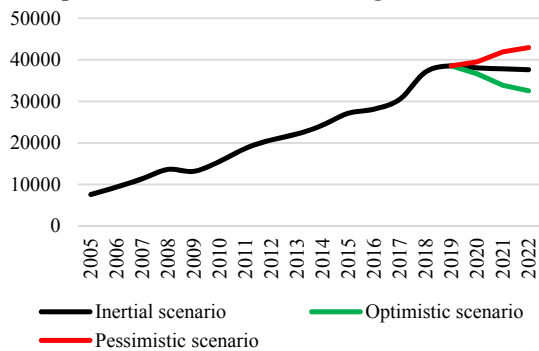
The third group of regions (with a growth trend in the public debt of the Russian regions from 2005 to 2020)
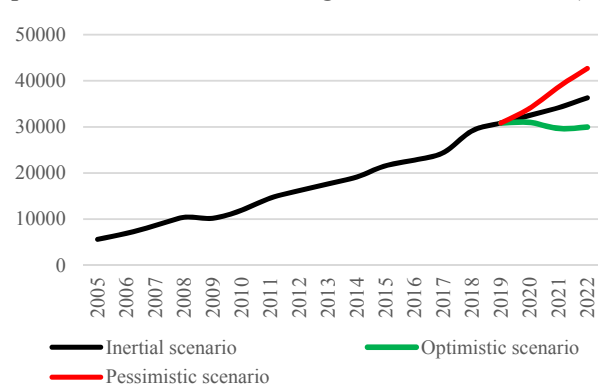
Fig. 9. **Basic forecast scenarios for the development of the dynamics of the GRP of the regions of the second and third groups until 2022, billion rubles**

Source: compiled by the authors.
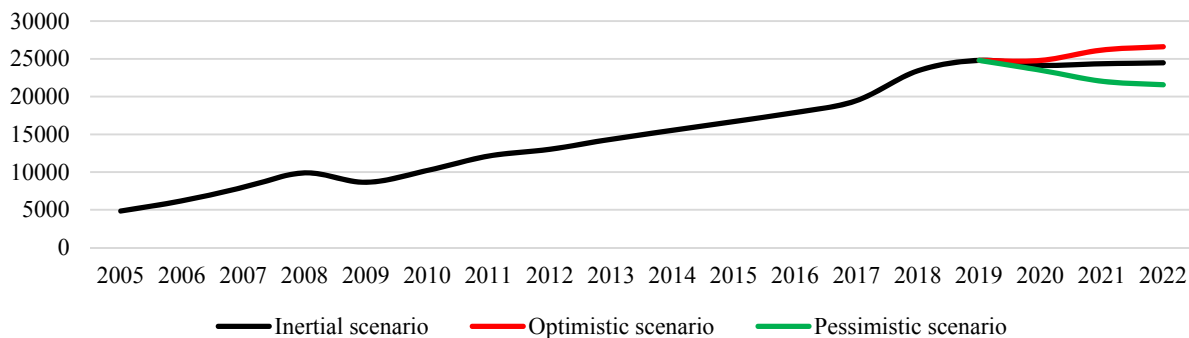
Fig. 10. **Basic forecast scenarios for the development of the dynamics of the GRP of the regions of the first group (Moscow and the Moscow region) until 2022, billion rubles**

Source: compiled by the authors.

relationship between these variables in the regression model is inverse. Thus, according to the constructed model, the growth of the national debt of these regions by 1 million rubles leads to a decrease in their GRP by 19.7 million rubles (*Appendix*).

In the second and third groups of regions, an inverse relationship is observed: an increase in the public debt of the Russian regions leads to an increase in their gross regional product. At the same time, the regions of the third group are most dependent on budget and bank loans, attracted investments in debt securities of financial institutions, with a stable trend of growth in public debt throughout the entire period under review.

An increase in the public debt of the Russian regions of this group by 1 million rubles, according to the constructed model, leads to an increase in their GRP by 15.7 million rubles, and in the regions of the second group by 13.4 million rubles. Regression modelling has shown the importance of attracting additional financial resources for the growth of the key indicator of the socio-economic development of regions (GRP) of the second and third groups. Due to insufficient budgetary provision, these regions are forced to increase public debt. Implement the optimistic scenario in the dynamics of the GRP of the regions of the second group, i.e. growth of this indicator from 38,557 to 42,929 billion rubles. (*Fig. 9*)

it is necessary to attract additional financial resources — the implementation of the pessimistic scenario (*Fig. 7*) in the dynamics of the public debt of these regions, its growth by 327.2 billion rubles.

To implement the optimistic scenario of changes in the dynamics of GRP (its growth from 30,843 to 42,682 billion rubles), it will be necessary to attract additional resources from the public debt in the amount of 741 billion rubles (implementation of the pessimistic scenario of changes in the dynamics of the public debt of the regions, shown in *Fig. 8*). A decrease in the level of public debt of the regions of Russia included in these groups will lead, according to the constructed regression model, to a decrease in the GRP of regions to the level of 2017 in the second group and to a decrease in the GRP of regions to the level of 2017, to the level of 2019 in the third (*Fig. 9*).

The inertial scenario of changes in the dynamics of the GRP of the regions of the second group (its moderate decrease) is possible in the presence of the previously noted (*Fig. 7*) trend of decreasing the public debt of the Russian regions i.e. inertial scenario of changes in its dynamics. Thus, the constructed model and scenarios confirm the positive impact of public debt on the dynamics of the GRP of the regions of the Russian Federation of the second and third groups. More prosperous regions (Moscow and the Moscow region), on the contrary, are forced to reduce the debt burden on the budget. An optimistic scenario of the dynamics of the GRP of the central regions is possible only if a similar scenario of changes in their public debt is realized. A decrease in the public debt of these regions of Russia has a positive effect on the dynamics of their GRP (*Fig. 10*). To implement the optimistic forecast for the development of the dynamics of the GRP of Moscow and the Moscow region, it is necessary to reduce the total size of their public debt by 91.7 billion rubles. Reducing the debt burden on the budgets of these regions will increase their GRP from 24,801 to 26,609 billion rubles.

Maintaining the current rate of decrease in the public debt of the regions will only slightly increase the volume of GRP. The constructed regression model and scenarios for this group of regions indicate the negative impact of the dynamics of public debt on their GRP. Thus, as a result of the study, it was confirmed that the public debt has a negative impact on the dynamics of the GRP of Moscow and the Moscow region and a positive effect on the dynamics of the GRP of the regions of the second and third groups, the importance of attracting investments in debt securities of the Russian regions, as well as additional bank and budget loans, i.e. building up public debt for the economic development of regions that do not have high budget security.

CONCLUSIONS

A theoretical analysis of works in this area has shown that public debt has a different effect on the key indicator of the socio-economic development of territories — the gross regional product. Panel regression analysis and ARIMA modelling were used to assess the impact of the public debt of the Russian regions on GRP. The developed methodological approach involves analyzing the dynamics of changes in the public debt of regions, grouping them according to the established trends in the dynamics of this indicator, building autoregressive ARIMA models and the most probable scenarios for predicting changes in the dynamics of public debt for each region of Russia until 2022 (inertial, optimistic and pessimistic), regression modeling of the dependence of the GRP of the Russian regions on the dynamics of their public debt according to panel data for three groups of regions and the design of corresponding scenarios for predicting changes in their GRP.

This approach allows us identifying the types of regions with different trends in the dynamics of changes in public debt: regions with a decrease in the debt burden on the budget, with a trend towards a decrease in the

debt burden of the Russian Federation on the budget since 2017 and regions with a steady growth in public debt throughout the period under consideration. ARIMA modelling of the dynamics of the public debt of these groups of regions, panel regression analysis of the impact of the dynamics of public debt on GRP within the selected groups, predicted scenarios of changes in the public debt of regions and the dynamics of their GRP until 2022 helped to substantiate the hypothesis that the public debt negatively affects the dynamics of the GRP of Moscow and the Moscow region and has a positive effect on the GRP of the regions of the second and third groups.

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Results of regression modelling of the dependence of the GRP of the Russian regions on the dynamics of their public debt for three groups of regions

Model 1 — for the first group of regions — Moscow, Moscow region (with a downward trend in public debt since 2010)				
	Coefficient	*St. error*	*t- statistic*	*P-value*
const	9231710000	1307040000	7.063	1.36e-07 ***
X	**−19.72**	9.581	−2.058	0.049 **
LSDV R-squared	0.675		Within *R*-squared	0.136
LSDV F(2, 27)	28.148		*P*-value (*F*)	2.48e-07 ***
Schwarz criterion	1406.46		Akaike criterion	1402.256
rho-parameter	0.87		Hannan-Quinn criterion	1403.601
Wald test for heteroscedasticity (null hypothesis — observations have total error variance):			Test statistic: Chi-square (2) = 38.684	3.97951e-009 ***
Wooldridge test for assessing autocorrelation:			Test statistic: *F* (1, 1) = 4394.63	0.0096 ***
Null hypothesis — normal distribution:			Chi-square (2) = 3.048	0.021 ***
Model 2 — for the second group of regions (with a downward trend in public debt of the Russian regions since 2017)				
	Coefficient	St. error	t- statistic	P-value
const	334826000	15524500	21.57	4.70e-075 ***
X	**13.364**	18.84	0.709	2.46e-061 ***
LSDV R-squared	0.819		Within R-squared	0.394
LSDV F (39, 545)	63.604		P-value (F)	2.8e-176 ***
Schwarz criterion	24557.87		Akaike criterion	24383
rho-parameter	0.991		Hannan-Quinn criterion	24451.15
Breusch-Pagan test statistic:			LM = 2266.56	0.0 ***
Hausman test statistic:			H = 0.259	0.61
Wald test for heteroscedasticity (null hypothesis — observations have total error variance):			Chi-square (39) = 2.09359e + 006	0.0 ***
Wooldridge test for assessing autocorrelation:			Test statistic: *F* (1, 38) = 222.483	1.81e-017 ***
Null hypothesis — normal distribution:			Chi-square (2) = 299.67	0.0 ***

Model 3 — for the third group of regions (with a growth trend in public debt of the Russian regions from 2005 to 2020)				
	Coefficient	*St. error*	*t- statistic*	*P-value*
const	185084000	14647900	12.64	1,85e-032 ***
X	**15.749**	0.780	20.17	8,72e-069 ***
LSDV R-squared	0.829		Within *R*-squared	0.415
LSDV F (41, 573)	68.199		P-value (*F*)	3.0e-192 ***
Schwarz criterion	25708.87		Akaike criterion	25523.16
rho-parameter	0.933		Hannan-Quinn criterion	25595.37
Breusch-Pagan test statistic:			LM = 2288.02	0.0 ***
Hausman test statistic:			H = 0.685	0.407
Wald test for heteroscedasticity (null hypothesis — observations have total error variance):			Test statistic: Chi-square (41) = 2.3304e+007	0.0 ***
Wooldridge test for assessing autocorrelation:			Test statistic: F (1, 40) = 2477.48	1.32859e-037 ***
Null hypothesis — normal distribution:			Chi-square (2) = 1890.4	0.0 ***

Source: compiled by the authors.

Note: ***, ** Statistical significance at the 1% and 5% level, respectively.

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IFIs Undertake Financing when their Environmental and Social Quality Criteria are Met

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ABSTRACT

The main content of this article is to describe "climate finance" and "green finance" in detail, as implemented by International Financial Institutions (IFIs) and their pertinent environmental and social project quality criteria. The approach of this article is to perceive and understand environment-related activities of international financial institutions (IFIs) as part of a societal learning process, and consequently to describe their "environmental and social project quality criteria" as an expression of such ongoing societal learning processes. What can our readership, related to global finance, profit from such a comparison? Against the expectation of many, IFIs already implemented efficient rules for redirecting global funds to climate and environmental projects — and have thus performed a successful "act of societal learning". The "environmental and social project quality criteria" have played a crucial role in convincing economic and administrative actors (i.e., learners in our context) to behave in a climate-compatible manner. Thus, the lesson can be drawn from the domain of "societal learning" to the domain of "individual learning" that clear and transparent criteria sets are decisive for a rule-based societal transformation. This article shows that a criteria-based selection process provides the best results for long-term societal interest; in this case climate protection.

Keywords: collective learning; societal learning; global learning; rule-based society; criteria-based decisions; global warming mitigation; global warming adaptation; International Financial Organisations; IFIs; infrastructure projects; Central Asia; environmental quality criteria; social quality criteria

1. INTRODUCTION

The <u>main content</u> of this article is to describe "**climate finance**" and "*green finance*" actions [1–12] to *allow for innovation and growth* [13–29]. Such green financing is undertaken by **International Financial Institutions** (IFIs) and their pertinent and relevant **environmental and social project quality criteria** in great detail.

The <u>approach</u> of the article is to intentionally take a learning-oriented standpoint in order to receive additional insight into suitable procedures of global finance. Given that conceptual progress in science is often made when two apparently incongruent domains of knowledge are combined, this article joins the field of didactics with the field of financing. It is possible that both domains are well known to the reader, or perhaps only one of them — and therefore a brief introduction is provided here.

In general, two main types of learning are perceived, and their key terms are presented and defined here:

• **Individual learning**: one human individual learns from books or other content, on their own or jointly with other partners, and consequently changes behaviour in such a way that said person is more apt for the complex requirements of the present globalised world.

• **Societal learning**: an entire society (or even global society) learns from whatever the given sources are and by whichever (social, political, evolutionary) procedures about the needs of how to form a sustainable humanitarian civilisation and further develop its behaviour, actions, methods, institutions, rules and ethical systems. At present, the most urgent case for such societal learning is global climate change, according to the views of many [30, 31] and.[1] The notion of societal learning is further analysed and linked to *transformative change* (as opposed to mere adaptation) in [32, p. 7, 15; 33; 34, p. 58; 35–39].

Based on the hypothesis that patterns, structures and procedures in individual and societal learning might to a certain degree be similar, successful patterns, structures and procedures from societal learning might also be considered for individual learning. Therefore, a case study

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[1] FFF (2019), Fridays for Future. International youth movement. URL: https://www.fridaysforfuture.org/ (accessed on 12.08.2020); UNFCCC (2019), United Nations Framework Contract on Climate Change. Procedures of annual Conferences of the Parties (COP). URL: https://unfccc.int/ (accessed on 22.06.2021).

for the procedure for societal learning is presented here in detail, based on desk studies; namely how decisions are made should large-scale infrastructure projects be financed worldwide or not. This case study will deal with the selection criteria for project funding defined by the IFIs.

The main structural similarities between collective and individual learning are self-reflective processes which lead to the constant re-adaptation of targets, methods and procedures. "*Reflection in action*" [40–42] is a fundamental procedural element that is applicable to both domains, while needing a more organised and institutionalised setup in the case of collective learning. In both cases, learning means to act, while the fundaments for such action remain under continuous scrutiny and re-assessment. Thus, an overall "fluid" appearance of the learning process is characteristic. In the domain of collective learning, this means using sets of socio-economic project criteria while at the same time being inclined to continuously re-assess their usability in the light of ongoing experience with their re-application. Even if the motto of "reflection in action" dates back to the last century, it suitably portrays the decent but unstable equilibrium of acting and contemplating (re-considering against the background of earlier experiences) within the procedure of moving forward in a highly unknown terrain.

The intention is to perceive and understand environment-related activities of international financial institutions (IFIs) as part of a societal learning process, and consequently to describe their "environmental and social project quality criteria" as an expression of such an ongoing societal learning process. More precisely, this article understands global humanity's reaction to the threats of global warming and global change [43] as a collective learning procedure. This is the key vantage point of the present text. The author suggests that making comparisons between individual and collective learning processes may offer additional insights into both, including suggestions on how to design them suitably, effectively and successfully.

There are differences between the two concepts of climate change and global warming [43–45]. Climate change focuses on meteorological parameters such as changes in temperature and precipitation, and consequently changes in soil moisture, incidences of strong winds and heavy precipitation, including resulting floods. However, the notion of global change extends into social spheres, both regarding driving factors (patterns of energy use and land use) and regarding effects (climate-induced migration, including resulting political instabilities) [30, 43].

What can this volume's readership, likely to be related to higher education and lifelong learning, profit from such a comparison? Against the author's initial expectation, IFIs are starting to become efficient at redirecting global funds to climate and environmental projects — and have thus performed a successful "act of societal learning" [46, 47]. In recent years, several IFIs claim to have succeeded in limiting their funding to projects that are beneficial for combatting climate change [48–51] and.[2]

The "*environmental and social project quality criteria*" have played a crucial role in convincing economic and administrative actors (i.e., learners in this context) to behave in a climate-compatible manner. Thus, the lesson can be drawn from the domain of "societal learning" to the domain of "individual learning" that clear and transparent criteria sets are decisive for a rule-based societal transformation.

What is the link between IFI and education providers? In this article's view, IFIs have a double functionality in the global process of "societal learning" which represents humanity's search for appropriate answers to global warming, environmental pressures and globalisation:

1. IFIs are *learners* in themselves who strive for a better understanding of global warming and its resulting challenges. Thus, IFIs optimise their own "societal learning"

2. IFIs are *trainers* because of their power to impose rule systems on global financial players such as consortia and state governments who strive to attain their funding support for specific project applications. Thus, IFIs may accelerate "societal learning" in those other actors.

This double nature of trainers actually being learners themselves has been repeatedly highlighted by didactic and pedagogic literature [52, 53]. Thus, the connections between didactic concepts and the domain of finance are manifold: IFIs are both agents of learning processes

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[2] AFD (2018), Agence Française de Développement — Climate Financing. URL: https://www.afd.fr/sites/afd/files/2017–10/climate-activity-afd-group.pdf. (accessed on 22.06.2021); EBRD (2017), The European Bank for Reconstruction and Development — Sustainability approach. URL: http://www.ebrd.com/our-sustainability-approach.html, http://www.ebrd.com/our-sustainability-work.html. (accessed on 22.06.2021); KfW (2017), Kreditanstalt für Wiederaufbau, Sustainability Criteria. https://www.kfw.de/nachhaltigkeit/KfW-Group/Sustainability/Sustainable-Banking-Operations/Sustainable-Investment/KfWs-Sustainable-Investment-Approach/Integration-of-ESG-Criteria/. (accessed on 22.06.2021).

(when imposing criteria sets) and recipients of learning outcomes (e.g. submitted project proposals).

This article suggests three fundamental overall success criteria (1–3) that translate into concrete, project-related quality criteria which will be applied for every single infrastructure project. These three criteria equal the current worldwide understanding of *sustainability encompassing social, environmental and economic dimensions* [54]. Later, these fundamental criteria will be mirrored against the quality criteria established by IFIs to ensure a suitable "collective social learning process":

1. Creating a long-lasting *societal* consensus among all involved social groups

2. Creating *environmental* sustainability in the region, including global climate justice

3. Maintaining long-term *economic* reliability and financially well-functioning economic enterprises and state institutions within the state in question.

Overall, the present article takes an unconventional viewpoint regarding the following aspects:

(1) the opportunity for an interesting combination of topics lies in combining didactics and finance;

(2) the link between collective and individual learning in the context of IFIs allows for inserting didactic concepts into the procedures of financing proposals;

(3) incorporating environmental and social criteria into the selection process will lead to better collective and individual learning among IFI staff.

This work was conceptualised and started on the basis of practical experience with IFIs, namely during the largest EU environmental project in Central Asia, during which several experts from each portrayed IFI were invited to quarterly conferences with the target of implementing ten large-scale transboundary infrastructure projects in the five Central Asian states in cooperation with their governments. Based on a didactic approach towards life, designing institutional structures is perceived here being analogous to an advanced and collective learning design. The insertion of humanitarian responsibility into our tertiary education[3] is actually a very profound target of all pedagogy.

In this article, combating climate change is seen as a learning endeavour which needs suitable global institutions with appropriate rules, procedures and structures. This article investigates what these should

look like. As a clarification, it is added that the terms "global warming" and "climate change" should be clearly differentiated conceptually, even if they are often erroneously used synonymously [43, p. 403; 45, p. 117].

In general, the question is: Can International Financial Institutions (IFIs) support efforts to save the globe from the greenhouse effect and from global warming? When couched in a (neo-) liberal philosophy — which is optimistic about the opportunities for free-market forces to optimally allocate resources [55] and[4] towards direct climate-relevant action — then presumably the answer is yes. However, when following the view that states should prescribe public and economic action, then a more hesitant answer will be given.

In any case, any optimism regarding a positive role of IFIs necessitates clearly guided framework conditions for the functioning of the "free" optimal allocation of capital to available project ideas.

In fact, in past years, practically all such IFIs (list below) established catalogues of "environmental and social quality criteria" which were supposed to guide project proposals to obey long-term global society's preferences for sustainability. More specifically, project proposals presented to IFIs for (co-)financing are systematically being measured against these detailed quality criteria, and if a proposal does not sufficiently meet the criteria it will not be funded. Such quality criteria in the environmental field will represent the main body of the present article. These were analysed in 2017 and an "Investor Guide" [56] for large infrastructural projects was created. In the context of the then largest environmental EU project in Central Asia, the "Investor Guide" has the target of informing actors and stakeholders such as governments and industry about options for receiving funding for large infrastructure projects of some 10–100M€ per project. In practice, several IFIs are co-financing such large, and often transnational, projects such as large dams, power plants, irrigation systems, agricultural amelioration, regional waste management — in brief, projects often relevant for climate change mitigation and adaptation [50, p. 41 and *Fig. 11*).

This article understands the act of establishing a rule-based procedure for identifying global infrastructure construction as an act of "collective global learning".

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[3] EUCEN (2017), UNIBILITY — University Meets Social Responsibility. URL: http://www.eucen.eu/projects/unibility (accessed on 22.06.2021).

[4] WB (2016), The World Bank. Environmental criteria ESF. URL: http://www.worldbank.org/en/programs/environmental-and-social-policies-for-projects; URL: http://documents.worldbank.org/curated/en/383011492423734099/pdf/114278-REVISED-Environmental-and-Social-Framework-Web.pdf (accessed on 22.06.2021).

The reason why learning is chosen as a general perspective in this article is that the instruments of didactics and pedagogy might offer an additional perspective on the issue of climate change and how to better tackle it. Given that "learning" is widely understood as "changing one's behaviour", the lessons of individual learning might be applied to what is referred to here as "collective learning"; namely inducing a change in collective, global societal behaviour in the face of global warming. Therefore, the two types of learning (societal and individual) can also be applied to the practices of IFIs because their quality criteria [56] involve the generation of a set of rules facilitating such improved collective human behaviour. In both individual and collective learning, the learners are pushed to alter behavioural patterns while facing structural obstacles and psychological impediments, be these on the individual or collective levels; and especially when regarding globalisation [57]. Today in our rule-based societies, higher education providers use sets of quality criteria for defining, implementing and monitoring quality on the level of individual learning. Equally, in the domain of "collective learning", such compliance has to be guaranteed: the world's international financial institutions (IFIs) and their "environmental and social quality criteria" are seen here as a lever for society to master the new challenges of climate change in a worldwide environment full of competitors and competing paradigms.

First, infrastructure projects (such as power plants, dams or waste management plans) proposed to IFIs are urged to satisfy Quality Assurance criteria to improve their operations. Second, they must satisfy society's needs for lifelong employability of their citizens. Third, they have to enhance a respectful culture of economic processes by leading to competency-based societal build-up.

The deeper meaning of an IFI is to support the materialisation of societal values. For the selecting of submitted projects, IFIs should use appraisal procedures with quality criteria on environment and climate change.

2. BACKGROUND: IFIS' ROLE IN COLLECTIVE LEARNING

In comparison to individual learners, all IFIs (such as the European Bank for Reconstruction & Development EBRD, European Investment Bank EIB, World Bank, Asian Development Bank ADB, etc.) can be perceived as "collective learners" [57], are strongly committed to environmental sustainability and social equity and apply targeted sets of project quality criteria accordingly to support investment decisions. As a quick example

describing the main European Union bank, EIB has defined four priorities,[5] supporting projects which make an important contribution to both sustainable growth and employment, specifically with regard to the following four priorities that will be explained further later: (1) skills and innovation, (2) SMEs (small & medium enterprises) and midcaps (companies with middle-size share values), (3) infrastructure, and (4) climate and environment.

Therefore, this article starts out by presenting information on relevant International Financial Institutions (IFIs), including the EU Investment Facility for Central Asia (IFCA) and its "blending" approach, based on desk studies and analysis of relevant sources. Blending as a basic concept might not yet be known to all readerships; it is definable as strategic use of a limited volume of grants to mobilise financing by partner FIs and the private sector in order to enhance the developmental impacts of investment projects. For more profound interest, the IG presents the respective project cycles as well as focus areas, environmental and social quality criteria that are to be applied to infrastructure projects in the fields of environment, water and climate change. As complementary information, the IG provides the IFIs' basic approaches to project proposal appraisal, respective project cycles and project award criteria. The IG supports administrations in their application preparations, especially via the European Union's Investment Facility for Central Asia (IFCA), provided to support Central Asia.

As a case study on the level of sovereign republics (representing the real actors and subjects of "collective learning") in the area of Central Asia, the EU has launched a regular consultative process entitled the "EU-Central Asia Work Group on Environment & Climate Change"[6] which is intended for the professionals of Central Asian state administrations who are involved in the identification and preparation of international investment projects in the areas of Environment, Water & Climate Change.

The main purpose of such a "collective learning process" [57] is to
- apply economic knowledge and procedural skills required to develop bankable project proposals that are compatible with the *requirements of climate change,*

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[5] EIB (2016), The European Investment Bank. Including relevant subpages. URL: http://www.eib.org/about/index.htm (accessed on 22.06.2021).
[6] WGECC (2017), EU-Central Asia Working Group on Environment and Climate Change. Regular consultative process on the state level. URL: http://wecoop2.eu/events/. (accessed on 02.12.2018).

• to increase awareness of mechanisms and conditions offered by various relevant IFIs and donors who provide funds for climate change (CC) adaptation or water or environment projects,

• to increase knowledge on preparation and submission of project proposals,

• to support the implementation of concrete measures couched in relevant policies & strategies and promote experience exchange between countries and actors.

The following sections therefore provide basic information on the key IFIs (International Financial Institutions), such as

• EIB (European Investment Bank),

• EBRD (European Bank for Reconstruction and Development),

• WB (World Bank),

• ADB (Asian Development Bank),

• KfW (German Kreditanstalt für Wiederaufbau),

• AFD (French Agence Française pour le Developpement),

• AIIB (China-based Asian Infrastructure Investment Bank),

• and others.

2.1. Literature review

A *review of academic literature* on the work and procedures of IFIs starts out with a general monitoring of IFI compliance to the Millennium Development Goals (MDGs) undertaken by [58; 59, p. 4], who underlines the importance of infrastructure projects for effectively implementing the MDGs while perceiving the well-known structural field of tension between growth, productivity and sustainability. Still couched in neoclassical approaches as recommended by [60], this early analysis is still rooted in the theories of optimal geographic localisation as well as in the (presumably over-euphoretic) hypothesis of a self-controlled worldwide "convergence" of economic levels and systems [61]. The more recent in-depth study,[7] proposes a methodology to evaluate and quantify the effects of agricultural practice on global climate change by means of a clear four-step approach.

Gallagher [62, p. 15] and Neves & Cavazotte [63, p. 612] propose a historic view on evolving strategies for fulfilling

environmental criteria in large-scale infrastructure projects while using the example of environmental safeguards developed at the World Bank since 1991. Similarly, the EBRD [64] and World Bank Group,[8] reflect their success criteria for project financing regarding policy coherence and legal accountability with an emphasis on human rights (not yet specifically on environmental or social ethics). WB,[9] concludes that "at a technical level, the body of knowledge on human rights measurement methodology, although growing, is incomplete despite significant progress in areas such as human rights impact assessments and human rights indicators" [65, p. 158]. An internationally cooperating Master's curriculum "Global Studies" was established at Graz University in Austria in order to especially care for the worldwide implementation of such humanistic values [66].

Nielson et al. [67] quantify the volume of international aid to which the social and environmental criteria in question should be applied: "Every year, states and international organizations provide somewhere between $ 120 and $ 170 billion in official development finance to recipient countries", while the first (~IFIs) cover one third of this sum. These authors ask if "divergence in institutional form leads to differences in content and function?" — actually it is the motive of the present article to avoid such difference.

2.2. IFCA, the Investment Facility for Central Asia

The tool of "blended finance" and the project line "IFCA", the EU *Investment Facility for Central Asia* has been presented earlier in this journal [51]. This subsection here will use the case study of Central Asia (CA) to depict details: The EU has launched the Investment Facility for Central Asia (abbreviated as IFCA, while analogous programs exist for other world regions, see coloured areas in *Figure 1*) in 2010 to help address the challenges perceived by Central Asian countries when financing their key infrastructure, particularly in their environment, energy and social sectors. An additional key aim of this facility is to engage private sector stakeholders, particularly SMEs

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[7] FAO (2017). Adoption of climate technologies by the agrifood sector — Methodology. Food and Agriculture Organisation, Rome, p. 15. URL: https://books.google.at/books?id=w-NfDwAAQBAJ (accessed on 22.06.2021).

[8] WB (2013), Legal Innovation and Empowerment for Development. The World Bank Legal Review, Vol. 4. Ed. by H. Cissé, S. Muller, C. Thomas, W. Chenguang. URL: https://books.google.at/books?id=j6SvECYXyCEC (accessed on 22.06.2021).

[9] WB (2013), Legal Innovation and Empowerment for Development. The World Bank Legal Review, Vol. 4. Ed. by H. Cissé, S. Muller, C. Thomas, W. Chenguang. p. 147. URL: https://books.google.at/books?id=j6SvECYXyCEC (accessed on 22.06.2021).

(small and medium-sized enterprises) within this developmental process.

The Facility can intervene in cases where *regular markets fail* to offer sufficient and affordable financing, namely in cases where market failure hinders a timely realisation of high-priority investment for projects with a potential to promote inclusive as well as sustainable socio-economic development.

Analogously to other EU blending facilities, IFCA is able to act as a *catalyst* when it comes to pooling resources and improving the coordination or coherence of donor actions. In conformity to the principles of ownership, partnership and shared responsibilities, IFCA thus operates by providing non-refundable financial contributions that support loans for Central Asian countries stemming from EIB, EBRD or other European multilateral or national development finance institutions (FI). Its main purpose is: promoting additional investments and key infrastructures while keeping an initial priority focus on energy, environment, water, climate, SMEs and social infrastructure.

IFCA undertakes to achieve the existing policy objectives of the Development Cooperation Instrument and of the Regional Strategy for Central Asia (*Fig. 1*).

2.3. Implementation of IFCA

One additionally relevant aspect of *education* here lies in the co-decision process: the contribution of the EU Commission to IFCA is decided annually (*Fig. 2*) and these EU resources are made available through the DCI (Development Cooperation Instrument). For the period 2010–2015, the EU Commission allocated an overall amount of € 145 million to IFCA.

For the educational domain, this example underlines that the cooperative *design* of decision processes is of key importance for learning, especially when it comes to complex interdisciplinary themes (globalisation, intercultural tensions, global warming policies) in tertiary education. The overall target (both in individual and collective learning) is to perceive and respect all possible viewpoints which are easily represented societally by diverse institutions; in the case of the EU by different bodies representing divergent interests.

2.4. Results of IFCA

The above-mentioned multilateral decision process optimises taking into account the diverging fact-based aspects of any interdisciplinary, multi-faceted issue. This "collective learning procedure" is thus a positive

example of how to solve transcultural, transdisciplinary learning tasks, for which the following enumeration is a concrete example. The insertion of such inter-stakeholder solutions into the pragmatic realm of economic realities is achieved by the financial tools enumerated thereafter.

According to the objectives of the 2014–2020 "Regional Indicative Programme for Central Asia", IFCA's main target means contributing to sustainable regional development as well as economic growth at the same time. Consequently, IFCA finances projects having these following aims:
- Improve energy and water infrastructures;
- Increase protection of CA environment with a better focus on and control of climate change impacts;
- Create and enhance SMEs and improve the employment situation;
- Improve social services as well as infrastructure, including health and education.

Moreover, IFCA may support the implementation of so-called bilateral Indicative Programmes in the region:
- investment grant for public infrastructure projects;
- financing loan guarantee costs;
- subsiding interest rates;
- technical assistance;
- risk capital operation

(the latter two are financed as a part of a specific investment operation or as an envelope made available to EIB).

The blending decision-making process is shown in higher procedural detail according to the "Guidelines on EU blending operations" (*Fig. 2*).

For this article, the decision was made on the one side to devote the entire Chapter 2 to IFCA and on the other article to include all IFIs (in the strict sense) to Chapter 3, because in fact IFCA is more than an IFI but rather a procedure allowing to combine several IFIs for a given project.

3. IFIS' SOCIAL AND ENVIRONMENTAL PROJECT AWARD CRITERIA

Again, in this article, the additional target (beyond portraying IFIs' work) is to highlight the way in which IFIs' actions can be perceived as "societal learning" or "collective learning" with humanity facing the challenge of global warming. IFIs are portrayed and evaluated, while keeping in mind that these are key players in the endeavour of mankind's learning experience of how to manage global change, globalisation, and especially climate change.
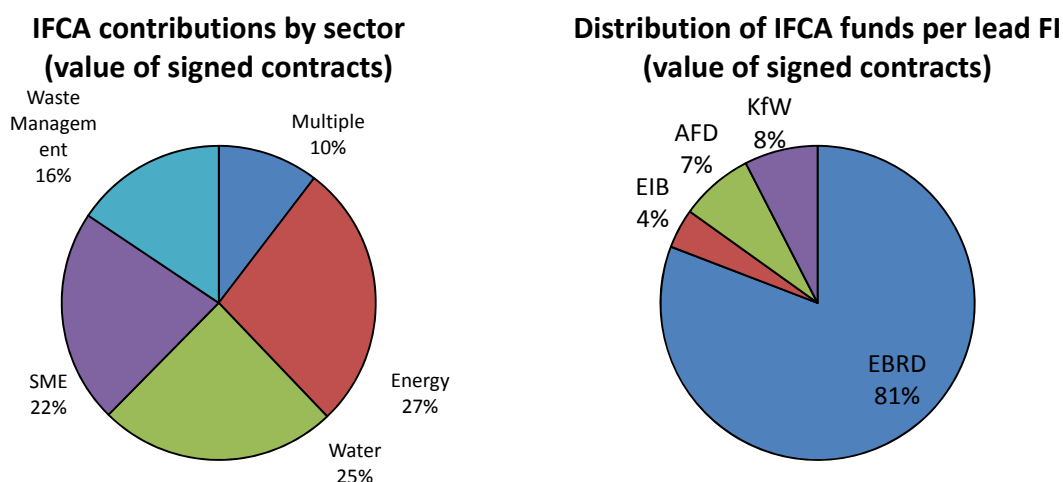
**IFCA contributions by sector
(value of signed contracts)**

**Distribution of IFCA funds per lead FI
(value of signed contracts)**

Fig. 1. **Components of the financial tool IFCA. At left: thematic sectors for IFCA aid (SME = small and medium enterprises); at right: leading IFI (for abbreviations, see list above)**

Source: EU (2019), Innovative Financial Instruments (blending). Brochure and information. URL: https://ec.europa.eu/europeaid/policies/innovative-financial-instruments-blending_en (accessed on 22.06.2021); EU (2015), EU Blending — European Union aid to catalyse investments. Explanation of the blending mechanism. URL: https://ec.europa.eu/europeaid/sites/devco/files/leaflet-eu_blending-2015_en.pdf (accessed on 22.06.2021).

In this view, the role of an IFI is *at the same time the role of a learner and of a trainer* for the education of other agents (by imposing their rules on the project application and financing mechanism) — mainly of project implementers such as large international companies and governments. Thus, and because of their institutional situatedness amidst the global control system of finances, IFIs can be in a position to considerably accelerate "global learning", i.e. humanity's answer to global warming.

3.1. EIB priorities
and environmental standards

As the first financial actor portrayed, EIB (as the EU's main bank) has defined four priority avenues for financing projects[10]: EIB decided to support projects which *make a significant contribution to sustainable growth & employment* in Europe and regions beyond, e.g., in Central Asia.[11] Annex 2 shows EIB's environmental and social standards in brief. Activities follow the EIB project cycle[12] and focus on the following four priority areas:

(1) Skills and innovation are held to represent key ingredients for ensuring sustainable growth and creating valuable jobs. These play important roles when driving competitiveness in the long term. This is a top priority for EIB. EIB is a major partner in those projects that actually develop innovation and skills for growing economies. In 2016, EIB supported innovation and skills with 13,500 M€ of EIB loans.

(2) SMEs and Midcaps: Small and medium-sized enterprises are essential drivers of growth, innovation and employment in Europe. SMEs represent well over 90% of businesses in the EU, while employing two thirds of the active working population. For the EIB Group, supporting access to finance for SMEs and midcaps is a clear top priority. In 2016 alone, the EIB Group financed SMEs & midcaps across the globe to a record 33,600 M€ (EIB Group). EIB supported 300,000 smaller companies, employing 4.4 million people.

(3) Infrastructure is held to represent an essential fundament that interconnects internal markets with economies. Such projects play important roles for economic growth, job creation and sustainability, as well as for ensuring competitiveness. Substantial financing at reasonable costs is required for new investment in infrastructure. Being 'the' EU bank, EIB has made it a top priority to continue supporting such initiatives, investing in energy efficiency, water, transport and sustainable urban infrastructure. Such projects are ambitious and vital for maintaining economic growth in Europe and wider

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[10] EIB (2016), The European Investment Bank. Including relevant subpages. URL: http://www.eib.org/about/index.htm (accessed on 22.06.2021).

[11] EIB (2017), The European Investment Bank's Central Asian Engagements. URL: http://www.eib.org/projects/regions/central-asia/index.htm (accessed on 22.06.2021).

[12] EIB (2018), The European Investment Bank's Project Cycle. URL: http://www.eib.org/projects/cycle/index.htm (accessed on 22.06.2021).

FIGURE 4.2 Blending decision-making process
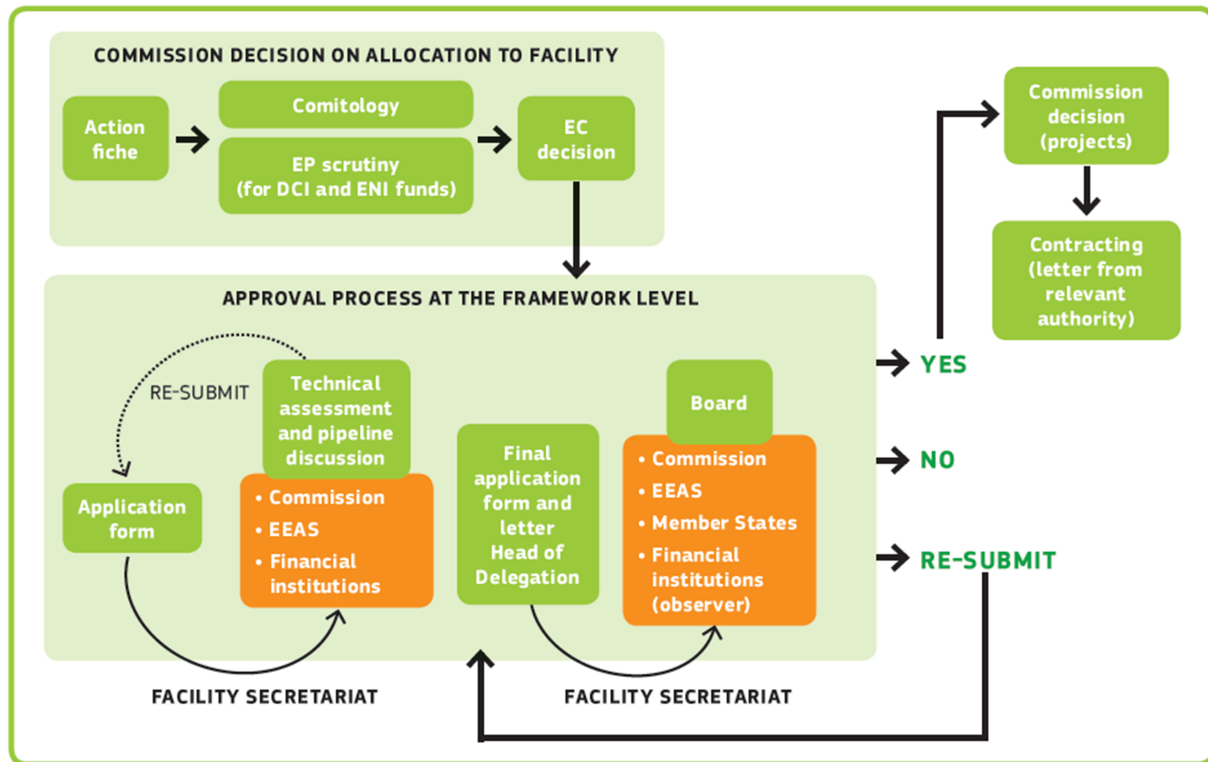

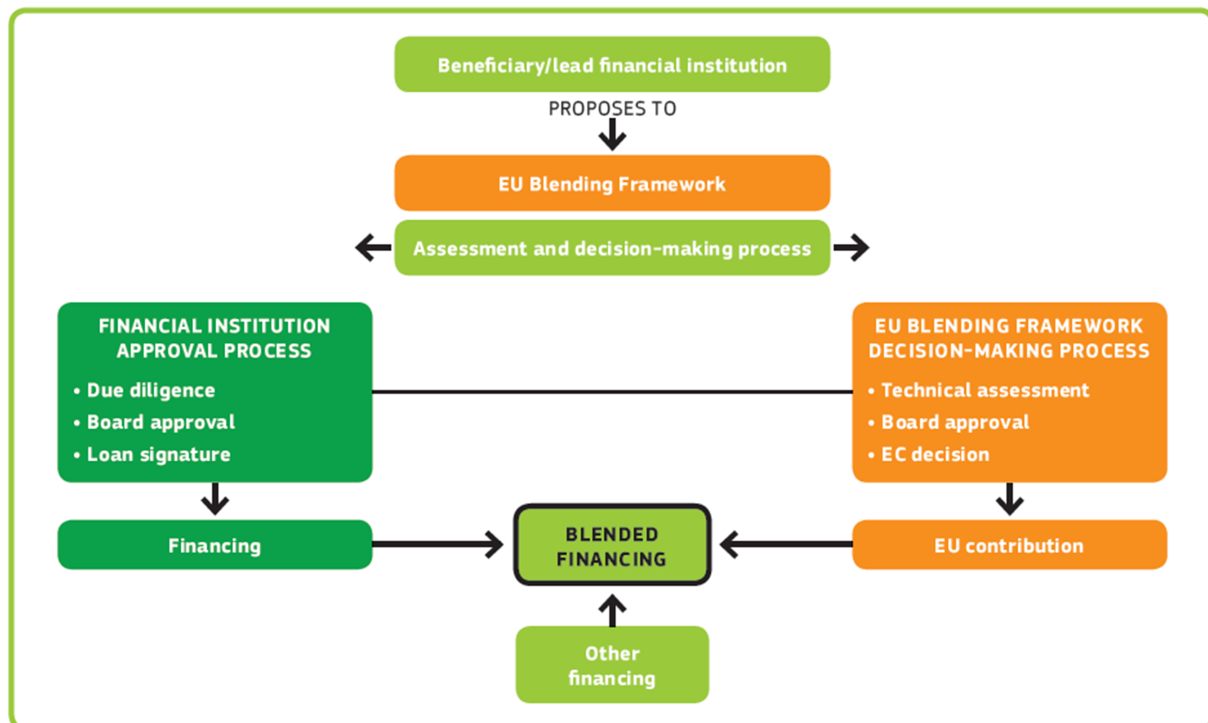**FIGURE 4.3** Parallel decision process of financial institution and EU

Fig. 2. **Above: the blending decision-making process. Below: the parallel decision process of IFI and EU. Both can serve as an example of co-decision in education**

Source: EIB (2016), The European Investment Bank. Including relevant subpages. URL: http://www.eib.org/about/index.htm (accessed on 22.06.2021).

regions. In 2016, EIB provided 19,700 M€ as support for infrastructure projects. Over 55 million people benefited from these projects, particularly in less developed European regions.

(4) Environment and climate**:** EIB supports transiting to a low-carbon, environmentally friendly, climate-resilient economy. Being the largest multilateral climate finance provider worldwide, EIB commits more than 25% of its lending portfolio to climate-resilient and low-carbon growth. In 2016, EIB provided 16,900 M€ for supporting environmental projects. As an example, EIB supported a safer drinking water supply for 25 million people worldwide. Regarding climate action, the EIB exceeded its target for the seventh consecutive year, providing over 19,000 M€ to support mitigating climate change and impact adaptation. Overall, this represents 26% of EIB's total lending in 2016.

As 'the' EU bank, EIB understands the need to strongly promote environmental goals in both developing and developed countries. EIB's funding supports sustainable projects in more than 160 countries and catalyses the mobilisation of private finance into climate action, thus encouraging other actors to match such long-term investment. Until now, EIB is the world's largest issuer of Green Bonds. In support of the Paris Agreement, EIB also committed to increase its lending for such action in developing countries to 35% of total lending by 2020.

Evaluation of EIB quality criteria:

• EIB's priorities show strategic focus is on innovation and skills (as a quite suitable proactive focus); SMEs (in harmony with Europe's structure having small and often private enterprises); infrastructure (as the main driver for economic progress); and climate and environment (with a share of at least 25% within overall funding in 2017; recently this percentage was set to rise). To date, EIB is the largest issuer of Green Bonds in the world and is dedicated in its support of the Paris agreement.

• EIB's ten environmental and social standards include classical targets such as pollution prevention and biodiversity, but also climate-related standards which are soundly integrated into EU climate policy — but should be further differentiated and operationalised for concrete practice.

In brief, EIB appears as a learning actor who tries to quickly catch up with recent progress in policy (after the Paris agreement) and operationalisation, but lacks wide coverage of all the necessary aspects of up-to-date understanding of sustainability including dynamic climate

protection. EBRD's role as trainer should still be improved by proactive training of applicants on how to suitably fulfil project assessment criteria substantially.

This monitoring of IFI quality criteria and those of the following other IFIs will be synoptically evaluated against the threefold quality criteria (established in section 2.8) later in section 3.8.

3.2. EBRD environmental performance requirements

EBRD[13] describes its key sectors of action as follows: Equity Funds, Agribusiness, Information and Communication Technologies, Financial Institutions, Manufacturing and Services, Municipal Legal Reform, Infrastructure, Natural Resources, Power and Energy, Nuclear Safety, Property and Tourism, Transport.

EBRD topics of action in Central Asia (9,400 M€ until 2017) include the key topics *green economy transition*, economic inclusion and food security; and concretely focus on transport, financial institutions, municipal and environmental infrastructure, information and communication technologies, natural resources, power and energy, and agribusiness.

Environmental and social sustainability is safeguarded at EBRD, namely through the criteria listed in Annex 3, and also through products of the green economy which amount to 1/3 of EBRD's investment. EBRD approaches sustainability through a "*Green Economy Transition*", and thus additionally undertakes[14]:

• to incorporate social and environmental requirements in the appraisal and implementation procedures of all EBRD-funded projects based on EU standards and on international good practice

• to provide finance and technical assistance that aims specifically at addressing social and environmental issues

• to promote economic inclusion as well as access to community services such as public transport and water

• to support projects which promote gender equality

• to encourage public participation (PP) through information disclosure and pre-investment consultation,

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[13] EBRD (2016), The European Bank for Reconstruction and Development. Environmental project criteria. URL: http://www.ebrd.com/who-we-are/history-of-the-ebrd.html, http://www.ebrd.com/news/publications/institutional-documents/basic-documents-of-the-ebrd.html (accessed on 22.06.2021).

[14] EBRD (2017), The European Bank for Reconstruction and Development — Sustainability approach. URL: http://www.ebrd.com/our-sustainability-approach.html, http://www.ebrd.com/our-sustainability-work.html. (accessed on 22.06.2021).

while maintaining regular strategic dialogue with stakeholders of civil society and beyond.

Evaluation of EBRD quality criteria:

• EBRD's priorities show a focus on transition, especially on a "Green Economy Transition", and thus uses an approach that is more dynamic than static. On the other hand, EBRD remains rather general about the need for "incorporating environmental and social requirements". A strong point is EBRD's requirement for "public participation (PP) through pre-investment consultation and information disclosure, while maintaining regular strategic dialogue with civil society organisations". Still, EBRD's criteria set seems improvable by incorporating the latest conceptual achievements.

• The key items within EBRD's 10 "Performance Requirements" (PR) are: Assessment and Management of Environmental and Social Impacts and Issues by a management system; Resource Efficiency, Labour and Working Conditions; Pollution Prevention and Control. A specific asset of EBRD set of rules is PR 9: ensure Financial Intermediaries' compliance with all above criteria.

In brief, EBRD appears as a slow but consensus-oriented learner who should catch up by operationalising recent consensus building after the Paris consensus. EBRDS's role as trainer should be significantly sharpened and made more effective by more targeted, better and more concrete project assessment criteria.

3.3. AFD priorities and environmental & social risk management

The French Development Agency (Agence française de développement: see[15]) is the inclusive public development bank of France. AFD undertakes technical assistance and financing for projects that genuinely improve everyday life.[16] It is noticeable that AFD recently took a very strong environmental and climate-related stance, and the new management recently announced that it will fund only climate-compatible projects. Thus, AFD plays an eminent role of "societal learner" who strongly impacts the consciousness of related societal

actors.

According to AFD, in France, development aid meets *four unique standards*:

1. Effectiveness: to perform an assessment of direct aid results, taking into account the specific features of the affected countries.

2. Transparency: to update, make available and differentiate information on the implemented programs.

3. Coherency: to take into account the effects of aid on all economic and social policies of donor countries.

4. Accountability: to use funds while the results obtained must be justified to citizens.

This is the commitment of the entire AFD group: *Information*, *dialogue* and *response to requests*. For AFD, these are the key conditions for a relationship of trust with all partners. AFD Group committed 3,583 M€ in 2016 to "climate" financing (see *Fig. 3*).

In addition to positive criteria, AFD works through a "negative" exclusion list, see Annex 4.

A Corporate Social Responsibility approach (CSR) is essential for the AFD Group. It involves social, environmental, ethical, human rights, anti-corruption, transparency, dialogue with its partners and reduction of its environmental footprint. AFD has developed and implemented a Corporate Social Responsibility (CSR) policy since 2005, both in its internal operations and for its financing.

AFD environmental & social risk management: For AFD, supporting sustainable projects that have a strong impact on the population; this involves comparing the results with judgments and opinions of all the stakeholders. Therefore, among the pillars of the social responsibility of the AFD group are included "informing, dialoguing and responding".

The key document "Environmental & Social Risk Management Policy for AFD-funded Operations" sets out the Vision, Objectives, and Principles. This document does not include structured lists of E&S criteria as for other IFIs, but the article "Principles" contains sections on: due diligence, integrated approach, responsibility of the client, categorization of the environmental and social risk, practice of categorization, analysis of the documentation, environmental & social commitment plan, environmental & social reference standards, other reference documents, stakeholder participation/consultation, disclosure of information, monitoring and implementation support, handling of

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[15] AFD (2016), Agence Française de Développement. URL: https://www.afd.fr/en; http://www.who.int/workforcealliance/members_partners/member_list/afd/en/ (accessed on 22.06.2021).

[16] AFD (2017), Agence Française de Développement. URL: https://www.afd.fr/en/finance-projects, https://www.afd.fr/en/recherche?page=all&view=start; https://www.afd.fr/en/agence-francaise-de-developpement. (accessed on 22.06.2021).

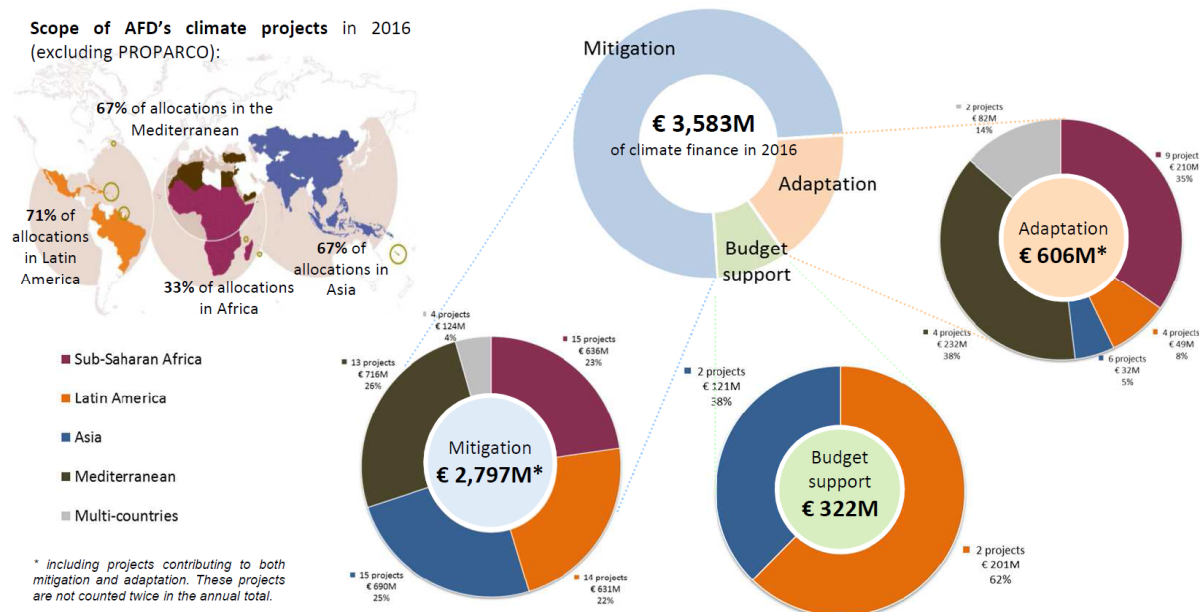# Geographical breakdown of AFD Group's "climate" allocations in 2016

Fig. 3. The breakdown of AFD climate financing 2016 shows the geographical foci of a French agency in French-speaking regions (at left) and its key thematic foci on climate change mitigation followed by adaptation (at right), which are governed by compliance with EU and global climate protection policies
Source: AFD (2018), Agence Française de Développement — Climate Financing. URL: https://www.afd.fr/sites/afd/files/2017–10/climate-activity-afd-group.pdf (accessed on 22.06.2021).

environmental and social complaints, management of later amendments, development policy loans, delegated funds, co-financing operations, financial intermediation, financing in the French overseas territories, validity and revision of this policy.

Dialogue around strategies: AFD *emphasises dialogue*. The strategic documents drawn up by AFD, which determine its areas of intervention at the sectoral level or on cross-cutting issues, are the subject of consultation with line ministries and involve a presentation to the stakeholders, before their transition to the AFD board of directors. In the specific case of Country Response Frameworks, a stakeholder dialogue (with local authorities, donors, the private sector, CSOs, etc.) is carried out systematically before drafting of the document. Such strategic documents are made available on the AFD website in sections dedicated to AFD's themes, sectors and intervention areas.

Regulatory & institutional dialogue: AFD is obliged to report to a set of stakeholders defined by the regulations. Such accountability is exercised notably in the AFD board of directors, which includes representatives of line ministries, parliamentarians, representatives of NGOs and representatives of staff, but also to social authorities

and via institutional documents and regulatory reporting (reports parliamentarians, the Group's reference document, social report, economic and social data base, etc.).

Dialogue with development actors: The AFD Group is moreover committed to being in dialogue with all development actors. ADB is thus in partnership with more than 150 organisations such as international donors, UN agencies, NGOs, local authorities, foundations, think tanks and companies.

Evaluation of AFD quality criteria:

• In its self-description, AFD emphasises dialogue and shows the highest engagement for climate protection. In its internal functioning, ADB gave itself clear and precise working rules: effectiveness, transparency, coherency, accountability. ADB focuses on the following: Corporate Social Responsibility (CSR) involving social, environmental, ethical, human rights, anti-corruption, transparency, dialogue; and environmental & social risk management.

• AFD's "project exclusion list" conforms with general classical understanding but does not yet define a climate protection emphasis (as AFD defined elsewhere) and should be updated by AFD management in the near future.

In brief, AFD presents itself as a cutting-edge learner who recently updated project criteria and project procedures according to the Paris consensus. AFD's role as trainer should be still further enhanced by sensible geographic broadening of its funding base and made more effective by close monitoring if expressed ideals are actually met in concrete projects.

3.4. The German Development Bank (KfW)

The German Development Bank named "Reconstruction Credit Institute" (free translation for the German term "Kreditanstalt für Wiederaufbau", KfW, see[17]), or more succinctly KfW Development Bank, is highly committed to the synergistic concept of sustainability and to an economic fabric that safeguards the conviviality and quality of life for future generations. Therefore, KfW considers the enhancement of ecologically reasonable, socially even and economically stable developments in partner countries, and to promote change forward by "green growth", to be its central tasks. Developing economically sustainable structures in developing and emerging economies is key within KfW's important business targets and is part of KfW's sustainability management system.

KfW Sustainability concept[18]: KfW defines its sustainability principles which apply in general to all KfW business fields and subsidiary companies. These are detailed in concrete guidelines and apply across the KfW organisation as well as to all KfW projects and investments. Thus, KfW guarantees a sustainable strategy for all funded projects globally and avoids risks for humans and the environment.

KfW Development Bank's projects and programmes help people in partner countries find access to clean drinking water as well as sufficient food. These projects improve standards of medical care, social security, education and access to sustainable energy. Furthermore, they offer solutions for resource shortages, climate change and threats to biodiversity all whilst increasing land use and resources with a view to rising population numbers. Such goes hand in hand with changes within economic and/or social structures.

In order to drive this change forward towards a "*green economy*", it has become important to promote the use of eco-friendly technologies throughout partner countries. For that target, KfW provides effective, targeted and efficient solutions together with its projects which meet sustainability criteria jointly with its specific development approaches. Additionally, KfW Development Bank follows an objective of actively enhancing the implementation of human rights worldwide through the instruments at hand. Thus, the KfW Group has issued a declaration on human rights in KfW's business operations.

KfW's Sustainability Guidelines: These KfW Sustainability Guidelines inform founded on its Statement on Environmental Protection & Sustainable Development at Germany's parliament; KfW Group already introduced a set of sustainability policies which are in line with the sustainability strategy of the Federal Government of Germany.

Guidance on how to respect aspects of sustainability within public procurement procedures for financing cooperation provides detailed principles applicable to its measures:

- avoiding, reducing or limiting environmental pollution and environmental damage including climate-damaging emissions and pollution;
- preserving and protecting biodiversity and tropical rainforests and sustainably managing natural resources;
- considering probable and foreseeable impacts of climate change, including utilising the potential to adapt to climate change. In this context, climate change is understood as climate variability and long-term climate change;
- avoiding adverse impacts upon the living conditions of communities, in particular indigenous people and other vulnerable groups, as well as ensuring the rights, living conditions and values of indigenous people;
- avoiding and minimising involuntary resettlement and forced eviction of people and their living space as well as mitigating adverse social and economic impacts through changes in land use by reinstating the previous living conditions of the affected population;
- ensuring and supporting health protection at work and the occupational health and safety of people working within the framework of a FC measure;
- condemning forced labour and child labour, banning discrimination with respect to employment and supporting the freedom of association and the right to collective bargaining;

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[17] KfW (2016), Kreditanstalt für Wiederaufbau. URL: https://www.kfw.de/kfw.de-2.html, https://www.kfw.de/KfW-Group/About-KfW/Auftrag/Entwicklungsfinanzierung/ (accessed on 22.06.2021).

[18] KfW (2017), Kreditanstalt für Wiederaufbau, Sustainability Criteria. URL: https://www.kfw.de/nachhaltigkeit/KfW-Group/Sustainability/Sustainable-Banking-Operations/Sustainable-Investment/KfWs-Sustainable-Investment-Approach/Integration-of-ESG-Criteria/ (accessed on 22.06.2021).

• protecting and preserving cultural heritage;

• supporting the executing agency in the management and monitoring of possible adverse environmental, social and climate impacts as well as risks within the framework of the implemented FC measure.

A comprehensive list is provided in <u>Annex 5</u>; more detailed info is in [56].

Evaluation of KfW quality criteria:

• In its self-perception, KfW's priorities are highly progressive and clearly aligned with protection of the global climate. However, on the level of operational project quality criteria, this tenet has still to be fulfilled and implemented. While KfW's sustainability concept is laudable and already includes the orientation towards a green economy, concrete guidelines are missing and should be established by KfW management for operational practice.

• KfW's Environment, Social and Governance (ESG) criteria suitably cover several specific parameters but are still too technically specific in highlighting single parameters (e.g.,% primary energy use from renewables), are not broad enough in scope and miss integration into an overall strategic narrative. Also, they concentrate on classical themes and should include an up-to-date systemic, transition-related understanding with a better focus on global climate change and required energy transformation.

In brief, KfW perceives itself as a cutting-edge learner but should fulfil this self-perception by updating its operational project criteria to the latest scientific consensus and know-how of suitable financial instruments. WB's role as trainer is already positive but should catch up by improving the efficiency of applicable project criteria.

3.5. World Bank Group (WB) project quality criteria (ESS)

The goals of the WB[19] are (1) to end poverty and (2) to promote shared prosperity. Both goals unequivocally also mean progress in the non-monetary aspects of *welfare* including education, nutrition, health, and access to essential *infrastructure*, and are about enhancing the voice or *participation* of all segments within society in economic, *social, or political* spheres. WB Goals include Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs).

WB offers support for developing countries via policy advice, research or analysis, and technical assistance. What WB says about Kazakhstan might hold true for all CA states to a varying degree: "The long-term development policy challenge means *transforming* the countries' growth model away from reliance on natural resource extraction towards a much more diversified and competitive economy." A comprehensive list is provided in <u>Annex 6</u>.

Evaluation of WB quality criteria:

• By including Millennium Development Goals (MDGs) & Sustainable Development Goals (SDGs), WB relies on the set of values with the highest degree of international legitimacy. On the other hand, recent tailoring and detailing towards climate protection is still improvable and should result in a list of operational and consistent project assessment criteria.

• WB's Environmental and Social Standards (ESS) include a wide scope and thus cover very well the worldwide consensus on environmental and social values. However, climate-related criteria still seem underdeveloped and appear to be not yet detailed into operational and powerful project appraisal criteria. Given the importance of WB as a key actor, these should be updated.

In brief, WB appears as a slow but consensus-oriented learner who should catch up by operationalising recent consensus building after the Paris consensus. WB's role as trainer should be significantly tuned up and made more effective.

3.6. ADB focus areas and environmental safeguards

ADB's document on "Environment Operational Directions 2013–2020" states (see,[20] p. 5):

For promoting the transition to green growth, and addressing the causes and consequences of climate change, four mutually supportive environment operational directions have been identified:

(1) to promote a shift to sustainable infrastructure, including clean energy (page 4) and sustainable water management (p. 5);

(2) to invest in natural capital, including integrated water resources management (p. 8);

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[19] WB (2013), Legal Innovation and Empowerment for Development. The World Bank Legal Review, Volume 4. Ed. by H. Cissé, S. Muller, C. Thomas, W. Chenguang. URL: https://books.google.at/books?id=j6SvECYXyCEC (accessed on 22.06.2021).

[20] ADB (2016), Asian Development Bank. URL: https://www.adb.org/documents/environment-operational-directions-2013–2020; https://www.adb.org/sites/default/files/institutional-document/33869/environment-operational-directions-2013–2020.pdf (accessed on 22.06.2021).

(3) to strengthen environmental governance and management capacity, including policy and incentive frameworks (p. 10);

(4) to respond to the climate change imperative, incl. GHG emissions mitigation (p. 12).

This mentioned report[21] also provides "Guidelines for Classifying Projects with Environmental Sustainability as a Theme" in order to ensure consistent application of criteria for classifying projects for the target of environmental sustainability (p. 27).

ADB's "Results Framework, 2013–2020" (pages 19 and 29 to 33) for the Environment Operational Directions (above-mentioned) guides operations during the period 2013–2020, and progress within these will be monitored by ADB. These come closest — among all information retrieved until now — to "*environmental project criteria*" which are actually searched for by this article and include:

• Improving energy efficiency & greater usage of renewable energy;

• Increasing usage of environmentally sustainable transport systems by the "avoid–shift–improve" approach;

• Improving water security and enhancing water efficiency and productivity;

• Increasing levels of inclusive urban economic growth and poverty reduction with fewer global and local environmental impacts;

• Improving the resilience of urban and rural infrastructure to climate change impacts;

• Improving regional trends in reducing land and forest degradation and in sustainable coastal and marine resources management;

• Accelerating and expanding the implementation of integrated water resources management (IWRM), delivering improved water security and enhanced efficiency and productivity;

• Improving the availability of, and access to, adequate and safe food for Asia's poor and vulnerable in a sustainable manner;

• Strengthening national governance for the environment and climate change;

• Strengthening country-level environmental assessment capacity;

• Strengthening regional capacities for addressing transboundary environmental challenges;

• Improving disaster & climate risk management capacities at a country level.

Furthermore, environmental and social quality criteria could presently be under development at ADB. Presently, no such clear single or recent document (as for WB) has been retrieved for ADB as of yet.

The ADB text representing environmental criteria is "environmental safeguards", see Annex 7.

Evaluation of ADB quality criteria:

• ADB includes the key themes: sustainable infrastructure, natural capital, environmental governance and management capacity, climate change imperative. While the ADB "Results Framework" is not yet a fully-fledged system of criteria, such a tool should be developed quickly and consistently.

• While ADB's Environmental Safeguards are a great example of very consistent synoptic and holistic thinking, they should soon be put into practice and converted into a proper set of operational project quality criteria.

In brief, ADB shows thorough compliance with its learning role by having established several sets of guidelines, but should soon operationalise them after having coordinated with other IFIs and made sure the latest developments in climate protection strategies are duly incorporated.

3.7. AIIB focus areas and environmental standards

AIIB's[22] focus areas are:

• Rural Infrastructure & Agriculture Development;
• Environmental Protection;
• Energy & Power;
• Water Supply & Sanitation;
• Transportation & Telecommunications;
• Urban Development & Logistics.

AIIB was founded on the initiative of China [56] and provides Sovereign-Backed Financing as well as Non-Sovereign-Backed Financing. It is believed to back Chinese interests, e.g., the Silk Road Initiative.

For AIIB's environmental and social framework see Annex 8.

Evaluation of AIIB quality criteria:

As a very young institution, AIIB is still on its way to fully establishing necessary regulations pertaining to

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[21] ADB (2016), Asian Development Bank. URL: https://www.adb.org/documents/environment-operational-directions-2013–2020; https://www.adb.org/sites/default/files/institutional-document/33869/environment-operational-directions-2013–2020.pdf (accessed on 22.06.2021).

[22] AIIB (2016), Asian Infrastructure Investment Bank. URL: https://www.aiib.org/en/about-aiib/index.html (accessed on 22.06.2021).

environment, climate and social dignity. Reviewing the achievements of other IFIs can greatly help in establishing a well-founded and reliably operational system of ensuring a broad set of ethical values.

AIIB's twelve requirements and three Environmental and Social Standards should be considerably improved to live up to present-day scientific consensus and global consensus on climate protection (and other social community values). What is needed is an operational criteria system that soundly ensures AIIB projects are compatible with the highest standards of climate protection and sustainability.

In brief, AIIB appears as a consistent learner catching up from the bottom line after its recent creation. AIIB's role as trainer is still to be consolidated by erecting a true, strong value/criteria system and should include harmonisation with other IFIs.

3.8. Evaluation of IFIs against this article's quality criteria

After the brief evaluations above at the end of the single sections 3.n, the above-mentioned IFI project quality criteria are now mirrored with the quality criteria established in Section 1 for a "collective social learning process":

1. Creating a long-lasting *societal* consensus among all involved social groups: especially AFD and KfW claim to have excellent standards (while other IFIs score medium), but these are still to be duly implemented by profound and in-depth operational criteria. AIIB is still to catch up in this regard.

2. Creating *environmental* sustainability in the region, including global climate justice: All IFIs claim to possess these criteria catalogues, with varying degrees of usefulness, validity and inclusion of recent paradigmatic findings regarding how to facilitate a global energy transition. Hence, it is recommended that IFIs coordinate their needed progress in updating assessment criteria, in order to facilitate applicants to satisfy all IFIs' criteria at the same time when using a blended financing approach — which is becoming increasingly necessary.

3. Maintaining long-term *economic* reliability and financially well-functioning economic enterprises and state institutions in the state concerned. In this parameter, the innate interest of IFIs leads them to regularly update

benchmarking requirements. Again, financial criteria should be harmonised with a view to an increased number of "blended" applications.

As mentioned above in the introductory Section 1, IFIs under the learning paradigm fulfil a double functionality within the process of "societal learning" on a global scale; namely being a learner and a trainer. Based on this article's analysis, the following conclusions are made for the investigated IFIs:

• In the role of a *learner,* the Europe-based IFIs show relatively the greatest success in incorporating increased levels of understanding of climate change into their "corporate DNA", meaning consciousness materialised as corporate mission targets and procedural rules. Hence, their sets of "environmental and social project quality criteria" are inspired by compliance with the needs of global climate change — but most of IFIs need strong implementation of detailed, practical operational parameter systems. Additionally, these criteria systems must be well harmonised among IFIs given the noticeable trend towards "blended financing", which means that project applicants have to satisfy the criteria sets of several (if not all) IFIs at the same time.

• In the role of a *trainer*, Europe-based IFIs are again starting to incite applicants (especially consortia and governments who apply for IFI finding) and other actors in the game of "societal learning" but they still need to convey the central guiding ideas to potential applicants better in order to influence their project identification at a very early stage.

4. CONCLUSIONS AND RECOMMENDATIONS

A brief discussion on the implications of this study's findings for the future of the field focuses (a) on the strategic re-definition of success criteria for submitted projects, and (b) their generally increased importance as a control tool for human evolution towards institutionalised humanitarian values.

(a) To the degree that the civilised world takes ecological and sustainable values more and more into account, the rationale of what is assessed as desirable gradually shifts. While in former decades the optimisation of individual advantage might have prevailed, increasingly the ethical values of caring for the entire planet in all its ecological, economic, political and social aspects come to the fore. Given that IFI-financed projects range at the top of steering impulses on socio-economic global evolution, their genesis comes under close scrutiny. Given that such projects are based on

a system of rules (and not on individual loyalties to whatever leading individual), the fine-tuning of this set of allocation criteria plays a most sensible role in planetary society. IFI-funded projects range among the largest infrastructure projects ever (such as huge dams for electricity generation, transnational irrigation projects, or transregional traffic veins), and they are able to determine future economic development. In the light of the above, the envisaged set of project allocations plays the role of "planetary software" for the allocation of large financial assets. This set of rules — like every civilisational structure — is subject to a coevolutionary process of self-creation through "reflection in action", thus equating a large-scale learning endeavour for the entire human species. In the light of earlier successes and failures, this rule system is gradually adapted and re-adapted. Exactly this is the nature of a planetary learning endeavour. This choice of viewing had motivated the present article's overall approach.

(b) Within the study of the development of the human species into possible futures (hence, the core interest of the Lomonosov-base "Globalistika" curricula and the analogously in many universities worldwide [67]), the control tools for such development quite naturally come into focus. This is the main motivation of the present article. During these current decades, a move to ever more harmonised criteria sets of IFIs is perceivable, quite practically triggered by the apparent need for ever more multi-donor financing worldwide. Such a harmonisation exercise should quite evidently be well managed, notably forming a standpoint of overall planetary responsibility. One helpful guidance for such a planet-wide management of sustainability-oriented project allocation criteria is to understand these criteria as a collective learning exercise on a planetary level. Foresight as a discipline has always expanded upon how to *steer* into a future. Quite fundamentally, rule sets applicable to the largest existing financial flows on the planet (i.e. IFI funds) are such control tools for planetary human techno-socio-economic evolution.

In concrete terms, what should be learned from the current state of IFI's incorporation of environmental and social criteria into their assessment processes is the following:

• The increasing level of awareness among all IFIs (including national FIs) of *environmental values* is satisfactory for observers who have noted in past decades that IFIs would simply follow economics and profit-oriented calculus. The achieved inclusion of environmental values might be called satisfactory for those who have long been advocating this.

• The parallel inclusion of *social and developmental ethical values* might be called partly satisfactory for those who have long advocated minority rights, intra-state equity and inter-state justice. Still, the degree to which equality of opportunity has been covered among higher and lower layers of society is not yet convincingly satisfactory.

• Both above assessments uniquely refer to the formal existence of criteria sets. As of now, no assessment could be undertaken on whether these social and environmental criteria sets *are actually operational* when it comes to identifying concrete infrastructure projects. Such an analysis is still to be done, and an overly euphoric attitude might be misleading at this point in time.

• One key criterion for a successful "learning endeavour" is the self-responsible procedure, meaning that all involved stakeholders are content with the outcome of the final result. It is still to be proven that civil society stakeholders in affected countries are content with the real-world selection of IFI-financed infrastructure projects. The collective of IFIs worldwide has the continuing obligation to include truly and widely civil society, i.e. actors beyond state administrations, in their consultancy structures and processes. This lack can be considered a major flaw in the state of the art.

• In a similar vein, the principal inclusion of civil society into the ongoing reformulation and re-harmonisation exercises of socio-ecological project success criteria is left untackled. IFIs' strategists are well advised to incorporate such criteria duly, with a focus on world regions with weak democratic traditions, among which include Central Asia, Latin America, Russia or other regions in the grip of autocratic regimes enjoying weak overall legitimacy.

• In order to improve the level of this integration of societal learning processes in the future, IFIs should proactively seek contact with national stakeholders taking care of disadvantaged groups such as migrants, minorities, civic movements and citizens' rights groups who have advantageously organised themselves on national levels. Such inclusion of civil society might profit from a formal UN umbrella.

• In contrast, the extent to which IFIs integration of environmental and social criteria leads to better societal and individual learning will greatly augment

IFIs' acceptance by a wider society. In such a successful case, IFIs would no longer be perceived as exponents of a merely capitalistic and self-interest-driven world order which is commonly seen as in decline on a planetary level.

- Thus, while the advocated wide dispersion of a thorough societal discussion process and consensus-generation procedure might appear as a waste of effort to a classical understanding of IFIs (namely seeing their identity in a Washington consensus-based identity of global capitalism), a more thorough understanding suggests that IFIs are actually working here on their own future safeguards: without profound ethical fundament, wide acceptance and popular empathy from the side of the disenfranchised, IFIs will not be able to withhold foreseeable repercussions during the 21st century.

Overall, the present article has taken an unconventional viewpoint regarding the following aspects:

(1) the combination of didactics and finance allowed to perceive the IFI project cycle as a learning exercise involving both IFI staff and participating state authorities;

(2) the link between collective and individual learning in the context of IFIs includes the concept of "reflection in action" into the procedures of financing proposals, thus permitting inter-IFI harmonisation of criteria on a global scale;

(3) proving that environmental and social criteria included in the selection process do lead to a better structured assessment by IFIs, thus triggering collective and individual learning within IFI staff for further project needs.

What are the implications of this brief analysis on the adoption of sustainability criteria by IFIs for other big financial institutions, e.g. commercial and investment banks, credit institutions, etc.?

1. First, it should become clear that under the auspices of an ever-increasing usage of multi-donor financing strategies and "blended" financing models, a *joint application* to several IFIs and other donors at the same time will become more and more common as a most realistic practice. As a clear consequence, project applicants will have to comply with *multiple sets of criteria at the same time*. This clearly calls for harmonising all IFIs' social and environmental sets of criteria thoroughly, both formally and on the deeper conceptual level. The same appears to be desirable for

subsequent monitoring and compliance mechanisms. Quite practically, the implementation of a climate-oriented project should not necessitate multiple compliance exercises, measured against insufficiently harmonised criteria sets.

2. Second, such harmonisation should be performed by a consortium of credible state institutions under the guidance of widely accepted supranational organisations such as UN, OECD or similar.

3. Third, resulting monitoring reports should be made available on the platforms of all involved IFIs in order to ban non-complying institutions (e.g., those applying for projects or performing them) from similar misconduct in the future. Only serious management on non-compliance will be able to convert huge consortia into a mode of self-control ex ante, and substantially prohibit green-washing.

4. Fourth, all evaluation and monitoring reports have to be made public and published in original form without being redacted for size and content, in order to prevent a new "business" of reporting "business" biased towards green-washing from developing out of illegitimate interests. Lists of explicit breaches (institutions and countries) should be published regularly. Such a severe set of rules will only improve public credibility of supranational organisations such as the UN and related worldwide organisations.

Summing up, this article has been undertaken to portray the endeavour of establishing worldwide sets of "social and environmental criteria" (under whatever name they may appear in different IFIs) as a task of global "collective learning" in the face of the global climate crisis. The article enumerated the various sets of such criteria that are employed to filter out non-sustainable project applications (at least in theory — and to an unknown degree also in practice) and suggests that they represent a meaningful step towards worldwide rule setting.

The *main conclusion* is that the toolboxes (i.e., the criteria lists plus the project application procedures) from *individual* learning may also be applied to *collective* learning and *vice versa*. Thus, all enhancement provided by "individual pedagogy and didactics" should be invested into "collective pedagogics and didactics", including knowledge on how to maintain high levels of enthusiasm, professionalism and achievement.

The key requirement, however, for any state is to esteem, cultivate, enhance and protect a free press which is capable of perceiving and communicating critical viewpoints on societal developments. Without such important institutions (the so-called 4th power in a state, following Montesquieu since 1748), no state will ever strive economically as it lacks its collective socio-political sensorium. Thus: **first, care for a free press**!

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Annex 1

IFCA Social and Environmental criteria list

The first example for a set of defined "environmental and social criteria" is the following list that is applied for IFCA projects, as comparable with the blending guidelines. For more details see in,[1] p. 116f and [56].

1. Context of the project
2. Coherence with policy objectives of IFCA and EU policies
3. Consultations before submission
4. Entities involved or Implementation scheme or Organisational set up or Exit Strategy
5. Indicative budget — Uses &Sources
6. Consultation before submission
7. Debt sustainability
8. Financial Leverage
9. Additionality of the EU contribution
10. Justification of EU contribution
11. Expected Results
12. Project sustainability
13. Risk Assessment
14. Climate & Environment Rio Markers
   - Is the contribution of a given project to climate change mitigation and adaptation clearly demonstratable?
     - **(1)** <u>Biological diversity</u>: apply at least 1 out of these 3 items mentioned here: conservation of biodiversity, fair and equitable sharing of the benefits of the utilisation of genetic resources or sustainable use of its components (ecosystems, species or genetic resources).
     - **(2)** <u>Combat desertification</u>: combat desertification or mitigate the effects of drought in (semi-)arid or dry sub-humid areas by prevention and reduction of land degradation, reclamation of desertified land or rehabilitation of partly degraded land.
     - **(3)** <u>Climate change mitigation</u>: contribute to the objective of stabilisation of GHG (greenhouse gas) atmospheric concentrations at levels that prevent dangerous anthropogenic interference within the climate system through promoting efforts for reducing or limiting GHG emissions or enhancing GHG sequestration.
     - **(4)** <u>Climate change adaptation</u>: intending to reduce the vulnerability for human or natural systems to impacts of climate change or climate-related risks, through maintaining and increasing adaptive capacity or resilience. This means a range of activities ranging from information and knowledge generation to planning and the implementation of climate change adaptation actions as well as capacity development.
15. Indicative Project Calendar
16. Description of procurement procedures
17. Monitoring, reporting and evaluation
18. Visibility.

Annex 2

EIB's Environmental & Social Standards

The so-called "EIB Statement on Environmental and Social Principles and Standards" sets a policy context for protection of environment and human well-being. An EIB "Environmental and Social Handbook" provides an operational translation of these standards on over two hundred pages grouped across ten thematic areas:

1. Assessing and managing environmental or social impacts & risks: developing an effective environmental & social management and reporting system, plus requirements for stakeholder engagement.

2. Pollution prevention and abatement: resource efficiency as well as pollution control in line with best available technologies (BAT).

3. Biodiversity and ecosystems: protect and conserve all levels of biodiversity, whether or not previously disturbed or legally protected.

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[1] DEVCO (2015), Guidelines on EU Blending Operations, Volume 1 "General", Brussels & Luxembourg, DG for Developmental Cooperation DEVCO. URL: https://europa.eu/capacity4dev/t-and-m-series/document/guidelines-eu-blending-operations plus 3 more special reports (accessed on 22.06.2021).

4. Climate-related standards: promote the renewable energy sector and clean energy, optimize the scope for energy efficiency, and align with other EU climate policy investment priorities.

5. Cultural heritage: identification, protection and management of tangible or intangible cultural heritage.

6. Involuntary resettlement: protecting the rights to property and to adequate housing, as well as of the standard of living of all affected people and communities.

7. Rights and interests of vulnerable groups seeking that these populations duly benefit from EIB operations, and full respect for the dignity and human rights of vulnerable groups including indigenous peoples.

8. Labour standards: non-discrimination, fair treatment and equality of opportunity of workers and establishment, improvement and maintenance of worker-management relationships.

9. Occupational health and public health, security and safety: protect and promote the dignity of the affected community while adhering to the international norms and relevant human rights principles.

10. Stakeholder engagement: Being a public institution, EIB actively promotes a right of accessing information, as well as public participation and consultation. Upholding open, transparent and accountable dialogue with all communities affected by the project and relevant stakeholders in an effective and appropriate manner.

Annex 3

EBRD's Environmental Performance Requirements

The European Bank for Reconstruction and Development,[2] as numbered item *36* on page 5 therein, lists the following **Ten Performance Requirements (PRs)** which are there provided in much more detail (several pages / PR) in the appendix of [56]:

"36. Projects are expected to meet so-called "good international practice" (GIP) related to social and environmental sustainability.

To help clients or projects achieve this aim, EBRD defined specific PRs for key areas of social and environmental sustainability as listed below, including their objectives:

• **PR 1** — <u>Assessment & Management of Environmental and Social Impacts & Issues</u>: identify, evaluate, mitigate and develop an "Environmental and Social Management System";

• **PR 2** — <u>Labour & Working Conditions</u>: respect equal opportunities of workers, including fair treatment and non-discrimination;

• **PR 3** — <u>Resource Efficiency, Pollution Prevention & Control</u>: energy, water and resource efficiency;

• **PR 4** — <u>Health and Safety</u>: safeguard health conditions of workers;

• **PR 5** — <u>Land Acquisition, Involuntary Resettlement and Economic Displacement</u>: avoid or compensate land loss for dwellers, independent of their legal title of land possession;

• **PR 6** — <u>Biodiversity Conservation & Sustainable Management of Living Natural Resources</u>: promote good international practice in sustainable management;

• **PR 7** — <u>Indigenous Peoples</u>: full respect for dignity and human rights;

• **PR 8** — <u>Cultural Heritage</u>: adopt the mitigation hierarchy approach;

• **PR 9** — <u>Financial Intermediaries (FIs)</u>: ensure their compliance with all above criteria;

• **PR 10** — <u>Information Disclosure and Stakeholder Engagement</u>: promote & provide means for adequate engagement with affected communities.

Annex 4

Exclusion list for AFD Group in foreign countries

AFD works through a "negative" exclusion list,[3] in addition to the positive criteria mentioned in the main text.

1. Production and sale of all illegal products, unlawful activity under laws of the host country and of France or international regulations, conventions or agreements;

2. Products and activities using forced labour/child labour;

3. Trade in animals or plants and any natural products not complying with the CITES convention's provisions;

4. Fishing activity using drift nets with more than 2.5 km length;

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[2] EBRD (2016), The European Bank for Reconstruction and Development. Environmental project criteria. URL: http://www.ebrd.com/who-we-are/history-of-the-ebrd.html, http://www.ebrd.com/news/publications/institutional-documents/basic-documents-of-the-ebrd.html (accessed on 22.06.2021).

[3] AFD (2019), Exclusion list for projects. URL: https://www.afd.fr/sites/afd/files/2017–10/exclusion-list-afd_0.pdf (accessed on 22.06.2021).

5. Any operation leading to or requiring the destruction of critical habitats, or any forestry project not implementing a plan for improvement or sustainable management;

6. Production, sale or use of any dangerous material such as products containing PCBs or asbestos;

7. Production, sale or use of pharmaceutical products, pesticides or herbicides, ozone layer depleting substances, any dangerous substances which are banned or are being progressively phased out internationally;

8. Transboundary trading of wastes, except for those accepted by the Basel Convention and its underlying regulations;

9. Production or sale:

- of arms or munitions;
- of tobacco;
- of strong alcohol intended for human consumption;

10. Casinos, gaming establishments or any equivalent undertaking;

11. Any trade related to pornography or prostitution;

12. Any activity leading to irreversible modification or significant displacement of elements of culturally critical heritage;

13. Production or distribution or investment in racist or antidemocratic media or such that advocate discrimination against a part of the population;

14. Exploitation of a diamond mine and marketing of diamonds where the host country has not adhered to the Kimberley Process;

15. Any sector or any service subject to an embargo by the UN, EU or France in a particular country and with no absolute or relative restriction regarding the amount.

Annex 5

KfW ESG (= Environmental, Social & Governance) criteria

KfW[4] uses taking into consideration a variety of individual criteria that are grouped into ESG criteria (Environment, Social and Governance). Additionally, KfW uses exclusion criteria [56].

(A) ESG criteria applicable to *non-governmental* issuers

- **Environment (**Environmental management system, Formal environmental policy, Programmes and targets for reducing GHG emissions or for increasing renewable energy use, Environmental and social standards in credit & loan business, Carbon intensity trend, percentage of primary energy use from renewables, Sustainable financial services).

- **Social** (Formal policy on the elimination of discrimination, Policy on freedom of association, Employee turnover rate, Programmes to increase workforce diversity, Employee incidents, Activities in sensitive countries, Collective bargaining agreements).

- **Governance** (Whistle-blower programmes, Policy on bribery and corruption, ESG reporting standards, Signatory to UN Principles for Responsible Investment, Disclosure of directors' remuneration, Policy on money laundering, In-house team dedicated to responsible investment/finance, Board independence).

(B) ESG criteria applied to *sovereign* issuers

- **Environment** (Air pollution, Land degradation, Percentage of energy from renewable sources, Trend total annual CO_2 emissions, Coal use, Water productivity, Ocean health, Risk exposure to natural disasters.

- **Social** (Education, Food security, Infant mortality, Level of peace, Income equality, Gender equality, Child labour, Youth unemployment, Political rights).

- **Governance** (Rule of Law, Voice and accountability, Regulatory quality, Government effectiveness, Habitat protection, Agricultural regulation, Treaties and conventions, Sustainable energy, Expenditure on education and healthcare).

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[4] KfW (2017), Kreditanstalt für Wiederaufbau, Sustainability Criteria. URL: https://www.kfw.de/nachhaltigkeit/KfW-Group/Sustainability/Sustainable-Banking-Operations/Sustainable-Investment/KfWs-Sustainable-Investment-Approach/Integration-of-ESG-Criteria/ (accessed on 22.06.2021).

WB's Environmental & Social Framework (ESF)

The Environmental and Social Policies for WB Projects led to the adoption of a new set of environment and social policies in August 2016, called the Environmental and Social Framework (ESF), containing 19 elaborate Environmental & Social Standards (ESS)[5]:

- **ESS-1**: Assessment & Management of Environmental & Social Risks & Impacts: ESS-1 sets out the *Borrower's* responsibilities for assessing, monitoring and managing social and environmental impacts and risks, in order to achieve social and environmental outcomes consistent with the Environmental & Social Standards (ESSs). ESS-1 *includes* a Social and Environmental Assessment, a Social and Environmental Commitment Plan; and Management of Contractors.

- **ESS-2**: Labour & Working Conditions: ESS-2 recognises the importance of *income generation* and employment creation in the pursuit of poverty reduction and *inclusive* economic growth while including sound worker-management *relationships*.

- **ESS-3**: Resource Efficiency & Pollution Prevention & Management: ESS-3 recognises that urbanisation and economic activity often generate *pollution to water, air, and land*, and consume *finite resources* which may *threaten people*, the *environment* and *ecosystem services* at the regional, local, and global levels. The current & projected atmospheric concentration of *greenhouse gases* (GHG) threatens the welfare of future and current generations. At the same time, more *effective and efficient resource use*, pollution prevention as well as GHG emission *avoidance*, plus *mitigation* technologies & practices have become more accessible & achievable. ESS-3 includes resource efficiency (energy, water, material), pesticides and air pollution.

- **ESS-4**: Community Health & Safety: ESS-4 recognises that equipment, project activities, and infrastructure may increase *impacts and community exposure to risks*. ESS-4 thus includes *community exposure to health issues*, ecosystem services, equipment design & safety and infrastructure, especially for *water dams*.

- **ESS-5**: Land Acquisition, Restrictions on Land Use & Involuntary Resettlement: ESS-5 recognises that *project-related land acquisition* and *restrictions on land use* may have adverse impacts on communities or persons. Project-related land acquisition as well as restrictions on land use may cause physical, involuntary or economic displacement or relocation.

- **ESS-6**: Biodiversity Conservation & Sustainable Management of Living Natural Resources: ESS-6 emphasises that conserving and protecting biodiversity in marine, terrestrial and generally aquatic ecosystems as well as sustainably managing living natural resources are most fundamental to *sustainable development*.

- **ESS-7**: Indigenous Peoples or Sub-Saharan African Historically Underserved Traditional Local Communities: Such criteria include "vulnerable and marginalized groups", "indigenous ethnic minorities," and "minority nationalities".

- **ESS-8**: Cultural Heritage: ESS-8 recognises: cultural heritage provides continuity in tangible or intangible forms between the present, past or future. People do *identify with cultural heritage* being a reflection or expression of their *constantly evolving values*, knowledge, beliefs or traditions.

- **ESS-9**: Financial Intermediaries: ESS-9 emphasises that *strong domestic financial* and *capital markets* and *access to finance* are very important for any economic development, poverty reduction and growth.

- **ESS-10**: Stakeholder Engagement as well as Information Disclosure: This ESS-10 recognises the high importance of *open as well as transparent engagement* between Borrower and project stakeholders being an essential element of best international practice.

ADB Environmental Safeguards

ADB's Environmental Safeguards (see[6]: Safeguard Policy Statements, p. 16, details in its Appendix 1, p. 30–43) have the following *objectives*: namely to ensure the sustainability and environmental soundness of all projects and to support integration of environmental considerations into a given project decision-making process.

[5] WB (2016), The World Bank. Environmental criteria ESF. URL: http://www.worldbank.org/en/programs/environmental-and-social-policies-for-projects; http://documents.worldbank.org/curated/en/383011492423734099/pdf/114278-REVISED-Environmental-and-Social-Framework-Web.pdf (accessed on 22.06.2021).

[6] ADB (2009), Asian Development Bank. Environmental Safeguards. URL: https://www.adb.org/sites/default/files/institutional-document/32056/safeguard-policy-statement-june2009.pdf (accessed on 22.06.2021).

Principles of Policy:

1. Using as early as possible a screening process for each single proposed project, to determine an appropriate extent & type of environmental assessment, so that appropriate studies are undertaken in harmony with the significance of potential risks and impacts.

2. Conducting environmental assessments for each one proposed project to identify potential indirect, direct, cumulative or induced impacts or risks to biological, physical, socioeconomic levels (including impacts on livelihood through environmental media, vulnerable groups, health and safety, and gender issues), and physical cultural resources in the area of the project's context of influence. Assess likely transboundary or global impacts, also regarding climate change. Use SEA (strategic environmental assessment) where appropriate.

3. Examining alternatives to the project's location, design, technology, and components and their potential environmental and social impacts and document the rationale for selecting the particular alternative proposed. Also consider the no project alternative.

4. Avoiding, and where avoidance is not possible, minimizing, mitigating, and/or offsetting adverse impacts and enhancing positive impacts by means of environmental planning and management. Preparing an environmental management plan (EMP) while including the proposed mitigation measures, environmental monitoring and reporting requirements.

5. Carrying out meaningful consultation with affected people and facilitating their informed participation. Ensuring women's participation in consultation and involve stakeholders.

6. Disclosing a draft environmental assessment (including the EMP) in a timely manner, before project appraisal, plus in an accessible place and in a form and language(s) understandable to affected people and other stakeholders.

7. Implementing the EMP and monitoring its effectiveness. Documenting monitoring results.

8. Not implementing project activities in areas of critical habitats, unless (1) there are no measurable adverse impacts on the critical habitat that could impair its ability to function, (2) there is no reduction in the population of any recognized endangered or critically endangered species, and (3) any lesser impacts are mitigated. Using a precautionary approach to the use, development, and management of renewable natural resources.

9. Applying pollution prevention and control technologies and practices consistent with international best practices as reflected in internationally well-recognized standards such as the World Bank Group's Environmental, Health & Safety Guidelines. Adopting cleaner production processes & good energy efficiency practices.

10. Providing workers with safe and healthy working conditions and preventing accidents, injuries, and disease. Establishing preventive and emergency preparedness and response measures.

11. Conserving physical cultural resources and avoiding their destruction or damage by using field-based surveys that employ qualified as well as experienced experts during environmental assessment.

Annex 8

AIIB's Environmental & Social Framework

During February 2016, the AIIB issued a document of ~60 pages including the following twelve requirements (A to L) and 3 Environmental and Social Standards (ESS 1 to ESS 3) in order to be included in any project process (AIIB, 2016):

12 Requirements (A — L):

A. Screening & Categorization: The AIIB screens and categorizes each proposed project to determine the level and nature of the required social and environmental review, stakeholder engagement for the project and type of information disclosure. The categorization considers the nature, sensitivity, location as well as scale of this project, plus is proportional to its potential environmental significance and its social risks and impacts.

B. Environmental & Social Due Diligence: The AIIB conducts social and environmental due diligence, representing an integral element of its project appraisal, and in a way that is (1) appropriate to the scale and nature of the project and (2) proportional to the project potential social and environmental risks and impacts level.

C. Environmental & Social Assessment: Generally, the AIIB requires the Client to approach the assessment in an integrated process, given all complex interrelationships between social and environmental risks or impacts in both private-sector or public-sector projects.

D. Assessment Documentation & Instruments: The AIIB ensures that the Client prepares all appropriate social and environmental assessment documents.

E. Environmental & Social Management Plan (EMSP): When the Client identified a project's risks and impacts by means of the social and environmental assessment, the AIIB requires it to develop all measures to manage & mitigate the impacts plus reflect them in an ESMP, as is required under ESS 1.

F. Environmental & Social Management Planning Framework (ESMPF): The AIIB requires the Client to use an ESMPF if (1) the Project consists of programs or series of activities the details of which are not yet identified during the time the project was approved by the AIIB; or (2) if the AIIB authorizes the Client to use a so-called phased approach in accordance with para G below.

G. Special Circumstances: Only in exceptional circumstances, when duly justified by the Client, the Bank may determine that the timing of the Client's social and environmental assessment of identified activities being part of the project, and the timing of AIIB's social and environmental due diligence or the Client's social and environmental assessment, may follow a phased approach that takes place following AIIB's approval of this project. [...]

H. Use of Country & Corporate Systems: The AIIB may, if required, decide to offer the Client (whether public or private) the option to use all or part of the Client's existing social and environmental management system for part or all of the project, on the basis of detailed criteria [...].

I. Information Disclosure: The AIIB requires the Client to ensure that relevant information about social and environmental impacts and risks of the project is available in the project area in an accessible and timely manner, as well as in a form and language(s) understandable to the people affected by the project, the general public and other stakeholders, so they can provide meaningful inputs into the project implementation and design.

J. Consultation: The consultation comprises project design, monitoring and mitigation measures, sharing development opportunities and benefits on a basis specific to this project, plus implementation issues. The AIIB requires that the Client engages with stakeholders in meaningful consultation during all project preparation or implementation phases, namely in a manner commensurate with the impacts on and risks to those affected by this project.

K. Monitoring & Reporting: The AIIB and the Client have distinct but complementary monitoring responsibilities. The monitoring activities' extent is proportional to a project's impacts and risks, including their scope or periodicity.

L. Grievances: The AIIB requires any Client to establish a suitable mechanism for grievances in order to receive plus facilitate resolution of those concerns or complaints of such people who believe they have been adversely affected by this project's social or environmental impacts, and to inform people affected by this project of its availability.

Environmental and Social Standards (ESS-1 to ESS-3):

ESS-1: Social and Environmental Assessment & Management: For ensuring the social and environmental soundness and sustainability of projects and in order to support the integration of social and environmental considerations into the project's decision-making process and implementation.

ESS-2: Involuntary Resettlement: In order to avoid involuntary resettlement wherever possible; to minimize involuntary resettlement by exploring alternatives to the project; where avoidance of involuntary resettlement is unfeasible, enhancing, or at least restoring, the livelihoods of all displaced persons in real terms relative to pre-project levels; improving the overall socio-economic status of the displaced poor or other vulnerable groups; and conceiving & implementing resettlement activities as sustainable development programs, which provide sufficient resources to enable the persons displaced by the project to share in project benefits.

ESS-3: Indigenous Peoples: Designing and implementing projects in a way that enhances full respect for Indigenous Peoples' identity, human rights, dignity, economies & cultures, as defined by the Indigenous Peoples themselves, so that they (1) receive culturally appropriate economic & social benefits; (2) do not suffer adverse impacts resulting from projects, and (3) can participate actively in projects affecting them.

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New Technologies for Managing Industrial Innovation Funding

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ABSTRACT

The **subject** of the study is new technologies for managing industrial innovation funding. The **aim** of the article is to form an optimal mechanism for the application of technologies for managing industrial innovation funding based on the use of new financial instruments. The **relevance** of the research is due to the increasing role of innovation in ensuring competitive advantages and market stability of industrial enterprises, as well as the growing need to attract funding. The **scientific novelty** consists in grouping the existing financing technologies into three main groups: traditional, modern and new. The **research methods** are analysis, systematization, synthesis, induction, deduction, modeling. The authors built a model of the mutual influence of innovative industrial development and the subsequent development of financing technologies in the financial sector. In the course of the study, the author obtained the following **results**: a mechanism for applying new technologies to manage innovation funding was developed, a priority financial instrument was identified for use within the framework of the developed mechanism. The authors **conclude** that the role of digital technologies in the activities of an industrial enterprise and, accordingly, in innovation funding is increasing. At the same time, the activities of an enterprise in attracting resources by issuing digital securities (shares) to finance innovations are of the greatest practical interest.
Keywords: funding; industry; innovation; financing technologies; investments; securities; blockchain; digital securities

INTRODUCTION

The role of innovation is growing in modern economy. In the postindustrial economy of the 21st century. The innovative nature of the development of business entities (as well as the economy as a whole) is not so much a competitive advantage as a prerequisite for maintaining the financial stability of the company, ensuring the growth of the market share [1, p. 235]. The rapid development of technology and the subsequent evolution of consumer preferences increasingly pose a challenge for companies to ensure the regularity of research and development work and the implementation of their results directly into the technology of production of goods and services. This statement is true for most sectors of the modern economy, especially the high-tech industrial sector.

The growing role of innovation contributes to a shift in the focus of the company's management towards optimization and improvement of financial performance. Scientific research, contributing to the qualitative development of the company's products, improving the technologies of their production, require significant financial resources. At the same time, funding sources must meet two key requirements: firstly, funds must be attracted for a long term (or indefinitely), and secondly, the investor or lender must agree to the high risk of these investments, since not all scientific research ends with the successful implementation of new technologies and products.

At the same time, the widespread introduction of innovations contributes to the expansion of the company's financial capabilities in terms of attracting resources. The development of new technologies in the financial sector of the economy (commercial banks, financial companies and insurance organizations) leads to new financing instruments becoming available to industrial enterprises, some of which are applicable to finance innovative development [2, 3].

The relationship between the development of financial instruments and the subsequent innovative development of the economy and industry is the subject of research by such scientists as Ya. M. Mirkin [4], B.B. Rubtsov [5]. S.Z. Moshenskii studied innovative processes in the financial sector and their impact on stimulating the high-tech component of the real sector of the economy: "… opposing financial-industrial capitalism is as senseless as opposing the post-industrial economy to the industrial one. Time goes by, the world is changing, the economy and financial markets are changing. Capitalism is also developing. Industrial production will never be the same as in the era of steam engines. And capitalism will no longer be the same as a hundred years ago. Currently, the financial side of capitalism is more manifested. To protest against this is like protesting against the existence of the stock market or the derivatives market" [6, p. 481–482].

M. V. Vlasov researched the issues of innovative activity of small and medium-sized enterprises in an industrially developed region. At the same time, as factors constraining the innovative activity of economic entities, he singled out problems with financing, namely: an insufficient amount of own financial resources and a low amount of loaned funds provided [7, p. 1432]. Also, the scientist attributed a high level of risks, high transaction costs and insufficient management experience to negative factors.

In the foreign scientific community, similar issues were studied by N. Roubini and X. Sala-i-Martin [8], D. S. Kidwell, D. W. Blackwell, D. A. Whidbee, R. W. Sias [9] and others. The general conclusion of the review of the achievements of Western science on the issue under consideration is the proven relationship between the development of the financial market and the investment (including innovation) activity of economic entities — private companies.

This paper aims to form an optimal mechanism for the application of technologies for managing innovative financing in the industry based on the use
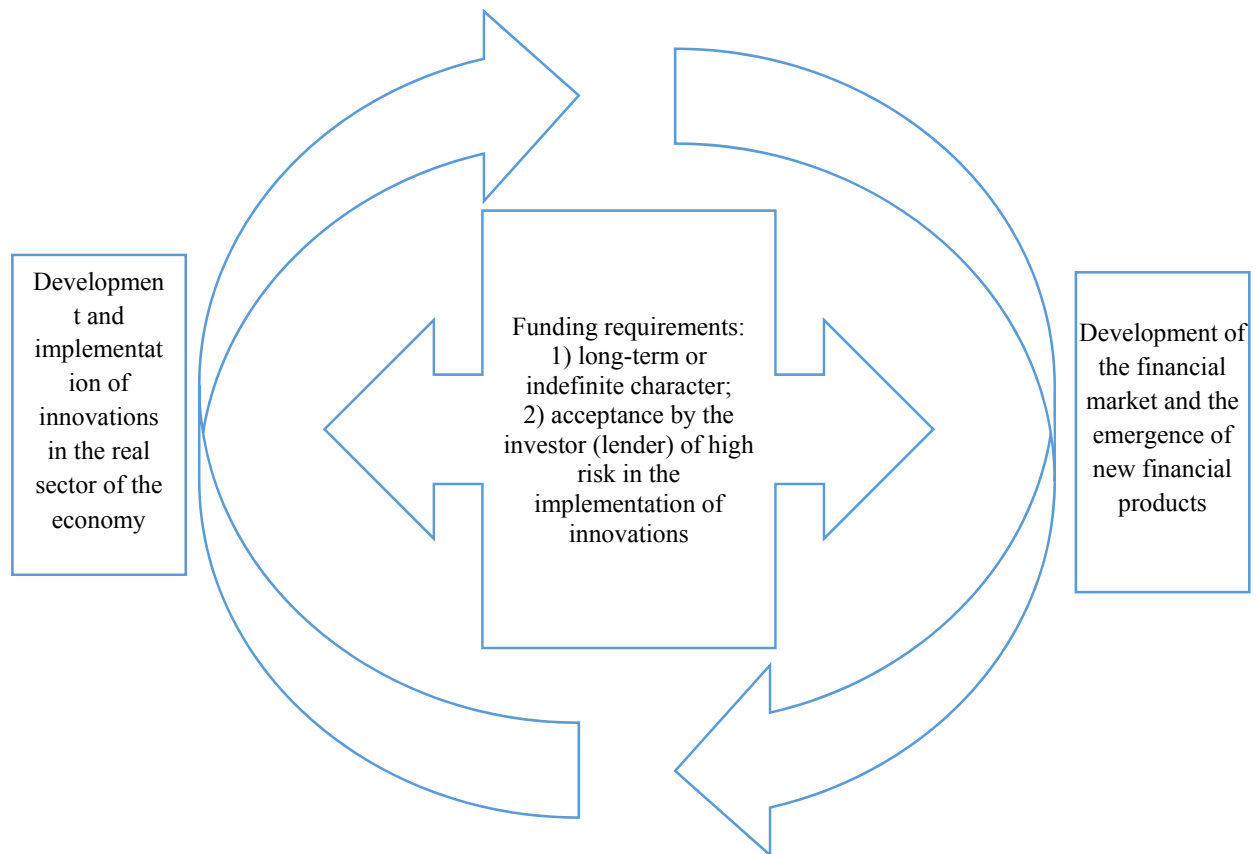
Fig. 1. **The relationship between innovation and funding sources**
Source: compiled by the author.

of new financial instruments. Achieving the aim involves solving the following tasks: researching available financing instruments and technologies, analyzing the applicability of the identified instruments and technologies for funding innovations in the industry, developing a mechanism for applying new technologies to manage innovation funding in the industry.

The scientific and practical significance of the paper lies in the systematization of currently available technologies for managing funds in the industry and the development of a mechanism for applying new financing technologies to most effectively provide innovative projects with financial resources.

MATERIALS AND METHODS

The nature of the scientific problem of this paper requires the use of both general scientific methods (analysis, systematization, synthesis, induction,

deduction, comparison) and specific methods (mainly economic and mathematical modeling).

The analysis of the logical and systemic relationship between the development of financing technologies and the level of innovation should be presented in the form of a diagram (*Fig. 1*)

If we consider the relationship between the innovative way of economic development and the evolution of the financial market at the macro level, then the mutual influence is natural: after providing scientific research with a sufficient volume of financial resources, some innovations are successfully introduced into the industrial production process, as a result of which (with the development of information technologies) opportunities for the creation of new financial products are provided. In addition to the overall effect on the economy, industrial innovation and

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┌─────────────────────────────────────────────────────────────────────────────┐
│              Innovation funding technologies and instruments                  │
└─────────────────────────────────────────────────────────────────────────────┘
         │                              │                             │
         ▼                              ▼                             ▼
┌──────────────────┐         ┌──────────────────┐         ┌──────────────────┐
│   Traditional    │         │      Modern      │         │       New        │
│   technologies   │         │   technologies   │         │   technologies   │
└──────────────────┘         └──────────────────┘         └──────────────────┘
         │                              │                             │
         ▼                              ▼                             ▼
┌──────────────────┐         ┌──────────────────┐         ┌──────────────────┐
│ Own sources:     │         │ Venture          │         │                  │
│ profit,          │         │ investment,      │         │ Digital          │
│ enterprise funds.│         │ specialized      │         │ securities,      │
│ Targeted budget  │         │ investment       │         │ crowdfunding     │
│ funding.         │         │ funds;           │         │                  │
│ Stocks, long-term│         │ initial public   │         │                  │
│ bonds,           │         │ offering         │         │                  │
│ investment loan  │         │ (IPO)            │         │                  │
└──────────────────┘         └──────────────────┘         └──────────────────┘
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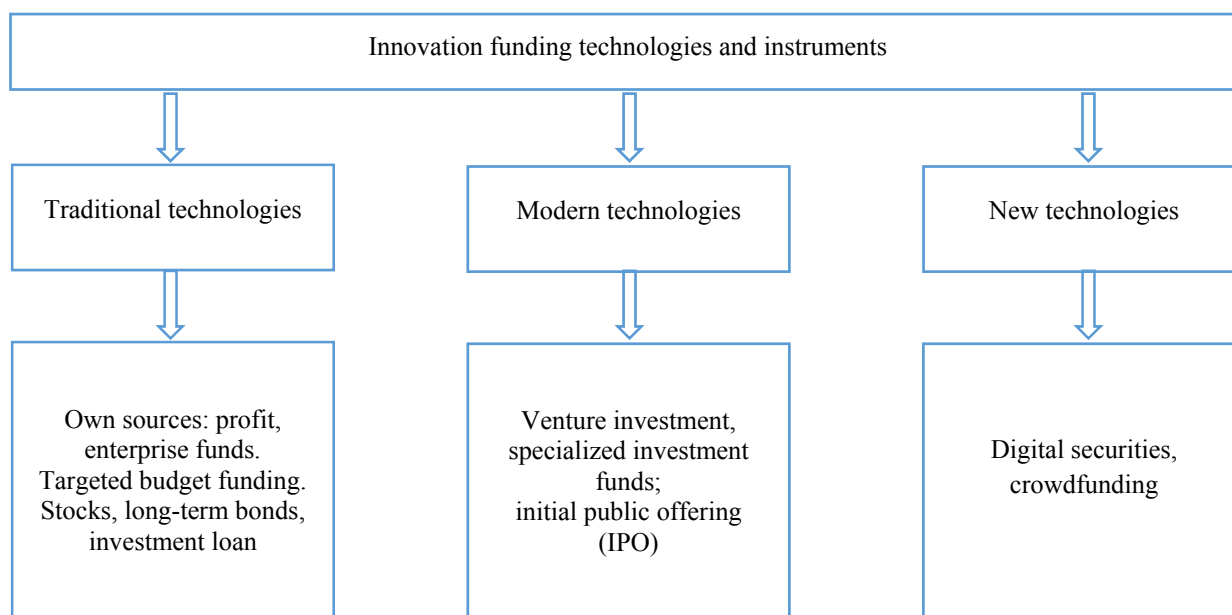
Fig. 2. **Innovation funding technologies and instruments**

Source: compiled by the author.

information technology also help to reduce the cost of financial infrastructure (through the production of cheaper and more efficient technical means) and increase the availability of financial instruments for a wide range of institutional and individual investors. This, in turn, provides innovation-oriented industrial enterprises with financially attractive and affordable sources of funding to increase investment in innovative areas.

It should also be borne in mind that financial management technologies are inextricably linked with financial instruments. The emergence of new organizational, legislative and technical capabilities (i.e., the development of technology) leads to the emergence of new tools. This process is also continuous and inextricably linked with the economic, scientific and technological development of the economy.

The increasingly popular blockchain technology should be mentioned as the indicated systemic breakthrough in both the innovation and financial sectors [10]. In addition to the direct creation of a new type of financial assets — cryptocurrencies, the technology itself provides enormous

opportunities for the digitalization of financial relations while maintaining the strict accounting of rights to financial assets (or cash) and protection from hacking and other illegal actions of third parties. At the same time, the very emergence of blockchain technology would be impossible without high-performance computing power, which is the result of the successful implementation of industrial innovations [11]. In turn, the technology of a distributed ledger (blockchain), when used within the framework of financial relations, is capable of "reducing operational risks, shortening the period for document approval and facilitating transactions".[1] These advantages have led to the emergence of new financial technologies — the issuance of digital securities and digital currencies.

Returning to the issue of systematization of financial instruments and technologies, it should be noted that all currently available instruments should be divided into three groups: traditional, modern and new (*Fig. 2*).

The first and most accessible tool within the framework of traditional

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[1] Trafigura and Sberbank signed their first deal through blockchain. URL: https://www.rbc.ru/crypto/news/ 5d721f369a794766d7fcc 6da (accessed on 05.11.2021).
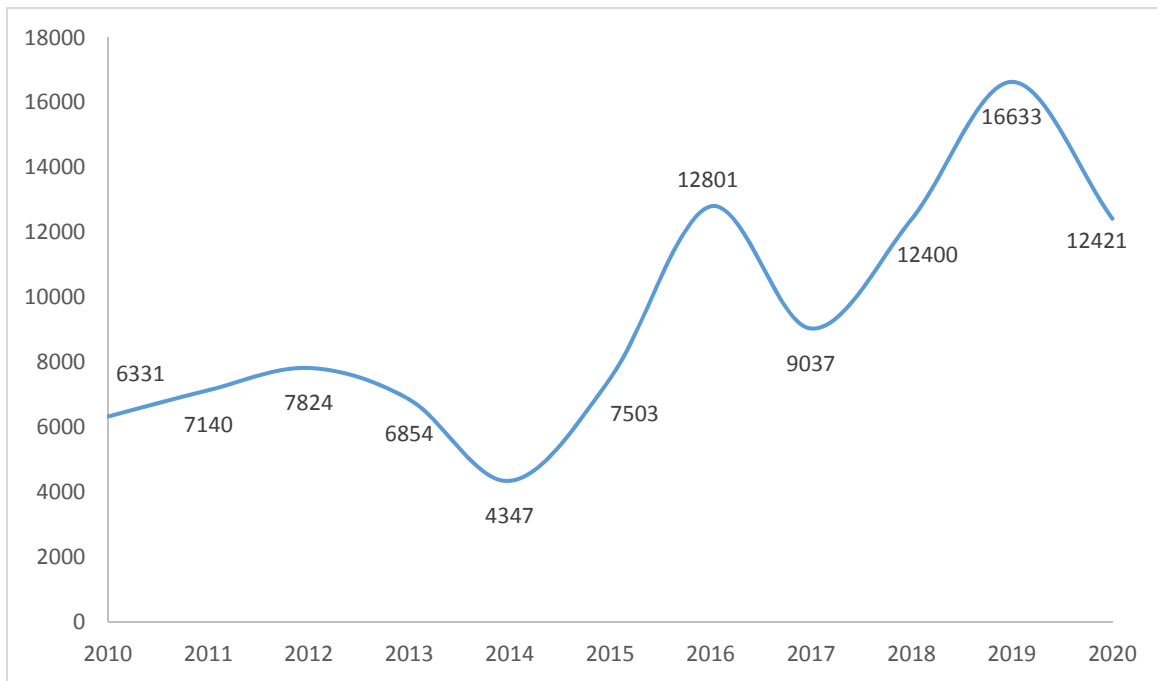
Fig. 3. **Dynamics of financial results of organizations (excluding small businesses) in the Russian Federation in 2010–2020, billion rubles**

Source: Federal State Statistics Service data. URL: https://rosstat.gov.ru/ (accessed on 05.11.2021).

financial management technologies is self-funding — the introduction of innovations independently and at the expense of its own funds: retained earnings and earmarked funds of the enterprise (primarily depreciation charges) [12]. This source is actively used in industry due to its availability. In fact, the company's own funds are long-term financial resources, they can be used for innovative development while profit and depreciation funds are formed, and do not require the participation of third parties (creditors, investors) in the investment innovation process. The disadvantage of self-funding is the limited volume of resources and the diversion of resources to renew the fixed capital of the current technological level, i.e. the company, in any case, must maintain at least the level of simple reproduction and make capital investments to maintain production; innovation ultimately is funded residually. It is also likely that the problem of a "financial funnel" will arise: an industrial enterprise cannot properly fund the necessary innovative projects due to a lack

of its own funds (low level of net profit or unprofitable activities) and, accordingly, has no opportunity to increase its market share and profitability in the future through the successful implementation of innovations. At the same time, industrial innovation often requires significant investment; therefore, it is not always possible to finance innovation only from its own funds.

Analysis of macroeconomic statistics confirms the instability of this funding instrument (*Fig. 3*). Despite the fact that in the period from 2010 to 2020 the share of profitable organizations was relatively stable (fluctuated in the range of 68–72%), the dynamics of net profit in the Russian economy (excluding small business) indicates the instability of this indicator. Considering the fact that part of the profits received was withdrawn from companies in the form of dividends, as well as in connection with the aforementioned need for investments in fixed assets to maintain simple reproduction, the possibility of using own funds to finance innovations is very limited.
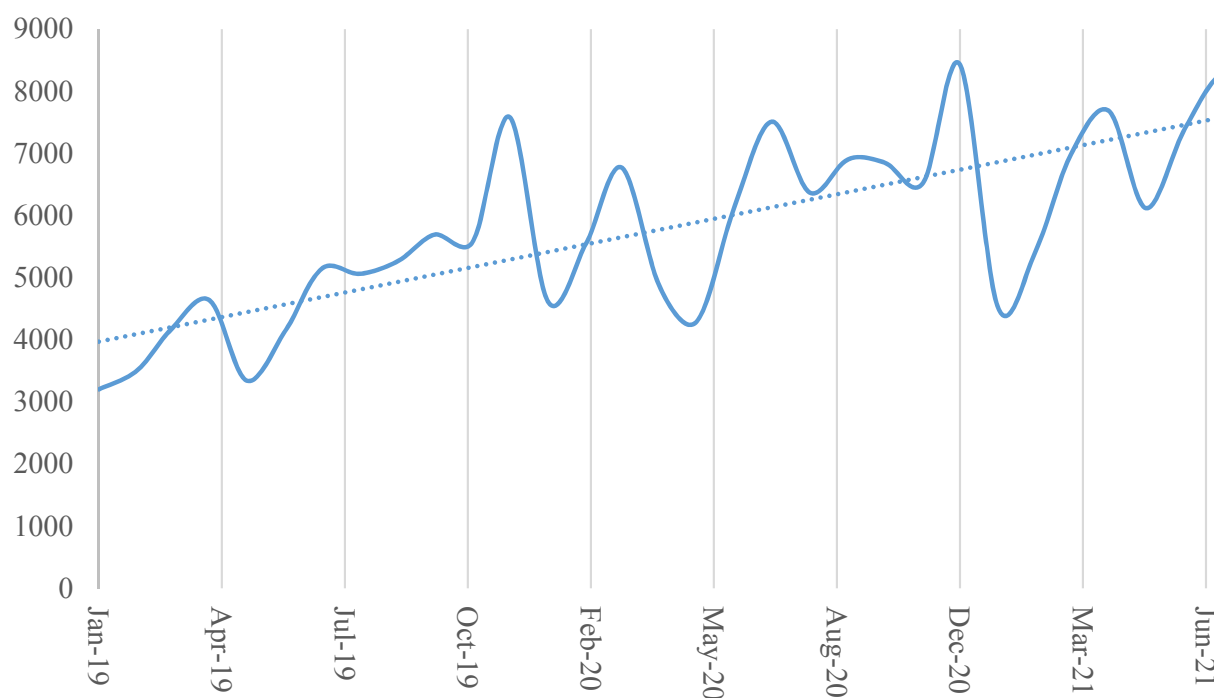
Fig. 4. **Dynamics of the volume of loans provided to legal entities – residents and individual entrepreneurs in the Russian Federation, billion rubles, January 2019 – August 2021**
Source: data of the Central Bank of Russia. URL: https://cbr.ru/statistics/bank_sector/ (accessed on 05.11.2021).

Traditional technologies for innovative financing also include capital market instruments: common and preferred shares, as well as long-term bank lending (the so-called investment loan [13, p. 1831]). These financial market instruments have been used in Russia for 30 years (much longer in Western financial practice). The regulatory framework is the Civil Code of the Russian Federation and the corresponding Federal Laws: "On the Securities Market", "On Joint Stock Companies", "On Banks and Banking Activities". A distinctive feature of this group is the relative availability for all companies (regardless of industry or size of the enterprise) and the versatility of the tools themselves. It should be borne in mind that long-term bonds and investment bank loans, despite their belonging to the capital market (and not the money market) instruments, are still less convenient for the purpose of innovation funding, since the urgent nature of borrowing is assumed (the need to pay interest and gradual repayment the amount of the principal

debt in accordance with the terms specified in the contract). Accordingly, if the loan repayment date (or the redemption of the par value of the bonds) comes before the time of implementation and payback of the innovation results, the company may experience financial problems. However, this disadvantage is compensated for by the availability and relative efficiency in attracting resources (especially in terms of bank lending).

It should be noted that, despite potential macroeconomic risks, the total volume of lending to business entities increased from January 2019 to August 2021 (*Fig. 4*). Analysis of monthly dynamics reflects seasonality (growth in lending at the end of each year and a subsequent "failure" at the beginning of the next), but the trend line shows an increase in lending. Investment lending follows a similar trend. Thus, this instrument is increasingly available for funding industrial innovations, and the restrictions are rather of an organizational nature: the above restrictions on the

The total value of issued and placed shares at par value, at the beginning of the year, billion rubles

Indicator	2003	2005	2008	2010	2012	2014	2017	2020
Total value of shares at par	877.9	4416.7	5653.3	5722.3	10560.8	12945.3	13343.6	12450.9
Total value of bonds at par	48.6	102.9	341.9	761.8	1419.1	2060.6	4756.8	6751.9

Source: Federal State Statistics Service data. URL: https://rosstat.gov.ru/ (accessed on 05.11.2021).

time frame for attracting funds, the need to comply with the bank's requirements when considering a loan application, etc. However, it should be considered that bank lending (both general and investment) is not available to all borrowers, but only to those that meet the parameters of the bank's credit policy. There is a contradiction at this point: an industrial enterprise needs funding for research and innovation, but commercial banks are more willing to provide funds for more conservative (i.e. less risky) projects. Consequently, investment lending is more applicable at the stage of introducing innovations (making capital investments as part of the introduction of new technology) than at the stage of direct research and development.

Based on the analysis carried out, common and preferred shares appear to be the most preferred method of innovation funding. These securities imply an indefinite nature of attracting investments, which is preferable from the point of view of the company's financial stability. At the same time, unlike debt relations when issuing bonds and bank lending, the company does not have an unconditional obligation to return funds to the investor: shares, like securities, do not imply a return of the par value (under normal operating conditions, the enterprise). The investor's financial

interest lies in receiving dividends from the ownership of shares, as well as in the ability to sell shares to any other person at a higher price. At the same time, the problem of directly attracting investors for the successful placement of the securities issue remains.

The dynamics of the placement of securities testifies to the growing popularity of security market instruments (within the framework of traditional funding technologies) for the formation of permanent capital of organizations (*Table 1*). Over the period from 2003 to 2020, the total amount of funds raised through the issue of shares increased from 877.9 to 12450.9 billion rubles, i.e. more than 14 times. The sustainable growth trend was interrupted only in 2020, which can be explained by external factors, namely: the conditions of the pandemic and the corresponding risks in the global and national economy. At the same time, the issue of bonds at par value increased from 2003 to 2020 by more than 138 times: from 48.6 to 6751.9 billion rubles. Accordingly, despite the attribution of these instruments to traditional financial management technologies, the issue of securities does not lose its relevance.

An evolutionary continuation of the issue of shares as a way to attract investment is
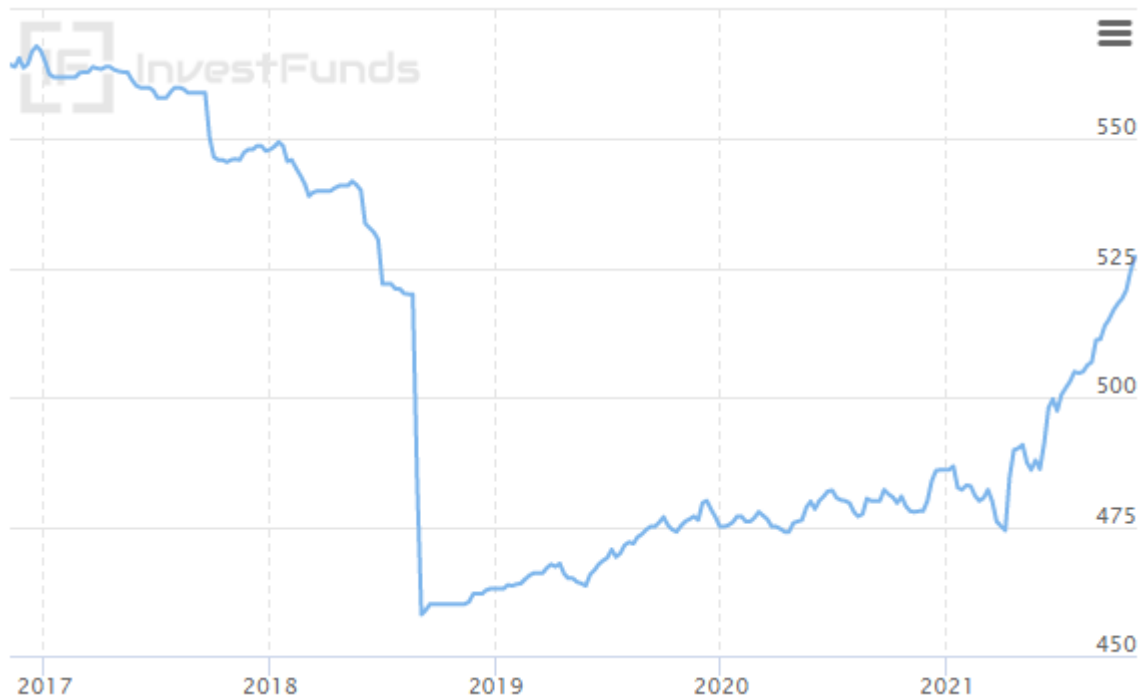
Fig. 5. **Dynamics of the number of investment funds in 2017–2021**
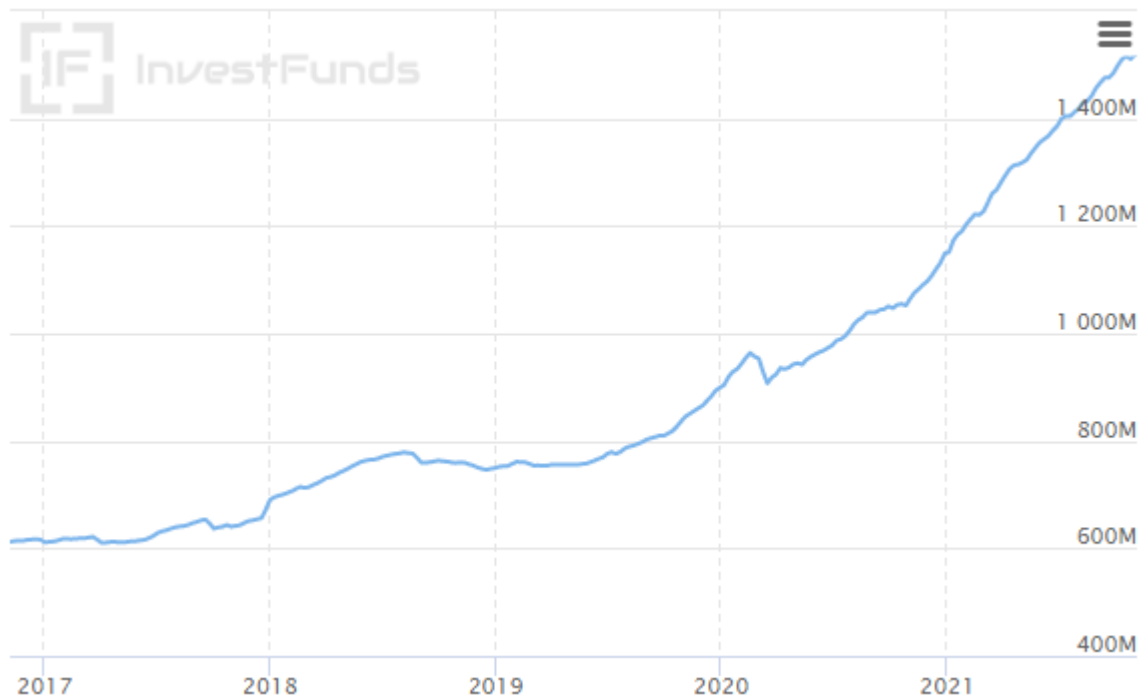*Source:* Iinvestfuds.ru website. URL: https://investfunds.ru/funds-statistics/ (accessed on 05.11.2021).

Fig. 6. **Dynamics of the net asset value of investment funds in 2017–2021, million rubles**
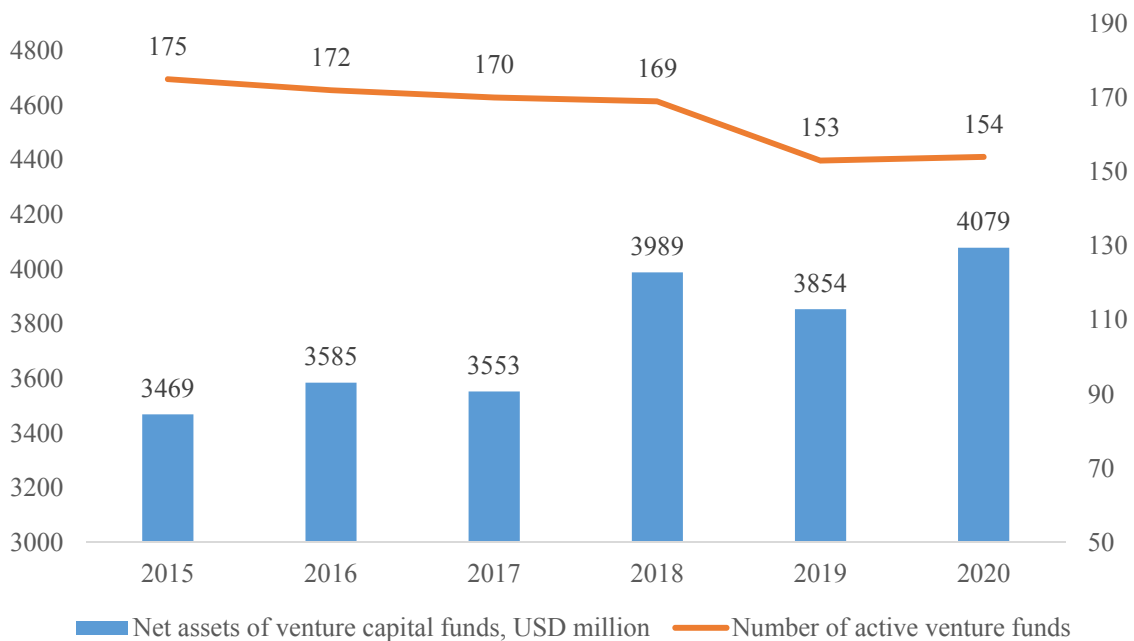*Source:* Iinvestfuds.ru website. URL: https://investfunds.ru/funds-statistics/ (accessed on 05.11.2021).

Fig. 7. **Number and volume of active venture funds, 2015–2020**

Source: Private equity and venture investment market review for 2020: RAVI analytics. URL: http://www.rvca.ru/upload/files/lib/RVCA-yearbook-2020-Russian-PE-and-VC-market-review-ru.pdf (accessed on 05.11.2021).

a venture investment and the activities of specialized investment funds, that is, institutional (collective) investors. For long-term attraction of investments in innovative projects, venture investment funds are created [14, p. 12; 15], science-intensive projects are of interest for private equity funds [16, p. 22–23]. The regulatory framework for collective investors is the Federal Law "On Investment Funds",[2] as well as the previously considered Federal Laws "On the Securities Market" and "On Joint Stock Companies". At the same time, the statistics of the last five years (from 2017 to 2021) indicate that after a sharp decrease in the number of investment funds in 2018 (which was caused by the tightening of regulation of the activities of mutual investment funds and joint-stock investment funds), since 2019 there has been an increase in the number of investment funds and the total value of their assets (*Fig. 5, 6*).

The activity of investment funds itself is more likely not a financial instrument, but the technology for managing financing, since an investment fund invests in securities (mainly in shares) of an enterprise (i.e., the company attracts an investment fund to place its securities). From the point of view of collective investment, the activities of regional venture funds at enterprises of the scientific and technical sphere are of particular interest, i.e. specialized venture funds created in the region on the basis of public-private partnerships [17, p. 96; 18, p. 1488]. An investment fund as an investor in industrial innovation funding is a suitable organization in accordance with the requirements indicated in *Fig. 1* (long-term nature of the investment, readiness for a high level of risk). At the same time, the investment fund, as a collective investor, shares the risks of its own shareholders, which allows diversifying the risks of investing in several innovative projects at once. Even considering the fact that the share of implemented (and commercially successful) innovations is usually below

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[2] Federal Law of November 29, 2001, No. 156-FZ "On Investment Funds".
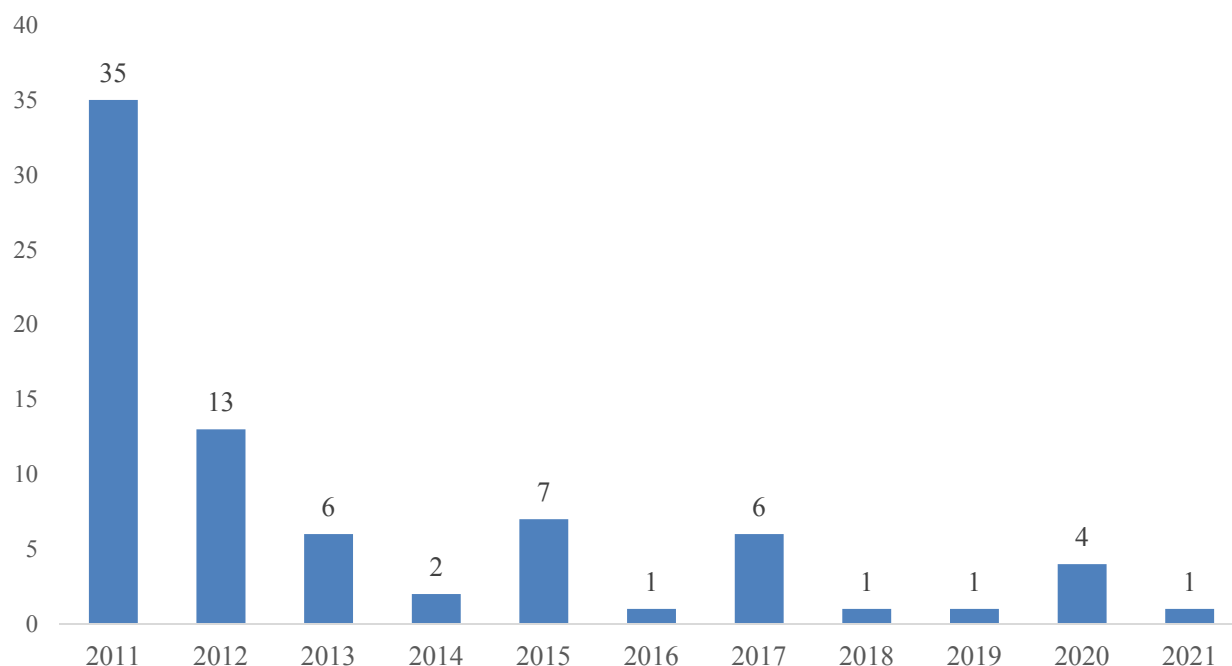
Fig. 8. **Number of initial public offerings (IPOs) on the Moscow Exchange, 2011–2021**
Source: "Conomy — Smart investment" website. URL: https://conomy.ru/analysis/articles/213 (accessed on 05.11.2021).

100%, on the whole, a positive result with a high level of internal profitability is observed for the portfolio of venture projects [19].

According to the methodology of the Russian Venture Capital Association (RVCA), venture funds include not only funds created in accordance with the legislation of the Russian Federation, but also foreign venture investment funds that finance innovations of Russian companies. According to RVCA estimates, the number of operating venture funds decreased from 175 to 154, while the total volume of the funds' net assets, on the contrary, increased by 17.6% — from $ 3 469 to $ 4 079 million (*Fig. 7*). At the same time, the possibilities of attracting foreign capital to finance industrial innovations are significantly limited due to geopolitical risks. Thus, modern technologies and corresponding instruments for financing innovation have significant potential, but their use is also limited by the sources of formation of the resources of the funds.

Also, such technology of financial management as an Initial Public Offering

(IPO) deserves special attention. While exchange transactions form the exchange segment of the secondary market, the IPO directly refers to the primary securities market, i.e. assumes direct funding of the issuer as a result of the placement of shares. In this case, the stock exchange is a platform that collects applications and funds in the interests of the issuer. Unfortunately, this technology is not widely used in Russia: only for 2019, 2020 and in the first half of 2021, there were only 6 successful IPOs (*Fig. 8*). For comparison, there were 190 IPOs in the US in 2018. Thus, given the legislative, technical and infrastructural capabilities, this method of financing does not have a significant impact on the innovation funding of industrial enterprises.

Based on the analysis of traditional and modern financial technologies, it should be concluded that these technologies and their corresponding instruments do not currently lose their relevance. At the same time, each of the considered instruments has a number of limitations. Self-funding is characterized by instability due to its dependence on the

Table 2

Comparative characteristics of digital and traditional securities

Criterion	Traditional securities	Digital securities
1. Legal regulation	Federal Law "On Securities" and other regulatory documents within the framework of securities legislation	Federal Law "On Securities" and other regulatory documents within the framework of securities legislation, as well as the Federal Law "On digital financial assets, digital currency and on amendments to certain legislative acts of the Russian Federation"
2. Form of issue	Non-documentary or documentary	Digital rights
3. The entity responsible for recording rights to securities	Kegistrar, central depository, depositories	Information system operator
4. The entity responsible for the registration of the securities issue	The regulatory body (Central Bank of the Russian Federation) or the stock exchange (in the case of the issue of exchange-traded or commercial securities)	Information system operator
5. The procedure for transferring funds when placing securities	The issuer can receive funds from the placement directly or through intermediaries (stock exchange, underwriters)	The operator of the information system opens a nominal account with a credit institution; upon completion of the placement, the funds are transferred to the issuer

Source: compiled by the authors.

dynamics of net (and retained) profits. Bank lending is available primarily to financially stable companies with sufficient experience, while it is preferable for banks to provide borrowed resources for the purpose of capital investment funding, rather than for direct scientific research. In this context, the issue of securities to attract additional financial resources is the most preferable, appropriate and corresponding to the purpose funding instrument. In particular, the indefinite nature of the shares makes it possible to finance research and development (industrial innovations) with a significant level of risk, sharing financial risks with the investor, subject to the latter's subsequent participation in profits as a result of the successful implementation of innovations in the company's operations. Moreover, stocks and long-term bonds are used at any stage in the development

of financial management technologies: traditional technologies imply over-the-counter direct placement of securities, modern technologies complement the scope of securities used by the sector of collective investments (including venture capital and direct investment, i. e. institutional investors predisposed to accepting a high level of risk) and direct public offering of securities on the stock exchange. The disadvantage of corporatization (both directly, in accordance with traditional technologies, and through an IPO or attracting institutional investors) is a significant period of implementation of the funding process itself. According to the Russian legislation on securities, the totality of actions and measures for the issue and placement of securities is recognized as an issue, and this issue process must comply with the requirements specified in the

legislation. In this regard, the regulatory period of the issue (from the moment the decision is made to raise funds until the approval of the report on the results of the issue and the recognition of the placement of securities as valid) exceeds 18 months (although in fact, this process is shorter).

The development of industrial, information and financial technologies has led to the formation of new technologies for attracting funds, namely, the emergence of digital securities[3] and a legally functioning crowdfunding mechanism.[4] The emergence of these financial management technologies is a consequence of the development of blockchain technology and its application in the implementation of financial activities by companies.

In particular, digital financial assets are securities that are identical in their status and legal consequences to common, "traditional" securities, since both of these groups of securities are subject to issue, placement and subsequent circulation in accordance with the Russian legislation on securities (first of all — with the Federal Law "On the Securities Market"). However, digital securities have a number of differences that make them a promising technology for managing innovation funding (*Table 2*). Thus, one of the key differences between digital securities and traditional ones is the absence of additional subjects of the financial market (professional participants in the securities market) in the process of issuing, placing and circulating securities, as well as accounting for rights to them. In addition, registration of the issue of digital securities is also carried out by the operator of the information system. The centralization of all processes (issue, placement, circulation of securities and registration of rights to them) will reduce

transaction costs and shorten the time it takes to attract funds by an enterprise.

The above technologies are new (statistics are not available at the moment) and the CBR is currently developing the appropriate infrastructure. However, considering the current trends in the digitalization of the economy, digital securities and crowdfunding technologies [20] have great prospects in terms of funding industrial innovations since they can reduce the time to attract investments, reduce transaction costs, as well as traditional and financial risks.

Based on the analysis and systematization of tools and technologies for managing innovative financing, it should be concluded that their grouping is conditional, and the use of new technologies and tools does not exclude the simultaneous use of traditional tools. On the contrary, for efficient and effective funding of industrial innovations, it is advisable to simultaneously and comprehensively use the above methods of attracting investment.

The research result of this paper is the construction of an effective and convenient mechanism for managing the technology of innovative financing.

RESULTS AND DISCUSSION

With a more detailed analysis of the qualitative characteristics of new financial management technologies, it is advisable to conclude that digital securities are the most preferable for financing industrial innovations.

Crowdfunding (attracting investments using investment platforms) has a number of financial constraints that are of great importance for companies in the industrial sector. In particular, individual entrepreneurs and legal entities can attract no more than 1 billion rubles a year through investment platforms.[5] Moreover, the

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[3] Federal Law of July 31, 2020, No. 259-FZ "On digital financial assets, digital currency and on amendments to certain legislative acts of the Russian Federation".

[4] Federal Law dated 02.08.2019 No. 259-FZ "On attracting investments using investment platforms and on amending certain legislative acts of the Russian Federation".

[5] Федеральный закон от 02.08.2019 № 259-ФЗ «О привлечении инвестиций с использованием инвестиционных платформ и о внесении изменений в отдельные законодательные акты Российской Федерации».
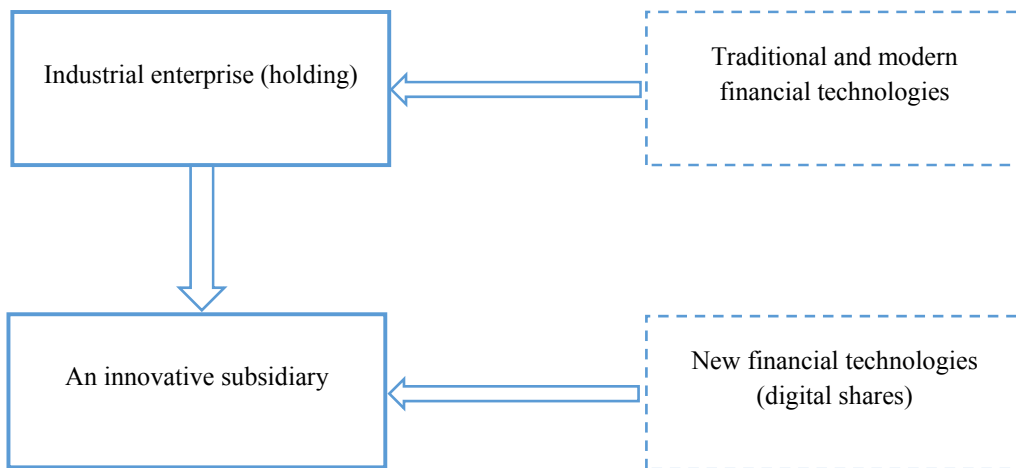
Fig. 9. **Mechanism for applying new technologies to manage industrial innovation funding**
Source: compiled by the author.

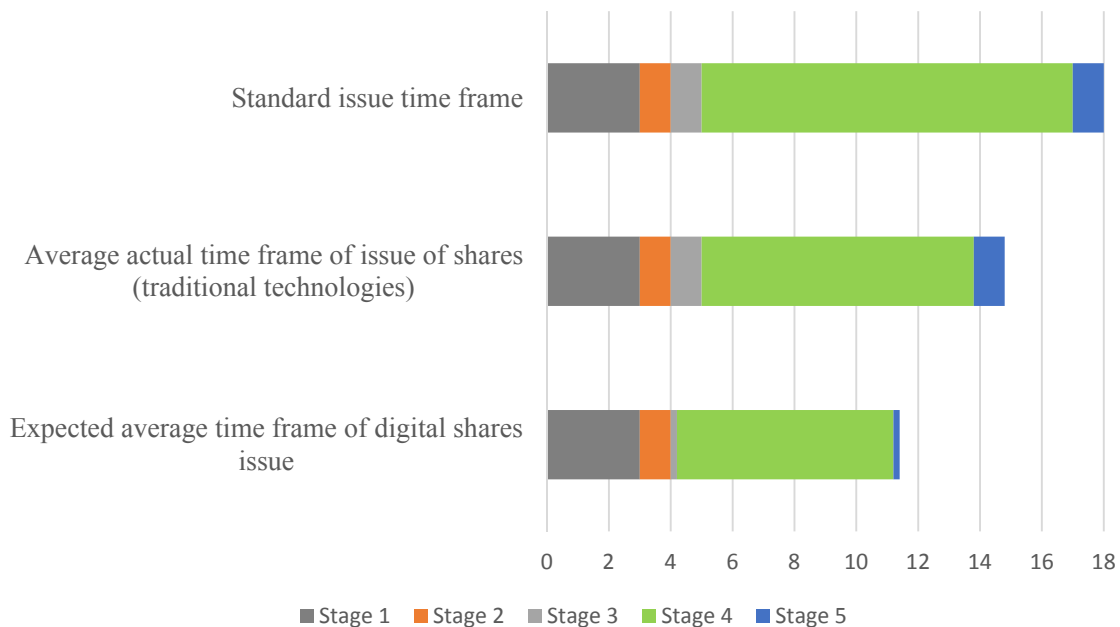■ Stage 1   ■ Stage 2   ■ Stage 3   ■ Stage 4   ■ Stage 5

Fig. 10. **Comparative assessment of the timing of the issue of shares**
Source: compiled by the author.

practice of using such a financing technology in Western countries indicates that for investors on such platforms, the key role is played not by the economic justification of the investment attractiveness of the project, but by non-financial, personal preferences [21]. Accordingly, innovative projects of industrial companies with a strict economic justification for return on investment are likely to be less in demand on investment platforms.

In contrast, issuing digital financial assets provides industrial companies with ample opportunities to finance innovation. Article 13 of the Federal Law "On digital financial assets, digital currency and on amendments to certain legislative acts of the Russian Federation" contains requirements for the issue of digital shares. The key feature is the complete prohibition of converting stocks from digital to traditional and vice versa. That is, a joint stock company that

has already issued and placed shares using traditional technologies and within the framework of the Federal Laws "On Joint Stock Companies" and "On the Securities Market" is not entitled to issue digital shares to increase the authorized capital. This prohibition persists in the event of a reorganization of a legal entity.

Despite this limitation, industrial enterprises are showing interest in new technologies. The Transmashholding [6] announced the planned cooperation in the framework of the release of digital assets. Less than a year has passed since the legislation on digital financial assets came into force (January 1, 2021), and as the financial and technical infrastructure of this technology develops, interest from the industrial sector will only increase.

For the successful implementation of new technologies for financial management of industrial innovations, it is necessary to address the problem of developing a mechanism for the application of new technologies, considering the restrictions of the legislation (Article 13 of the Federal Law "On digital financial assets, digital currency and on amendments to certain legislative acts of the Russian Federation").

Fig. 9 shows the proposed mechanism.

Thus, the mechanism involves a combination of traditional and new technologies for financial activities. To access digital financial assets, it is advisable to create a new subsidiary, the authorized capital of which will be formed by issuing digital shares. In addition to the direct contribution of the parent company, the participation of third-party investors is also preferable at this stage.

Since the technology for issuing digital financial assets is new and has not yet been applied in Russia, statistics on digital financial assets are also lacking. It does not allow building an economic and mathematical model for attracting funds. In

terms of financial parameters, the potential for raising funds through traditional and new technologies is identical, and the assessment of transaction costs is possible only with the accumulation of sufficient experience in the functioning of digital financial assets. However, the obvious advantage of new technologies is the reduced time frame of issue of securities. Despite the fact that the deadlines for the issue are specified in the Federal Law "On the Securities Market" and are the same regardless of the financial technologies, in practice it is expected that the time spent to issue and place digital shares will be shortened (*Fig. 10*).

Based on the assessment, the average expected time frame of the issue of shares (i.e. the period from the moment of a decision to finance until the completion of the procedures and registration of the report on the results of the issue of shares) would be 10.4 months for digital shares versus 14.8 months for traditionally issued shares. In modern conditions of a dynamic external environment, the reduction of the period for attracting funds for innovation by 4.4 months becomes an important competitive advantage.

CONCLUSIONS

In the context of modern trends in large-scale digitalization of the economy, the constant introduction of innovations is both a competitive advantage and a factor in the economic security of an industrial enterprise. The growing role of R&D leads to a constant increase in the need for financial resources. At the moment, traditional and modern financial technologies and corresponding instruments cope with this task: common and preferred shares, long-term bonds, long-term bank investment loans, investment funds finances (venture capital or direct investments).

At the same time, it is indisputable that the introduction of new technologies — crowdfunding and the issuance of digital securities — in the long term will have

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[6] Business goes digital. Kommersant. URL: https://www.kommersant.ru/doc/4710180 (accessed on 05.11.2021).

a significant impact on the financing of enterprises and, in particular, on their innovative activities. The important advantages of new technologies are the reduction of operational risks and transaction costs, as well as the reduction in the time it takes to raise funds.

To address the problem of financing innovations by industrial enterprises, the most suitable solution is the issue and placement of digital financial assets, primarily shares. For this, within the framework of the proposed mechanism for applying new technologies in financial management, it is planned to create a new subsidiary within an industrial holding, the authorized capital of which will be formed at the expense of digital securities. This will make it possible to effectively use a combination of traditional, modern and new technologies to manage innovative financing, which in the long term can provide an industrial enterprise (or holding) with opportunities for sustainable growth.

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Impact of Risk Disclosures on IPO performance: Evidence from India

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ABSTRACT

The main **aim** of the paper is to explore the performance of Indian IPOs in the context of risk disclosures in the offer documents. For the purpose of assessing the impact of risk disclosure factors on initial returns, subsequent returns and post issue risk of IPOs, the study has implemented ordinary least square regression. The study has analysed 109 IPOs that were listed in two main Indian stock exchanges (BSE and NSE) from 2015–2019. Outcomes of the present study are contrary to the previous studies which showed that information disclosure reduces the asymmetry, which is touted as the main reason for underpricing, the present study did not find any association between risk disclosures and underpricing. Quantitative risk measures showed positive association with 1-year returns, but qualitative measures failed to show any association. The post issue risk of the firms showed positive association with external risk factors listed in prospectus and negative association with liquidity. The results of this study are useful for the investors as based on the results they can make decisions about investing in Indian IPOs. Besides, the managers of issuing companies and lead managers of issues can use the results of this study to improve the pricing of issues. To the best of the authors' knowledge no study has been done before in the Indian context which is specific to risk disclosures (quantitative and qualitative measures) and IPO performance. The present study seeks to fill this gap and contribute to the existing literature.

Keywords: risk disclosure; IPO; initial return; subsequent return; risk; India

INTRODUCTION

In the emerging economy of India, the financial markets are also growing rapidly. The global pandemic caused by COVID-19 led to a slump in the market in the initial phase, in 2020, but nonetheless, the markets recovered in the later part of the year. Especially, the Indian stock markets showed great recovery with the stock markets achieving their lifetime highs in January 2021. This sentiment of stock markets was visible in the Initial Public Offering (IPO) market as well, which showed strong momentum in late 2020 and early 2021. The number of IPOs in the last quarter of 2020 increased by 100 percent as compared to the last quarter of 2019. In terms of the number of IPOs, Indian stock markets ranked 9th in the world, in the year 2020 [1]. In 2021, till 20th March, 10 mainboard IPOs got listed on the Indian stock exchanges. On average, each of these IPOs got oversubscribed 16 times by the retail individual investors.[1] This shows high involvement of even retail investors in the Indian stock markets. To safeguard investors' interests and to boost their confidence, the Indian Government has created certain laws and rules for IPOs. Mainly, The Companies Act, 2013, Securities and Exchange Board of India's (SEBI) ICDR (Issue of Capital and Disclosure Requirements) regulations of 2009 and SEBI (Listing Obligations and Disclosure Requirements), Regulations 2015 govern the new issues as well as the later operations of the listed companies. When a company comes with an IPO, information about its operations and performance is not publicly available. It is made available through offer documents like prospectus, which are made and presented as per the above mentioned rules and

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[1] Moneycontrol (2021): IPO historic table, available at: IPO Historic Table — IPO listing, IPO market, IPO issue, Subscription (moneycontrol.com).

laws, so that the prospective investors can make an informed decision. Investors' interest and confidence in an IPO can be judged from the subscription rate and from the prices after listing. From the 10 IPOs that got listed till 20th March 2021, the average listing day gains were more than 37 percent. This means the offer prices found through the book building process were around 37 percent less than the price that the investors decided on the first day of listing. Some authors have attributed this trend of positive first day returns to the difficulty faced by the issuers and underwriters in setting IPO prices, which makes them 'underprice' the issues, leading to this apparent error in pricing [2]. K.W Hanley., G. Hoberg [3] showed that quality and substantial disclosure of information in the prospectus reduces pricing error of IPOs.

In India, SEBI ICDR regulations of 2009 detail the provisions and conditions of different types of public issues as well as the disclosure requirements in the offer documents. Main contents of the different offer documents (like red herring prospectus, prospectus and shelf prospectus) are the cover page, risk factors, introduction of the issuer, objects of the issue, financial information, management's discussion and litigation and defaults[1]. Many past studies have been conducted to study the IPOs performance and many have studied the impact of information disclosure on IPO performance [4–6]. Relatively few studies have specifically focused on risk disclosures and IPO performance [7–8]. The purpose of the current paper is to examine the performance of Indian IPOs in the light of risk disclosures in the offer documents. The first objective is to investigate whether the risk disclosures impact the pricing or initial returns of the IPOs. Secondly, the comprehensiveness of the risk disclosures is judged by testing their impact on long term returns. Finally, the relationship between risk disclosures in prospectus and the subsequent market measures of risk is examined so that the investors can use the risk variables from the prospectus as proxy for market measures of risk. Additionally, reasons for underpricing are also explored considering the relationship of initial returns with some other offer related factors.

The remainder of the paper is structured as follows: Section 2 discusses the review of literature; Section 3 explains the sample and statistical techniques used for empirical analysis; Section 4 discusses the findings of the analysis; Section 5 concludes the study and gives out the implications; and Section 6 details the limitations and future scope of the study.

REVIEW OF LITERATURE

Much research has been done in the area of IPOs. The review of past studies is organised in the following three sections.

Studies about short term performance

Many previous studies have tried to find out the reasons for the listing gains caused by IPO underpricing, i.e., issue price being lower than the price on the 1st day of listing of shares. This has been explained with the help of 'asymmetric information'. As per this phenomenon, the issuers of shares, the investors and the underwriters, all have certain information that the other parties do not. This gives them an undue advantage in the price discovery process in an IPO. K.B. Libison and N.V. Narasimham [9] empirically tested for information asymmetry in the Indian market. They bifurcated the IPOs by the level of holdings by sophisticated (informed investors like foreign institutional investors) and unsophisticated investors (like domestic retail investors). They concluded that the IPOs which had higher holdings by informed investors performed better in the post IPO market, as compared to the ones which had lower holdings because the informed investors have access to more information. They suggested retail investors to stay away from those IPOs which have zero or low holdings by the informed investors. This study supports the information asymmetry explanation. This information asymmetry has proved to be associated with the underpricing of IPOs [10]. Underpricing of IPOs is a huge cost for the issuers, which they can try to reduce. Past studies have shown that information disclosure reduces information asymmetry leading to a reduction in underpricing [11–12]. J.M. Friedlan [13] showed that the firms which showed more detailed information in the prospectus had lower underpricing. A similar relationship was obtained with underpricing when V. Jog, B.J. McConomy [14] studied the voluntary disclosure of management forecasts; and R.P. Beatty, I. Welch [15] studied the number of risk factors mentioned in prospectus. A.J. Leone *et al.* [16] reported that more specific disclosure of the use of IPO proceeds leads to reduction in underpricing. Following these studies, it can be postulated that if the risk disclosures are more in the offer documents of IPOs, information asymmetry will be reduced and in turn, underpricing will be reduced. Few studies have shown a reverse relationship as well. J.L.M. Van

Der Zahn *et al.* [17] studied the relationship between intellectual capital disclosure and initial returns and showed a positive relationship between the two. They attributed this relationship "fads" or over optimistic behaviour of investors towards the IPOs causing high initial returns. Then there is a third prediction relating to the relationship between underpricing and risk factor disclosures. Some researchers predict no relationship between the two because of the lack of informativeness of the disclosures. They argue that the managers coming out with IPOs may themselves not be fully aware of all the possible risks to the firm. Further, the managers may try to withhold negative information from their prospective investors [18]. The managers may also choose to withhold information to avoid disclosing any proprietary information [19].

Besides the prospectus disclosures, some studies have tried to find out other reasons for underpricing. H.W. Leow and W.Y. Lau [20] conducted research on 310 IPOs listed on the Malaysian stock exchange from 2006 to 2016. Empirical analysis of the first three days' returns showed that oversubscription was positively related to initial return while trading volume showed no relationship. Venture capitalists are believed to value the firms on their true intrinsic value and hence it's expected that the IPOs backed by venture capitalists will not be underpriced. B. Kirkulak [21] compared the initial returns of Venture Capitalists (VC) backed firms with non-venture capitalists backed firms of Japan. On the basis of 433 IPOs listed from 1998 to 2001, the study revealed no significant difference between the two; thus, disproving the "VC certification hypothesis". P.K. Samanta *et al.* [22] calculated the Market Abnormal Excess Returns (MAER) to measure the short-term performance of Indian IPOs between 2009 and 2013. Their analysis showed that MAER increased in the period from 2009 to 2013 and infrastructure IPOs performed better than other firms. They also tried to find out the impact of issue size, price and subscription duration on the short term returns but found no statistically significant relationship.

Studies about long term performance

Not only underpricing, but the disclosures can also have spillover effects on the subsequent performance of IPOs. Past research shows that most IPOs perform well on the first day of listing but their returns become negative over a period of time. J.R. Ritter [23], T. Loughran and J.R. Ritter [24], V. Jog and

B.J. McConomy [14], all support this observation. J.R. Ritter [23] attributed the negative long-term performance to sheer bad luck, over optimism of investors about IPOs (fads) and mismeasurement of risk. Many studies have been able to relate the IPO prospectus disclosures with their long run performance. M. Sherif *et al.* [25] showed that the motives for raising capital through IPO, disclosed in the prospectus, affect the initial as well as subsequent performance of the companies in the Thailand stock markets. Similarly, T. Arnold *et al.* [26] in their study on US IPOs from 1999 to 2004, revealed a significant relationship between prospectus disclosures of risk and initial returns, long run return and return volatility. J.L.M. Van Der Zahn *et al.* [17] studied the long term performance of IPOs with respect to intellectual capital disclosure in the prospectuses of Singapore's 228 IPOs from 1997 to 2003. Their empirical analysis revealed a negative relationship between the two. They explained this with the over optimism of investors for companies that disclosed more information about the intellectual capital. Post issue, when the expectations aren't immediately met, the investors discount their long term prices. Similar results were found in Japan, as the IPOs underperformed in the long run [21].

Studies specific to risk disclosures

Offer documents give detailed information about the business of the offering company. Potential investors can make an informed decision using the information from the offer documents. To judge the riskiness of any opportunity, traditional measures like ratios of profitability, liquidity and operating efficiency are considered. However, the recent literature shows the usage of qualitative measures of risk. R.P. Beatty and J.R. Ritter [11] were probably the first ones to use qualitative information obtained from the prospectus. They used the number of "uses of proceed" to estimate ex ante uncertainty. R.P. Beatty and I. Welch [15] counted the captions in the risk factors section of prospectuses to measure the cautiousness of management. R. Kuswanto [8] used both qualitative as well as quantitative measures of risk and studied their impact on the initial return of IPOs in the Indonesian stock exchange. The results showed negative impact of risk disclosures on initial return. S.H. Ng and C.S. Lee [27] used content analysis for risk measurement. They used categorical principal component analysis to obtain

risk measures which they used to see whether they reflect the actual risks. For this, they regressed the post issue measures of market risk (total risk, systematic risk and failure risk), on the risk measures obtained from prospectuses. The prospectus-based measures of risk were unable to predict market measures of risk. S. Wasiuzzaman *et al.* [7] also conducted a content analysis on the prospectuses of 96 Malaysian IPOs to measure overall risk, internal risk, external risk and investment risk. Then they analysed their impact on initial returns using regression. The regression results revealed that the firms which disclosed more risk generated higher initial returns, however, only the investment risk was found to be significant. R. Ding [28] did a content analysis on prospectuses to measure the informativeness of risk disclosures. This was achieved by finding out the disclosures that were different from the standard disclosures done by all the firms. They found out that as the informativeness of risk disclosures increased, the underpricing, as well as the uncertainty, reduced. Exactly same results were shown by X.C. Hao and Z.X. Su [29].

RESEARCH GAP

As discussed in the review of literature various studies in the past have been conducted to study the IPOs performance and many have studied the impact of information disclosure on IPO performance [4–6]. Relatively few studies have specifically focused on risk disclosures and IPO performance [7, 8]. As far as studies in India are concerned, there are some that have focused on short term and long term performance of Indian IPOs [30, 31]. There are some studies that have sought to explain the reasons for underpricing [32]. However, to the best of the authors' knowledge, no study has been done before in the Indian context which is specific to risk disclosures and IPO performance. The present study seeks to fill this gap and contribute to the existing literature. With this background, the hypotheses for the study can be listed as follows:

H1$(a, b, c)_0$: liquidity does not affect initial return, subsequent return and market measure of risk;

H2$(a, b, c)_0$: sales growth does not affect initial return, subsequent return and market measure of risk;

H3$(a, b, c)_0$: earnings variability does not affect initial return, subsequent return and market measure of risk;

H4$(a, b, c)_0$: cash flow volatility does not affect initial return, subsequent return and market measure of risk;

H5$(a, b, c)_0$: internal risk factors do not affect initial return, subsequent return and market measure of risk;

H6$(a, b, c)_0$: external risk factors do not affect initial return, subsequent return and market measure of risk;

H7$(a, b, c)_0$: offer related risk factors do not affect initial return, subsequent return and market measure of risk;

H8$(a, b, c)_0$: total risk disclosure does not affect initial return, subsequent return and market measure of risk;

H9$(a, b, c)_0$: disclosure quality does not affect initial return, subsequent return and market measure of risk;

H10$(a)_0$: offered capital does not affect initial return;

H11$(a)_0$: market return does not affect initial return;

H12$(a)_0$: market risk does not affect initial return;

H13$(a)_0$: subscription does not affect initial return.

RESEARCH METHODOLOGY

The present section set forth the objectives, research model, variables, empirical models and data source used for the research.

Objectives and Research Model

The main aim of the paper is to explore the performance of Indian IPOs in the context of risk disclosures in the offer documents. The sub-objectives are as follows:

• To examine whether the risk disclosures impact the pricing and hence initial returns of the IPOs.

• To examine whether the risk disclosures impact the long term returns (one year returns post issue).

• To examine whether the risk disclosures impact the *ex post* market measure of risk.

• To examine whether there are some other offer specific variables that impact the pricing or initial returns of the IPOs.

In order to achieve the aforementioned objectives of the paper, research model has been framed (*Fig.*).

Description of Variables

The variables used to investigate the relationships between risk disclosure factors and returns and market risk are presented in *Table 1*. The study has used three predicted variables, namely, initial return, subsequent return and market measure of risk. Post issue share prices are used in the calculation of these variables. *Initial return* is calculated as the percentage change in the first day listing price of a company from its offer price. T. Arnold *et al.* [26], S. Wasiuzzaman

[7] and R. Kuswanto [8] followed this same method of calculating initial returns. *Subsequent returns* are calculated as the percentage change in price from 1st day of listing to the last day of 1st year. In other words, it is the holding period return from the 1st day to the last day of the year [26]. As can be inferred from the literature, information asymmetry and over optimism of investors play a huge role in IPO underpricing and long run performance of IPOs. Higher information disclosure should be able to reduce the asymmetry and should match the intrinsic and actual values of shares. Hence, it is expected that initial returns will be negatively related to risk disclosures and no significant relation between subsequent returns and risk disclosures will be found. This is based on the hypothesis that if the risk disclosures are comprehensive, then the initial returns will reflect this risk and hence the long term returns will be unrelated to the risks disclosed in the prospectus. Further, the performance of stocks after listing should depend on actual performance of firms in the respective time periods [26]. *Market measure of Risk* (*ex post* measure of risk) is the standard deviation of daily returns for 11 months after the first month of listing. This measures of the risk of the stock after the IPO. Since it is calculated on the basis of market price after the issue, it is named as the market measure of risk. The first month is excluded so that the initial volatility is settled and doesn't distort the real risk [26]. A positive relationship between risk disclosure and the *ex post* measure of risk is expected. The firms that disclose more risk factors and show higher risk prior to the IPO are expected to turn out relatively riskier post the issue. If the information related to risk, in the prospectus, is not relevant or is insufficient, then the disclosures should not have any relation with the market measure of risk post issue [28].

The variables explaining risk disclosure measures are classified into quantitative measures, qualitative measures and offer related measures.

Quantitative measures

Four measures of risk are taken in this study — *liquidity* [8], *sales growth* [8], *earnings variability* [8, 33] and *cash flow variability* [33]. Liquidity, measured by the current ratio, shows the ability of a firm to meet its current liabilities using its current assets. Lower liquidity shows a riskier position. Sales growth measured by percentage change in sales in one year prior to issue,

shows the revenue growth of a firm. Firms with good revenues growth are considered less risky. Earnings variability and cash flow variability are both measures to check the stability of business pre issue. Higher stability implies lower risk.

Qualitative measures

SEBI ICDR regulations require disclosure of *internal* as well as *external* risk factors for the company. The management must carefully assess the risk factors and disclose them in the offer document in the order of materiality for the benefit of the investors. They are further supposed to detail their risk management system. In the prospectus of each IPO, there is a section titled 'Risk Factors'. Generally, the companies list their risk factors in 3 categories: internal risk, external risk and risks related to the issue. The 'Internal Risk' covers all the risks specific to the business of the firm. 'External Risk' covers risks related to the industry the business operates in, the economy as well as the international factors that can have a bearing on the firm. The social and political factors are also listed in this section. '*Risks related to the issue*' includes the factors of risk for the investors if they invest in the offer. The 'Risk Factors' section of the prospectuses is used to formulate the measures of qualitative risk. The count of factors listed in each of the headings/categories are directly used to measure them individually [4]. To measure the *total risk disclosure*, the percentage of word count in 'Risk Factors' section to total word count in the whole prospectus is calculated [26]. There is a possibility that the companies might intentionally increase their number of risk disclosures. To control for the quality of these disclosures, the average number of words per listed factor is calculated as a measure of *Disclosure Quality* [26].

Other Offer Related Measures

Four offer related measures are considered for the present study. *Offered Capital* is the percentage of capital offered in the IPO to the existing issued capital. *Market Return* is measured by average daily returns of S&P BSE Sensex, for 3 months prior to the issue date. S&P BSE Sensex is India's 'most tracked bellwether index' and hence it is taken as the proxy for market. *Market Volatility* is the standard deviation of daily returns of S&P BSE Sensex. MARRTN and MARVOL are measures of market condition at the time of the IPO. *Subscription*
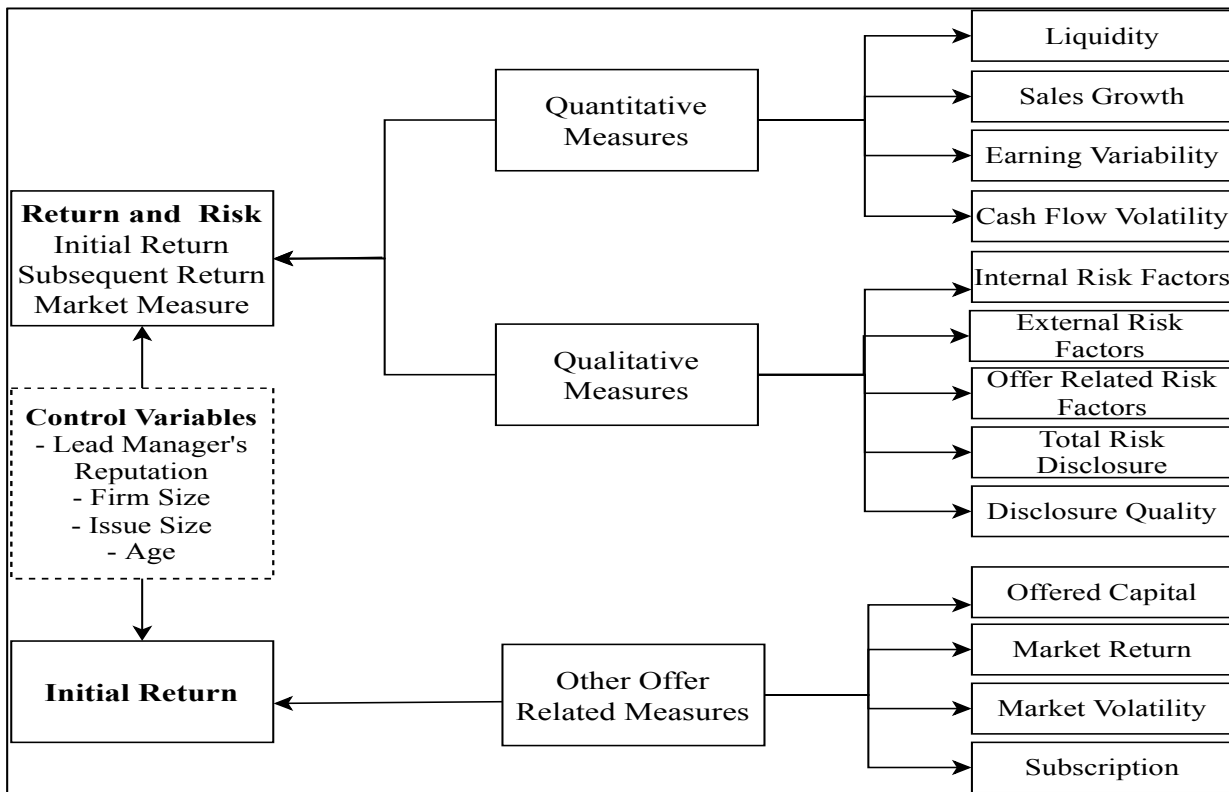
Fig. **Research Model**

Source: authors' compilation.

shows how many times the offer is subscribed. This shows the demand for the shares in the IPO.

Control Variables

The study has also incorporated four control variables so as to control their influence on returns and risk. In past studies, common control variables are firm size, firm age, offer size and lead managers' reputation [7, 34]. The calculations of these control variables are shown in *Table 1*.

Empirical Models

For assessing the impact of risk disclosure factors on initial returns, subsequent return and market measure of risk, the study has employed cross-sectional Ordinary Least Square (OLS) regression method. The present study tests four regression models. Model 1, 2 and 3 examine the impact of quantitative and qualitative measures of risk along with four control variables. To increase the robustness, the study also examines the impact of some other offer specific variables on initial returns of Indian IPOs. The following equations have been formulated to test the aforementioned relationships:

Model 1: $IR = \alpha + \beta_1(LIQ) + \beta_2(SG) + \beta_3(EV) + \beta_4(CFV) + \beta_5(IRF) + \beta_6(ERF) + \beta_7(ORRF) + \beta_8(TRD) + \beta_9(DQ) + \beta_{10}(LMREP) + \beta_{11}(SIZE) + \beta_{12}(ISSUESIZE) + \beta_{13}(AGE) + \varepsilon$

Model 2: $SUBRTN = \alpha + \beta_1(LIQ) + \beta_2(SG) + \beta_3(EV) + \beta_4(CFV) + \beta_5(IRF) + \beta_6(ERF) + \beta_7(ORRF) + \beta_8(TRD) + \beta_9(DQ) + \beta_{10}(LMREP) + \beta_{11}(SIZE) + \beta_{12}(ISSUESIZE) + \beta_{13}(AGE) + \varepsilon$

Model 3: $MMR = \alpha + \beta_1(LIQ) + \beta_2(SG) + \beta_3(EV) + \beta_4(CFV) + \beta_5(IRF) + \beta_6(ERF) + \beta_7(ORRF) + \beta_8(TRD) + \beta_9(DQ) + \beta_{10}(LMREP) + \beta_{11}(SIZE) + \beta_{12}(ISSUESIZE) + \beta_{13}(AGE) + \varepsilon$

Model 4: $IR = \alpha + \beta_1(OFFCAP) + \beta_2(MARRTN) + \beta_3(MARVOL) + \beta_4(SUBSCRP) + \beta_5(LMREP) + \beta_6(SIZE) + \beta_7(ISSUESIZE) + \beta_8(AGE) + \varepsilon$

Where, α is constant term; $\beta_1 .... \beta_{15}$ are coefficient for explanatory variables; ε is the error term and other variables are discussed in detail above.

List of Variables and their Description

Predicted Variables	Measurement	Description
Initial Return (IR)	(1st day closing price-offer price) / offer price	IR shows the short term/immediate performance of an IPO
Subsequent Returns (SUBRTN)	(Price at end of 12 months-Price at end of 1st day) / price at end of 1st day	Returns over one-year post issue excluding the initial returns, to gauge the subsequent performance of IPO after issue
Market Measure of Risk (MMR)	Standard deviation of daily returns for 11 months after 1st month of listing	After controlling for initial volatility, MMR represents the total risk of the company post issue
Explanatory Variables	**Measurement**	**Description**
Quantitative Measures		
Current Ratio (LIQ)	Current Assets / Current Liabilities	Current ratio is a measure of liquidity. A firm with high liquidity is believed to be less risky
Sales Growth (SG)	(Sales current year − Sales previous year) / Sales previous year	Higher growth in revenues shows good prospects of business and lesser risk
Earning Variability (EV)	Coefficient of variation of net income of 3 years prior to listing	More variations in earnings are risky for sustenance of business
Cash Flow Volatility (CFV)	Standard deviation of cash flow to total assets ratio calculated for 3 years prior to listing	High variations in cash flows puts the organization in a risky position
Qualitative Measures		
Internal Risk Factors (IRF)	Number of risks listed under this head in the "Risk Factors" section of the prospectus	Shows the risks related to the business
External Risk Factors (ERF)	Number of risks listed under this head in the "Risk Factors" section of the prospectus	Shows the risks external to the company, i.e. related to the economy
Offer Related Risk Factors (ORRF)	Number of risks listed under this head in the "Risk Factors" section of the prospectus	Shows the risks specific to the investors due to the issue
Total Risk Disclosure (TRD)	Percentage of word count in "Risk Factors" section to total word count of prospectus	Shows the total risk disclosure in every prospectus
Disclosure Quality (DQ)	Word count in "Risk Factors" section/ total number of risks listed in "Risk Factors" section	Average words per risk factor shows the quality of disclosure
Other Offer Related Measures		
Offered Capital (OFFCAP)	Percentage of offered capital in IPO to total issued capital	Shows whether the amount to be raised is significant for the offering company
Market Return (MARRTN)	Average of daily log returns of S&P BSE Sensex of 3 months prior to the date of issue	Shows the general market sentiment
Market Volatility (MARVOL)	Standard deviation of daily log returns of S&P BSE Sensex of 3 months prior to the date of issue	Shows the general market sentiment through daily variations in the market index
Subscription (SUBSCRP)	Percentage of total subscription received for the IPO to offered capital	Shows the investors' sentiment towards the IPO
Control Variables		
Lead Managers Reputation (LMREP)	Number of public issues handled by the lead managers in the past 3 years	The reputation of lead managers associated with the issue
Firm Size (SIZE)	Log of Total Assets	Size of assets held by each firm
Issue Size (ISSUESIZE)	Total issued capital in Rupees Crores	Total amount of capital to be raised by each company
Age (AGE)	Age of firm (in years) from date of incorporation to date of listing	Time period for which the company has been operating

Source: authors' compilation.

Data Collection

The study has considered IPOs listed in both NSE (National Stock Exchange) and BSE (Bombay Stock Exchange) for analysis. Only the mainboard IPOs are considered, and not the Small and Medium Enterprises (SMEs). S.K. Sharma and M.S. Wazal [35] compared the performance of Indian Mainboard IPOs and SME IPOs and showed that SME IPOs were more efficient in terms of pricing of issues. The present study seeks to find the reasons for inefficiencies in pricing of mainboard IPOs. Further, only the book-built IPOs are considered as book building is seen as a better way of issue as the price is discovered through the market mechanism. 122 IPOs were found, which satisfied these criteria. 13 IPOs were then excluded from the sample because of unavailability of data, and finally 109 IPOs formed the final sample size for the study. The year-wise number of IPOs is listed in *Table 2*. For calculation of initial return, subsequent return and market measure of risk, post issue share prices are used, which are retrieved from BSE and NSE websites. All the data for calculating measures of independent variables are collected from offer documents, mainly the prospectuses and issue advertisements. These documents are taken from the SEBI, BSE and NSE websites. Historical values of S&P BSE Sensex are retrieved from the BSE website and the return and volatility calculations are done, which are used as independent variables in the last regression model. Subscription values are retrieved from the money control website.

FINDINGS AND DISCUSSION

Descriptive Statistics

Descriptive statistics are tabulated in *Table 3*. The table exhibits the total number of observations, mean, standard deviation, minimum and maximum values. It can be seen from the results that the average initial return from IPOs in the sample is 13.6 percent, while the average subsequent return is 12 percent. This result is contrary to most previous studies like J.R. Ritter [23] and T. Arnold *et al.* [26], which showed a negative long run return. This shows that the returns in the Indian IPOs have declined subsequently as compared to their initial returns, but have still been positive. The average of standard deviation of daily returns of IPOs post issue i.e., the market measure of risk is 2.5 percent. All the independent and control variables do not have any unusual patterns. An

Table 2

IPO's per year

Year	No. of newly listed companies on BSE/NSE	Unavailability of Data	Final Sample Size
2019	16	3	13
2018	24	1	23
2017	35	6	29
2016	27	2	25
2015	20	1	19
Total	122	13	109

Source: authors' compilation.

interesting aspect of the Indian new-issues market can be seen from the average subscription of 31.28. This shows that on average every IPO is oversubscribed to the extent of 31.28 times. Investors' great confidence can be gauged from this.

Correlation analysis

The correlation matrix between dependent and independent variables is displayed in Appendix. The correlation matrix shows no significant relationship between any variable and initial returns. However, subsequent returns show a significant negative correlation with risk disclosure quality, issue size and lead managers' reputation, while a significant positive correlation with market volatility. The firms' market measure of risk shows no correlation with any variable except a negative correlation with the issue size. Also, the association between independent variables can also be seen. High correlation among independent variables i.e., more than 0.8 or 0.9 is considered to create a problem of multicollinearity [36]. The findings clearly show that the highest degree of association is 0.590 between market volatility and market return which is less than the threshold limit. Hence, a conclusion can be drawn for no problem of multicollinearity in the models. In addition, Variance Inflation Factors (VIF) are also computed to verify multicollinearity among independent variables (*Table 4*).

Descriptive Statistics of Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
IR	109	0.136	0.275	−0.681	1.277
SUBRTN	109	0.12	0.522	−1	1.844
MMR	109	0.025	0.009	0.002	0.061
LIQ	109	1.549	1.139	0.323	7.723
SG	109	0.35	1.212	−0.116	12.668
EV	109	0.528	2.181	−5.256	17.573
CFV	109	0.058	0.045	0.001	0.198
IRF	109	50.404	9.785	30	103
ERF	109	9.679	3.761	2	22
ORRF	109	8.349	6.63	3	72
TRD	109	0.085	0.015	0.047	0.119
DQ	109	311.769	45.643	169.386	431.606
OFFCAP	109	26.642	14.311	3.329	102.345
MARRTN	109	0	0.001	−0.002	0.002
MARVOL	109	0.008	0.002	0.005	0.013
SUBSCRP	109	31.288	46.73	0.76	248.51
LMREP	109	24.468	16.126	0	66
SIZE	109	9.607	1.278	6.841	13.153
ISSUESIZE	109	6.392	0.918	3.135	8.329
AGE	109	21.382	13.769	2.447	84.677

Source: authors' calculations.

Diagnostic Tests

Before running regression it is vital to apply diagnostic tests so as the accurate regression model is implemented to get appropriate results. To test heteroscedasticity, the study has used the Breusch-Pagan test by calculating the residuals of each model and then the impact of all explanatory variables has been seen on the predicted residuals of the models. The results of the test (*Table 5*) reveal that F-statistics is not significant and hence, the study fails to reject the null hypothesis and conclusions can be drawn that all the models have constant variance i.e., absence of heteroscedasticity [37]. Moreover, VIF scores have been calculated where if the VIF score is below 10 and tolerance i.e., 1/VIF is below 0.10 then there is no problem of multicollinearity in the models [38, 39].

The results clearly depict that there is no problem of multicollinearity.

Regression Analysis

To investigate the impact of quantitative risk measures extracted from prospectuses and qualitative risk measures formed on the basis of "Risk Factors" section of the prospectuses on IR, SUBRTN and MMR, OLS regression was implemented. As discussed earlier, the present paper has used four control variables namely; LMREP, SIZE, ISSUESIZE and AGE so as to control their influence on the short-term and long-term return and market risk measures. With a view to assessing the impact of risk disclosures, three regression models were developed. The findings of Model 1, 2 and 3 are tabulated in *Table 6*. Model 1, 2 and 3 tests the effect

on quantitative and qualitative measures of risk on IR, SUBRTN and MMR along with control variables. The results show that the overall model 1 is not fit as the F-statistics for the model is not significant at a 5 percent significance level. The explanatory power of the model is 9 percent which is quite low. The regression results show that no variable showed any significant relationship with initial returns. Hypotheses H1(a), H2(a), H3(a), H4(a), H5(a), H6(a), H7(A), H8(a) and H9(a) are not rejected. Previous researchers in finance believed that information asymmetry is the main reason for IPO underpricing. This means the prices that the offering company and the lead managers believe to be true and the prices that the investors believe to be true are different, because of information that some parties may possess while others do not. So, information disclosure should reduce the asymmetry and hence the initial returns. Past studies have empirically proved this [8, 11, 28]. Contrary to this belief, the present study did not find any association between risk disclosures and underpricing. A possible explanation is that when an IPO is priced, the already known risks are taken into consideration by the book running lead managers, so the disclosures do not affect investors' perceptions about pricing. Besides, some disclosures are statutory and some are standard disclosures done by all companies. So, this portion of risk disclosures is insignificant in the evaluation of risk by the investors. Another explanation for no relation is that the risk disclosures could be just meaningless and not informative. Reasons for this could be that the managers themselves aren't aware of the possible risks associated with their business, or they could purposely withhold negative information or they may withhold the risk information to eliminate the possibility of disclosing proprietary information along with it [28].

Model 2 expresses the relationship of subsequent returns (one year returns post issue) with quantitative and qualitative risk measures. The findings clearly show that the overall model is fit at a 5 percent significance level and risk disclosure measures explain about 13 percent of long-term returns. The results reveal that no qualitative measure of risk disclosure showed any association with subsequent returns. So, H5(b), H6(b), H7(b), H8(b) and H9(b) are not rejected. After the issue, the performance of a firm in stock markets is expected to be in line with its operating performance. Further, the risk disclosures in the prospectus are supposed to be imbided in the offer price and first day stock

Table 4

Multicollinearity Test Results — VIF and Tolerance

Variables	VIF	1/VIF
LIQ	1.387	0.721
SG	1.15	0.87
EV	1.113	0.898
CFV	1.297	0.771
IRF	1.402	0.713
ERF	1.191	0.84
ORRF	1.261	0.793
TRD	1.361	0.735
DQ	1.851	0.54
OFFCAP	1.453	0.688
MARRTN	1.79	0.559
MARVOL	1.999	0.5
SUBSCRP	1.148	0.871
LMREP	2.067	0.484
SIZE	1.466	0.682
ISSUESIZE	2.009	0.498
AGE	1.247	0.802

Source: authors' calculations.

price. So, the past performance and expected risks disclosed in the offer documents are not anticipated to be related to the subsequent returns after the issue [26]. The results are in line with the theory as most risk measures did not show a significant relationship with 1-year returns post the issue. Only sales growth showed a significant negative relationship and earnings variability showed a significant positive relationship. This means hypotheses H1(b) and H4(b) are also not rejected; while H2(b) and H3(b) are rejected. The results imply that quantitative measures of risk disclosed in the prospectus affect the subsequent returns positively. The finance historical records show that higher risk is rewarded with higher returns [40, p. 377]. In case of IPOs, it can be said that the investors are being compensated for the higher risk they assume when investing in risky ventures.

Diagnostic Tests

Tests	Model 1		Model 2		Model 3		Model 4	
Breusch Pagan (Heteroscedasticity)	F-stats 0.90	Prob > F = 0.5543	F-stats 0.93	Prob > F = 0.5303	F-stats 0.52	Prob > F = 0.9056	F-stats 0.85	Prob > F = 0.5700

Source: authors' calculation.

Regression Results for Model 1, Model 2 and Model 3

Independent Variables	Model 1 — IR		Model 2 — SUBSRTN		Model 3 — MMR	
	Coefficient (t-value)	Standard Error	Coefficient (t-value)	Standard Error	Coefficient (t-value)	Standard Error
Constant	−0.115 (−0.38)	0.303	1.158* (1.80)	0.644	0.046*** (4.35)	0.011
LIQ	0.043 (1.45)	0.029	0.023 (0.71)	0.033	−0.001* (−1.80)	0.001
SG	0.001 (0.10)	0.008	−0.028* (−1.82)	0.015	0.000 (−1.53)	0.000
EV	0.007 (0.96)	0.007	0.034*** (2.85)	0.012	0.000 (1.63)	0.000
CFV	−0.269 (−0.51)	0.531	−0.815 (−0.75)	1.082	0.024 (1.20)	0.020
IRF	−0.004 (−1.29)	0.003	−0.002 (−0.43)	0.005	0.000 (−1.06)	0.000
ERF	0.002 (0.27)	0.007	−0.017 (−1.18)	0.014	0.000*** (−0.37)	0.000
ORRF	−0.003 (−0.93)	0.003	0.001 (0.22)	0.005	0.000 (3.04)	0.000
TRD	2.035 (0.80)	2.543	4.311 (1.02)	4.224	−0.015 (−0.30)	0.050
DQ	−0.001 (−0.77)	0.001	−0.002 (−1.30)	0.002	0.000 (0.61)	0.000
LMREP	−0.002 (−0.87)	0.002	−0.004 (−1.01)	0.004	0.000 (0.55)	0.000
SIZE	0.012 (0.59)	0.021	0.003 (0.07)	0.048	0.001 (0.72)	0.001
ISSUESIZE	0.055 (1.63)	0.034	−0.058 (−0.87)	0.067	−0.004*** (−3.93)	0.001
AGE	0.000 (0.12)	0.002	−0.003 (−0.76)	0.004	0.000 (−0.92)	0.000
F-statistics	1.083		3.198		5.123	
Prob > F	0.383		0.001		0.000	
R-squared	0.096		0.132		0.183	
n	109					

Note: *** p < 0.01, ** p < 0.05, * p < 0.1.

Source: authors' calculations.

Model 3 elaborates the relationship of the *ex post* market-based measure of risk, i.e. standard deviation of returns post the issue, with quantitative and qualitative risk measures from offer documents. The overall model is fit as the F-statistics is significant at a 5 percent significance level and the model explains about 18 percent of the market measure of risk. The coefficient of LIQ showed a negative association, ERF disclosed showed a positive association, other factors were found to be not significant. So, hypotheses H1(c) and H6(c) are rejected while all others related to the market measure of risk are not rejected. Also, out of the control variables, the

firms with a lower issue size of their IPOs showed higher risk in the market post issue. The results show that the internal risk factors, offer related risk factors, total risk disclosure and disclosure quality were considered irrelevant by the investors. They only valued the external risk factors, which resulted into higher risk post issue. Also, the investors considered firms with lower liquidity to be of higher risk even post issue. The rest of the pre issue quantitative risk measures did not affect the post issue risk of firms.

An additional regression model was run to explore more factors that could influence initial returns i.e., Model 4. In this model, some variables related to the offer were examined to study their relationship with initial returns. The overall model is fit at a 5 percent significance level and all the offer related factors along with control variables explain about 49 percent of initial returns. The results (*Table 7*) show that hypothesis H10(a) is rejected and percentage of capital offered to the existing issued capital (OFFCAP) shows a negative association with initial returns. This is an interesting result showing a peculiar feature of Indian IPOs. Many IPOs are not only done for the purpose of raising money but for other reasons also like improving the image of the company, improving its valuation and giving its managers a better bargaining position in negotiations [41]. The improved image also helps the firm to bring more issues later on, which can sell at high values. When the percentage of offered capital is low, it can be interpreted that the motive has been not as much of raising capital as much of improving the public image of the company and other such factors. In such cases, it is especially beneficial for the company if the issue is underpriced and there are huge initial returns. This creates a positive image of the company. Hence, firms with a lower percentage of offered capital are showing higher initial returns.

Further, hypothesis H13(a) is rejected and as expected, subscription percentage (SUBSCRP) shows a positive association with initial returns. High demand for the shares during subscription converts to high demand after issue, leading to high first day returns for the shareholders. Surprisingly, hypotheses H11(a) and H12(a) are not rejected and market sentiments (measured by MARRTN and MARVOL) do not affect the initial returns from IPOs, contrary to the results of previous researches [42]. Out of the control variables issue size shows a positive association with initial returns while LMREP, measured by the number of offers handled in the past 3 years, shows a negative association.

Table 7

Regression Results for Model 4

Independent Variables	Model 4 — IR		
	Coefficient	t-value	Standard Error
Constant	−0.271	−1.54	0.176
OFFCAP	−0.002*	−1.73	0.001
MARRTN	24.651	0.98	25.088
MARVOL	12.550	1.03	12.192
SUBSCRP	0.004***	6.85	0.001
LMREP	−0.002**	−2.03	0.001
SIZE	−0.006	−0.47	0.013
ISSUESIZE	0.057***	3.51	0.016
AGE	0.000	−0.06	0.002
F−statistics	12.736		
Prob > F	0.000		
R-squared	0.492		
n	109		

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: authors' calculations.

CONCLUSION AND IMPLICATIONS

Of the 10 IPOs listed in 2021, till 20th March, 9 have yielded positive listing day returns to the investors, with gains ranging from 1 percent to 109 percent.[2] Clearly, it can be seen why IPOs are becoming such a lucrative investment avenue. The inspiration behind the current paper was to delve deeper into this field to get a better understanding behind the reasons for such massive gains from IPOs. Specifically, what part did the disclosures, in the offer documents, play in the performance of the IPOs. The primary purpose of this paper was to analyse the risk disclosures in the prospectus to examine their impact on the initial returns, subsequent returns and risk of Indian IPOs. Additionally, some IPO offer specific variables were also included in the analysis to explore the additional factors affecting initial returns. The descriptive statistics, as well as the OLS regression models, gave

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[2] Moneycontrol (2021): IPO historic table, available at: IPO Historic Table — IPO listing, IPO market, IPO issue, Subscription (moneycontrol.com).

interesting results for the Indian markets. The average initial returns from 109 IPOs, for the sample period of 5 years from 2015 to 2019, was 13.6 percent. The subsequent average 1-year returns, post listing, was 12 percent. Investors showed great optimism towards Indian IPOs, as can be gauged from the average oversubscription rate of 31.28 times, which means that on average every IPO got oversubscribed to the extent of 31.28 times. The regression results of the study provide contrary evidence to the asymmetric information explanation behind IPO underpricing, as no significant relationship was found between underpricing and risk disclosures. This means that some actual risks might not be known which might not be disclosed. And those that are already known, must already have been given due consideration by the lead managers when deciding the price band of the issues. Risk disclosures might even be meaningless because the actual risks may have been intentionally withheld by managers to avoid presenting a negative picture of the firm and to avoid the chances of disclosing proprietary information. Hence, even the increased disclosures done in the prospectuses failed to reduce information asymmetry and underpricing. As for subsequent returns, quantitative measures retrieved from offer documents did affect them. The investors are rewarded for investing in firms with higher risk. However, the number of disclosures (qualitative measures) did not affect the subsequent returns. They are expected to be affected by the future market conditions and company performance and not past disclosures. Further, it can also be concluded that the investors only give importance to external risk factors and liquidity conditions of firms when judging about the risk. The *ex post* measure of risk showed association with only these two measures. Another conclusion that can be drawn from the analysis is that the Indian companies' main motives for IPO might be beyond raising capital. They come with IPOs to project a good image to the investors. A low percentage of capital offered to the existing issued capital was found to be associated with high initial returns. This shows that firms came out with underpriced IPOs to show positive first day returns which give a boost to their public image. Better image can provide them with higher negotiation power and help them raise more capital at a higher value in future. As previously shown, Indian IPOs are mostly oversubscribed. This oversubscription converts into higher demand for the shares on listing, leading to high initial returns. While some other factors have been studied besides the qualitative risk disclosures and quantitative risk measures, yet more research needs to be done to understand more reasons for underpricing in the Indian market. The results of this study are useful for the investors as based on the results they can make decisions about investing in Indian IPOs. The study also gives them an idea about long term performance of the IPOs and the factors that can affect the long-term performance. Besides, the managers of issuing companies and lead managers of issues can use the results of this study to improve the pricing of issues.

LIMITATIONS AND FUTURE RESEARCH

For qualitative risk measures, the present study has focused only on the "Risk Factors" section of the prospectuses. However, risk can be judged from other sections of a prospectus through thorough analysis. The sample size has been limited to 109 IPOs, for better generalizability, sample size can be increased in future studies.

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Correlation Matrix

Variables	IR	SUBRTN	MMR	LIQ	SG	EV	CFV	IRF	ERF	ORRF	TRD	DQ	OFFCAP	MAR-RTN	MARVOL	SUB-SCRP	LMREP	SIZE	ISSUE-SIZE	AGE
IR	1.000																			
SUBRTN	-0.023	1.000																		
MMR	-0.059	-0.015	1.000																	
LIQ	0.011	0.032	-0.114	1.000																
SG	-0.023	-0.130	0.114	-0.106	1.000															
EV	-0.120	0.086	0.046	-0.007	-0.103	1.000														
CFV	-0.086	-0.022	0.174	0.136	0.033	0.131	1.000													
IRF	-0.036	-0.007	-0.086	-0.289*	-0.037	0.028	-0.176	1.000												
ERF	-0.060	-0.037	-0.039	0.062	-0.099	0.107	0.039	0.137	1.000											
ORRF	-0.038	0.063	0.102	0.178	-0.009	-0.059	-0.043	-0.055	0.049	1.000										
TRD	-0.099	0.129	0.056	0.034	-0.022	-0.041	0.061	0.164	0.153	-0.076	1.000									
DQ	0.004	-0.195*	-0.105	-0.030	-0.005	0.139	-0.129	-0.095	-0.119	-0.353*	0.117	1.000								
OFFCAP	-0.080	0.013	0.081	-0.191*	0.243*	-0.055	-0.121	0.007	-0.169	0.034	0.076	-0.217*	1.000							
MAR-RTN	-0.000	0.016	-0.004	0.141	0.016	0.028	0.024	-0.038	-0.159	0.027	0.083	0.074	0.041	1.000						
MARVOL	-0.014	0.215*	0.087	-0.121	0.046	-0.045	-0.057	0.103	0.124	0.043	0.058	-0.174	0.161	-0.590*	1.000					
SUB-SCRP	0.127	-0.060	-0.055	0.184	-0.071	0.009	-0.005	-0.118	-0.023	-0.044	0.016	0.031	-0.120	0.257*	-0.235*	1.000				
LMREP	0.079	-0.216*	-0.134	0.215*	-0.162	0.049	0.120	0.050	-0.066	0.027	-0.161	0.319*	-0.286*	0.210*	-0.389*	0.048	1.000			
SIZE	0.001	-0.151	-0.077	-0.131	0.002	0.019	-0.006	0.158	-0.053	-0.110	-0.104	0.265*	-0.250*	-0.004	-0.020	-0.014	0.322*	1.000		
ISSUE-SIZE	0.095	-0.230*	-0.331*	0.164	-0.059	0.100	-0.103	-0.035	-0.015	0.014	-0.289*	0.373*	-0.330*	0.026	-0.179	0.001	0.561*	0.391*	1.000	
AGE	0.029	-0.060	-0.082	-0.030	-0.138	0.026	0.013	-0.085	-0.084	0.015	-0.100	-0.035	-0.207*	-0.060	-0.184	0.055	0.086	0.208*	0.055	1.000

Note: * shows significance at the .05 level.

Source: authors' calculations.

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The Nexus Between Financial Failure and Stock Prices: Panel Pedroni, Panel Kao and Panel ARDL Co-Integration Tests in Turkey REITs

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ABSTRACT

In today's globally competitive environment, companies must keep up with these competitive conditions to be successful. Failure of companies to show the expected financial performance, fulfil their financial obligations, or reach their financial targets is considered a financial failure or bankruptcy risk. Real Estate Investment Companies or Trusts (REICs or REITs) are capital market institutions that qualify as legal entities and are partnerships in a joint-stock company that provides financing to all kinds of real estate or real estate projects and bring together many investors for the desired real estate. REITs are an essential investment choice that continues its rapid development in Turkey. This study aims to examine the relationships between the Z-Scores calculated by periods of REIT companies traded in Borsa Istanbul between 2010–2019 and the stock price performances. In the study, primarily Altman Z-Score and Springate S-Score values of companies traded in Borsa Istanbul were calculated with the help of financial ratios. Then, Pedroni and Kao panel co-integration analysis and Dumitrescu-Hurlin panel causality analysis were performed. According to the analysis results, there is a long-term relationship between the financial failure scores of REIT companies and their stock prices. However, a causality relationship was found between the series.

Keywords: Financial Failure; Bankruptcy Risk; REITs; Altman Z-Score; Springate S-Score; Panel Causality Test; Panel Co-integration Test

INTRODUCTION

Recently, with the increasing complexity and liberalizing markets, the level of competition and risk factors that drive companies to financial failure has increased. Financial failure is a factor that can affect not only companies and their stakeholders but also the whole economy of the country in which it operates. The country's cumulative risk of financial failure has led to a more in-depth investigation of the issue by researchers, financial analysts, business managers, and business owners. As a result of the studies carried out in this direction, quantitative and qualitative models have been put forward to predict financial failure and bankruptcy before it occurs [1].

Today, the development of technology and the information world has made the competition even more challenging. Under these conditions, businesses that contribute significantly to the development process of countries and international financial markets are also more exposed to the risk of financial failure in the competitive environment brought by globalization. In an environment where competition is so fierce, the most important factors of financial failure in businesses are internal reasons

and economic conditions. However, the financial failure of the companies can have a significant negative impact on the economy of the country in which they operate. All parties involved in the business can be adversely affected by the financially unsuccessful business. Business-related parties especially want to get out of such a process with as minor damage as possible. The enterprise in financial failure imposes high costs on all interest groups. Therefore, financial failure should be predicted in terms of enterprise and the whole country [2].

There are various internal reasons such as insufficient working capital, excessive increase in short-term debts, increased resource costs, unsuccessful budgets and other financial plans, delayed payments, and inability to find financing sources that cause financial failure in the companies [3]. In addition to internal reasons, there are also external reasons that drive companies to financial failures, such as the country's economic growth level, financial or economic crisis or recession periods, inflation rates, high-interest rates, excessively fluctuating exchange rates, the tight monetary policy implemented by the central bank, changes in customer preferences, attitudes and behaviour [4].

By predicting financial failure and responding to this situation as early as possible, the business's financial failure can be minimized. Moreover, investors and lenders can reduce the risk of investment depreciation or failure to collect receivables by considering the risk of financial failure while evaluating the issues of investing in businesses and lending [5]. Accordingly, it is seen in the literature that different estimation methods such as artificial neural networks, logistic regression analysis, cluster analysis, discriminant analysis, fuzzy logic are used in determining financial failure. Furthermore, in detecting financial failure, it is seen that methods such as the Altman Z-Score and Springate S-Score models, which are among the multiple discriminant analysis methods, logistic regression, multi-criteria decision-making methods come to the fore.

Within the scope of this study, the relationship between financial failure and share price was investigated based on REITs. As stated by J. Shen [6], there are several reasons for this. The first is that financial failures are observed more intensely in the REIT sector compared to other sectors. So much so that REICs or REITs were highly affected by the financial crises in the Turkish economy in the early 2000s. While losses of up to 70% were observed in returns, severe losses were experienced in REITs' portfolio and market values [7]. Representatives of REITs established the Real Estate Investors Association (GYODER)[1] in 1999 to promote and represent the real estate sector, encourage its development, and set standards in quality control and training in the sector [8].

REITs also use more debt financing than firms in other sectors and are subject to regulation. It has to pay a significant portion of its earnings to investors as dividends. In this context, REITs are likely to have a higher distress risk than similar firms in other industries [9]. For the same reasons, stock prices can be expected to be more volatile. Third, there have been significant developments and changes in the REIT sector, such as organizational changes, shifting the large investor base from individual investors to institutional investors, and rapid asset growth. The role of these changes in the interaction between financial failure and stock price is also becoming important [6].

The financial failure or bankruptcy risk, which are the essential topics in the literature, is frequently examined in the Altman Z-Score and Springate S-Score context. In this study, also these methods were used to examine financial failure. However, in this study, the aim is not only to calculate the scores. In this context, the relationships between REITs' Z-scores and S-scores and the stock price performance of REITs are examined. The REITs in the scope of this study are traded in Borsa Istanbul continuously between 2010: Q1 and 2019: Q4 and whose data can be fully accessed. In the analysis section following steps were followed:

• First, Altman Z-Score and Springate S-Score values of companies traded in Borsa Istanbul were calculated with the help of financial ratios.

• Second, quarterly stock prices of 18 companies determined for Altman Z-score and 17 companies determined for Springate S-score were obtained from Borsa Istanbul.

• Third, Pedroni, Kao and ARDL Bound panel co-integration analyses and Dumitrescu-Hurlin panel causality analysis were performed.

Analysis results prove that there is a long-term relationship between financial failure scores and stock prices. Furthermore, we determined that there is causality between the series. The main differences of the study from previous studies are as follows:

• This is the first study on the relationship between financial failure and stock price in REITs and carried out in such a broad scope.

• For the first time in the literature, Panel ARDL co-integration analysis, Pedroni and Kao co-integration analysis, and Dumitrescu and Hurlin panel causality analyses were used together.

In the following sections of the study, firstly, REITs and the current situation of the sector in Turkey will be discussed. In the following sections, literature review, data and methodology and findings will be given, and the study will be concluded with the conclusion part.

REITs IN TURKEY

The construction sector in Turkey has an essential share in the economy and economic growth. Since real estate purchases are seen as an investment tool simultaneously in Turkey, the sector's volume has grown more and more each year. REITs are capital market institutions that qualify as legal entities and

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[1] GYODER was founded in 1999 by the representatives of existing real estate investment trusts and those under establishment process in Turkey (REIT). The organization that gathers all sub-industries of the sector under the same roof as "Turkey Real Estate Platform" changed its name in 2013 as "Real Estate and Real Estate Investment Trusts Association" and transformed into a structure that embraces the overall sector (https://www.gyoder.org.tr/en/about-us (accessed on 12.03.2020).

are partnerships in a joint-stock company. If the public joint-stock company establishes to operate the portfolio consisting of real estate, real estate projects, rights based on real estate, capital market instrument, and assets and rights determined by the board are called "Real Estate Investment Trusts." Real estate investment trusts have advantages in terms of corporate tax. Regardless of the amount of profit they make, they are not subject to corporate tax in any way and have a *100% exemption*. Therefore, real estate investment trusts allow small investors to generate income from the profits made in this field and to direct the large funds that these investors will create to this sector. In addition, REITs also have objectives such as building real estate necessary for the increasing population, decreasing the informal economy, and increasing the use of capital market instruments. The majority of assets in the financial statements of real estate investment trusts listed on the stock exchange are investment properties [10].

With the development of financial markets, investment instruments and financing alternatives are also increasing. In this context, Real Estate Investment Trusts (REITs) are one of the most important institutional investors in the real estate sector. REITs first started operations in 1961 in Massachusetts (USA). In Turkey, REITs started their activities with legal regulation in 1995. In 1997, the shares of REITs began to be traded on the Borsa Istanbul. The primary duty of REITs is to meet the financing needs of the real estate sector and bring transparency to the market. However, REITs have become a critical capital market institution that enables large-scale real estate projects to be implemented [11]. Currently, there are REITs in 36 countries around the world. In addition, global mutual funds mainly include REITs in their portfolios [11].

REITs sector takes the lead among the other sectors as it acts as such an anchor in the economies of developed and developing countries. However, as in the world, the financing problem in the real estate sector in Turkey constitutes a significant problem. Some real estate projects require too much capital that a single investor cannot handle. Therefore, this obstacle to realizing projects is eliminated by REITs. In this way, the required liquidity is provided through the securitization of real estate. Therefore, REITs have an essential place in the effective use and management of their resources for the stable growth of developed and developing countries [12].

As of the 4th quarter of 2019, the number of REITs traded in Turkey and Borsa Istanbul is 33. While the free float rate of the REIT sector in Turkey is 53%, stocks in the actual circulation rate are 36%. The total REITs market value is 27 billion 777 million ₽. In 2019, the total transaction volume was 70 billion 436 million ₽ in the REITs market. According to the residence addresses of the investors, it is seen that most investments are made from the USA (1,039,357,609 ₽). USA is followed by the United Kingdom (727,741,216 ₽), Netherlands (287,198,909 ₽), Italy (135,846,803 ₽) and Bahrain (127,020,000 ₽).[2] The total asset value of REITs traded in Turkey has reached the level of about 12.965 million € as of December 31, 2019.[3] The sector's return on assets has seen the lowest level since 2011, with 6% in 2018. The gross profit of REITs in Turkey increased continuously from 2011 to 2018 and rose from approximately 1.6 million ₽ to 5.2 million ₽. Due to the significant increase in the $ exchange rate in the 2014–2018 period, the sector's profitability decreased in $ terms in this period.[4]

Although it is such an essential sector for developing countries such as Turkey, few studies in the literature evaluate the financial failure probability of REITs. Therefore, this study, besides evaluating REITs' financial failures, aims to reveal beneficial results for investors and focus on the relationship between financial failure and stock prices.

THE CONCEPT OF FINANCIAL FAILURE

Financial failure is defined as the companies not paying their debts on time, declaring concordat, making a loss for three years in a row [13]. According to W.H. Beaver [14], financial failure is the companies' inability to fulfil their due financial debts.

In order to talk about financial failure in a company, at least one of the following situations must exist [15].

1. Cessation of company activities or bankruptcy;

2. The company encounters events such as pledge, execution, and foreclosure;

3. Realization of court processes such as liquidation of the company, appointment of a trustee or restructuring;

4. The company's voluntary agreement on the payment of its due debts.

Companies faced with one of the four situations mentioned above are considered to be financially

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[2] GYODER (The Association of Real Estate and Real Estate Investment Company). GYODER Indicator Turkish Real Estate Sector 2019 4th Quarter Report. 2020: Vol. 19.

[3] European Public Real Estate Association (EPRA). Global REIT Survey 2020.

[4] GYODER (The Association of Real Estate and Real Estate Investment Company). GYODER Indicator Turkish Real Estate Sector 2019 4th Quarter Report. 2020: Vol. 19.

unsuccessful. Most studies define financial failure as filing for bankruptcy in the literature. That is why bankruptcy comes to mind first when it comes to financial failure. However, bankruptcy is only one of the situations of financial failure, or it is possible to state that financial failure does not only mean bankruptcy [16].

If financial failure cannot be prevented, bankruptcy occurs. This situation indicates that a legal process has been entered into. Unlike financial failure, defining bankruptcy in relevant laws makes this concept more understandable [17]. Bankruptcy occurs when the company's assets cannot meet its debts, and the net asset of a bankrupt business becomes negative in real terms. However, the loss incurred by businesses is not always expressed as a financial failure. For example, it is estimated that there is a risk of financial failure for the company, although it is not seen as a financial failure if a company makes an intermittent loss one or two times in ten years operating period [18].

ALTMAN Z-SCORE AND SPRINGATE S-SCORE

Many methods are used in the literature to determine the financial failures of companies, and Altman Z Score and Springate models are among the most commonly used methods.

Altman Z-Score Model

Anticipating financial failure and taking necessary measures are very important for the continuity of companies. However, for this purpose, although it is a general opinion, it is not sufficient to examine the tendency of some rates of companies. One of the methods developed due to this deficiency is the Altman Z-Score model. The Altman Z-Score model is a multivariate discriminant analysis used to predict companies' financial failures and bankruptcy risks. The general structure of the Altman model was revealed in 1968, then the model was re-developed for non-public companies in 2000 and then for companies other than manufacturing companies [19].

The Altman Z Score model has highly reliable applications in various areas, including merger and disposal activity, asset pricing and market efficiency, capital structure determination, credit risk pricing, distressed securities, bond ratings, and portfolios [20].

Altman [21] determined many financial ratios that can be used to measure financial failure and stated that among these ratios, those related to company profit, liquidity and

solvency should be considered primarily compared to others. However, in the studies carried out in the following period, it has been shown that different ratios may be important. Therefore, no definite conclusion has been reached on this issue. Altman [21] expressed the model with the following equation:

$$Z = 0.012X1 + 0.014X2 + 0.033X3 + \\ + 0.006X4 + 0.999X5 \quad (1)$$

$$X1 = Working\ Capital\ /Total\ Assets,$$

$$X2 = Undistributed\ Profit\ /Total\ Assets,$$

$$X3 = Profit\ Before\ Interest\ and\ Taxes\ /Total\ Assets,$$

$$X4 = Book\ Value\ of\ Equity\ /\ Book\ Value\ of\ Total\ Debts$$

$$X5 = Sales\ /Total\ Assets\ and$$

The ranges determined for the Z-Score results obtained from the first equation above are given below:

Z > 2.99 is financially successful,
1.8 < Z <2.99 is Gray zone and
Z < 1.8 is determined as a financial failure.

A Z-Score greater than 2.99 indicates that the company is financially successful, and a lower than 1.8 indicates that the company is financially unsuccessful.

Altman revised the current model by completely re-estimating it in 1983 and substituting the book value of equity for market value. As a result, the revised Z-Score model is expressed by the following model:

$$Z' = 0.717T1 + 0.847T2 + 3.107T3 + \\ + 0.420T4 + 0.998T5 \quad (2)$$

$$T1 = Net\ Working\ Capital\ /Total\ Assets,$$

$$T2 = Undistributed\ Profit\ /Total\ Assets,$$

$$T3 = Profit\ Before\ Interest\ and\ Tax\ /Total\ Assets,$$

$$T4 = Book\ Value\ of\ Equity\ /Total\ Debts,$$

$$T5 = Sales\ /Total\ Assets.$$

The ranges determined for the Z'-Score results obtained from the second equation are stated below:

If Z > 2.9 *financially successful,*
1.23 < Z < 2.9 *is the grey zone,*
If Z < 1.23, financial failure.

Altman has taken into account public and non-public companies in his first two studies. In his last study, he developed a model for companies other than manufacturing companies, and this model is expressed below:

$$Z'' = 6.56X1 + 3.26X2 + 6.72X3 + 1.05X4 \qquad (3)$$

$$X1 = Net\ Working\ Capital\ /Total\ Assets,$$

$$X2 = Undistributed\ Profit\ /Total\ Assets,$$

$$X3 = Profit\ Before\ Tax\ /Total\ Assets,$$

$$X4 = Book\ Value\ of\ Equity\ /Total\ Debts.$$

The intervals determined for the Z''-Score results obtained from the third equation are given below:

If Z″ > 2.6, it is financially successful,
If 1.1 < Z″ < 2.6, gray zone,
If Z″ < 1.1, financial failure.

Springate S-Score Model

In 1978 L. V. Gordon the Springate S-Score model developed by Springate is the development of the Altman Z-Score model, and the four ratios used in the Altman Z-Score model are weighted with different weights. According to this model, if the S-Score value is less than 0.862, the company is considered financially unsuccessful or close to bankruptcy [22]. The model is stated below [23]:

$$S\ Score = (1.03X1) + (3.07X2) + \\ + (0.66X3) + (0.4X4) \qquad (4)$$

$$X1 = Net\ Working\ Capital\ /Total\ Assets,$$

$$X2 = Profit\ Before\ Interest\ and\ Tax\ /Total\ Assets,$$

$$X3 = Profit\ Before\ Tax\ /Short\ Term\ Debts,$$

$$X4 = Net\ Sales\ /Total\ Assets.$$

If S < 0.862, the company is considered to be at risk of financial failure or bankruptcy.

LITERATURE REVIEW

Financial ratios are generally used to examine the success (H.C. Koh [24]; İ. Ege [25]), failure (R. Aktaş [26]; J. Chen [27]; J. Pindado [28]), performance (R. Kangari, F. Farid, H.M. Elgharib [29]), stock return (T. Martikainen [30]; J. S. Abarbanell [31]; S. Kheradyar [32]) and profitability (M.N. Khan, I. Khokhar [33]) in companies.

The studies on financial ratios, at the same time, focus on measuring financial failure or bankruptcy. Studies use different models to predict the probability of financial failure or bankruptcy in the literature. For example, multiple regression [26], discriminant [26], logit [26]; [34], artificial neural network ([26]; H.C. Koh [24]; J. Chen [27]), logistic regression (H.C. Koh [24]; J. Chen [27]; M. Baş [1]; H. Li [35]; A.M.I. Lakshan [36]), decision tree (H.C. Koh [24]), grey relational analysis (M. Baş, Z. Çakmak [2]).

In a significant part of other studies, Altman Z Score and Springate S-Score are preferred. For example J. Pindado [28], U. Büyükarıkan [37], İ. Kulali [38], M. Soba [39]), Z. Türk [40], O. Jawabreh [41], E. Dizgil [42], H. Bağcı [43] used Z and S scores either together or by choosing one of them.

The common result of the studies using different methods is that each method used has a consistency within itself and they claim that the methods used in their studies predict financial success and failure correctly to a certain extent.

The studies given in the next part of the literature review focus directly on the relationship between financial distress or failure (especially in the context of Z-Score) and stock price.

Altman [21] stated that failure could be predicted two years before financial failure. E.I. Altman and M. Brenner [44] examined the effect of "new information" that expresses changes in the Altman Z-score, stock prices and found abnormal returns in their stock prices studies. I.D. Dichev [45], J.M. Griffin and M.L. Lemmon [46] and J.Y. Campbell [47] found a negative correlation between the probability of default in companies and stock returns means that firms with high bankruptcy risk earn lower than average returns by using the models suggested by E.I. Altman [21] and J.A. Ohlson [48]. However, M. Vassalou [49] found that in firms with smaller capital and smaller MV/BV ratio, default risk is priced in because it is reflected in the stock price, and stocks with high default risk have higher expected returns than those with low default risk.

In another study M.K. Çelik [50] tried to determine the relationship between the stock returns and financial failure in Turkey and did not find a significant relationship throughout the 1998–2008 period. N. Apergis [51] also analyzed the stock price and bankruptcy according to the Altman Z-Score model and found a positive correlation between the Altman Z-Score and the company's stock price. This means that the stock prices of companies with low Z-Score are also low. Similar results were also found by I.B. Robu [52] in Romania, by E. Susilowati [53] in Indonesia and by G. Singh and R. Singla [54]. I.B. Robu et al. [52] found a difference between financially distressed companies and well-performing companies. The stock returns of companies in the high-risk category are lower than others. Simangunsong (2019) determined that the Z-score has a significant effect on stock prices. R. Singh and R. Singla [54] found that a positive relationship between Z-score and stock return. However, R. Afrin [55] did not find any relationship between Z-score and stock returns in the cement industry in Bangladesh.

Based on the findings of the studies given in this part of the study, we see that the Altman Z-Score model can substantially affect stock prices. Therefore Z-Score can be considered as an indicator for market performance and stock returns. Moreover, it is seen that the focus is on the Altman Z-Score, and the Springate S-Score is neglected in the literature. Therefore, the study also investigates long and short-term relationships between stock prices and the success grades obtained with the Springate S-Score and the Altman S-Score and fills the gap in the literature in this context.

DATA AND METHODOLOGY

The data set of the study were accessed from FINNET[5] (Financial Information News Network) database (finnet.com.tr/FinnetStore/En) and Borsa İstanbul Data Store (datastore.borsaistanbul.com). In this study, for Altman Z-Score analyses, 18 REITs and for Springate S-Score 17 REITs that traded in Borsa Istanbul between 2010: Q1 and 2019: Q4 and whose data can be fully accessed were considered. The REITs whose data were used in the study are shown in *Appendix 1*.

In the study, quarterly stock close prices of REITs were used as stock prices, and financial ratios were used to calculate Altman Z-Score and Springate S-Score. While calculating the Altman Z-Score, *Z''* model was used.

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[5] FINNET (Financial Information News Network) (accessed on 12.02.2020).

This model was developed for companies except for the manufacturing sector [20].

In the study, panel co-integration tests were conducted to examine a long-term convergence among the relevant variables. Pedroni and Kao co-integration tests and the Panel ARDL Bound Test were used to examine the long-term relationship between the series. If there is evidence of co-integration based on any of the Pedroni and Kao co-integration tests, in that case, the long-term co-integration vector will be estimated with the group-mean panel DOLS (Dynamic Ordinary Least Square) and FMOLS (Fully Modified Ordinary Least Square) estimation techniques developed by P. Pedroni [56] and P. Pedroni [57]. The causality analysis based on Granger causality analysis developed by E.I. Dumitrescu and C. Hurlin [58] is used for causality tests.

The purpose of the panel co-integration test is to combine similar long-term information among various panel members [59]. P. Pedroni proposed seven co-integration tests for panel data based on co-integration residues of error terms. Three of them are considered group mean panel co-integration tests and are based on between dimensions. They are created by dividing the numerator by the denominator before adding it over the N-dimension. The other four, called panel co-integration tests, are based on dimensions and are formulated by adding both numerator and denominator above the N dimension [60]. Another of the panel co-integration tests is the C. Kao [61] test. In this test, the null hypothesis suggests no co-integration relationship between dependent and independent variables is tested. C. Kao [61] uses Dickey-Fuller and Augmented Dickey-Fuller (ADF) type test structures while examining the long-term relationship between the co-integration analysis panel series.

In the study, the relation between Springate S-Score and the stock price was also examined with Panel ARDL Boundary Test. M. Pesaran et al. [62] stated that ARDL model is based on three estimators: Mean Group Estimator (MG), Pooled Mean Group Estimator (PMG), and Dynamic Fixed Effects Estimator (DFE). The mean group estimator places no constraints on the ARDL model parameters. The most criticized aspect of the mean group estimator model is that the parameters between units in the panel are heterogeneous. On the other hand, in Pooled Group Estimator; Short-term parameters are allowed to be heterogeneous, while long-term parameters are allowed to be homogeneous between units. Finally, although the Dynamic Fixed Effects Estimator is similar to the pooled mean group

Descriptive Statistics

Statistics	Price	z-Score
Mean	2.247158	43.82678
Median	1.236309	4.717263
Maximum	22.98000	1127.642
Minimum	0.000000	−3.489374
Std. Dev.	2.945761	104.5659
Skewness	3.210858	4.735053
Kurtosis	14.87399	34.00045
Jarque-Bera	5466.902	31521.33
Observations	720	720

Source: analysis output.

estimator, it restricts the co-integration coefficient equally in all panels in the long run and allows intragroup correlation [63, 64].

Finally, in the study, we apply the panel Granger causality test for heterogeneous panels proposed by E.I. Dumitrescu and C. Hurlin [58]. The null hypothesis means no causal relationship between variables and is tested using an alternative z-bar statistic [65]. The models used in the study are as follows:

$$Price_{it} = \beta_{0i} + \beta_{1i} \, zscore_{it} + \varepsilon_{it},$$
$$Price_{it} = \beta_{0i} + \beta_{1i} \, sscore_{it} + \varepsilon_{it}.$$

Where, $Price_{it}$ is the stock prices in i company at the time t, $zscore_{it}$ and $sscore_{it}$ are the financial failure scores as proxy financial failure in i company at the time t, β_0 is a constant term, β_1 is slope coefficients of the model, ε_t is an error term.

FINDINGS
Altman Z-Scores, Unit Root, Cointegration and Causality Results

In the first stage of the analysis, Altman Z-Scores were calculated. Thus, we see in the table included in Appendix 2, Z-Scores. The green, orange, and red colours show success, grey zone, and failure status. Z-Scores are calculated quarterly between 2010 and 2019.

The calculated descriptive statistics are shown in (*Table 1*). Descriptive statistics show mean, median, maximum, and minimum values, standard deviation, skewness and kurtosis values, Jargue-Bera statistics, and the total number of observations for variables.

Unit Root Test

In the study, Fisher-Type ADF and PP tests (G.S. Maddala and S. Wu [66] and I. Choi [67], one of the panel unit root tests, were used to determine the stationarities of variables. The G.S. Maddala and S. Wu [66] test offer a strategy that transcends the limitations of both LLC and IPS tests. They propose a nonparametric test based on a combination of p-values of t-statistics for a unit root in each cross-sectional unit (ADF test). This approach has the advantage of allowing as much heterogeneity between units as possible.

As a result of the analysis, it is seen that the null hypothesis claiming that both variables contain unit root in level values is rejected (*Table 2*).

Pedroni and Kao Co-integration Analysis

According to the Pedroni co-integration test results summarized in (*Table 3*), five of the seven statistics show co-integration, and two show no co-integration. Accordingly, the probability values of the Panel rho, Panel PP, Panel ADF statistics calculated as a result of the Pedroni co-integration test indicate a significant relationship at 1% and 5% significance levels. According to the Kao co-integration test result, the H_0 hypothesis, which suggests no co-integration between the series, is rejected at the 5% significance level. For this reason, it can be said that there is a co-integration relationship between the series. According to the results of the co-integration analysis, it can be said that the stock prices and Z-Scores series of REITs move together in the long run.

Estimation of Cointegration Parameters by DOLS and FMOLS Methods

After determining that the variables exhibit a long-term co-integration panel, the variables' long-run effects are estimated at the next stage. Considering that the OLS estimator is a biased and inconsistent estimator when

Table 2

Unit Root Test Results

Tests	Price (Sta.)	Z-Score (Sta.)
ADF — Fisher Chi-square	51.5369 (0.0450)	110.954 (0.0000)
PP — Fisher Chi-square	73.2993 (0.0002)	177.844 (0.0000)
Probabilities for Fisher-type tests are calculated using an asymptotic Chi-square distribution. The selection of lag levels for the Fisher-ADF test was determined by the Schwarz Information Criteria. In calculations that used the Fisher PP test, Newey-West automatic bandwidth selection, and Bartlett kernel. Contents in parentheses are probability values. Analyzes were carried out according to fixed term models.		

Source: analysis output.

applied to co-integrated panels, the long-term structural coefficients were estimated using DOLS developed by P. Pedroni [56] and FMOLS developed by P. Pedroni [57] procedures to generate consistent estimates.

According to P. Pedroni [56] DOLS method results in *Table 4*, where the dependent variable is Z-Score, the coefficient is estimated to be approximately 24.46. The estimated result is positive and statistically significant at the 1% significance level; It shows that the 1% change (increase) in stock prices across 18 REIT companies causes a change (increase) of approximately 24.46% on Z-Score in the long run. In the model where there is a dependent variable stock price, the coefficient is estimated as approximately 0.0036. The estimated result is positive and statistically significant at the 1% significance level. It shows that the 1% change (increase) in the z scores across 18 companies causes a change (increase) of approximately 0.0036% in the long run on foreign direct portfolio investments. These results show that the change in stock prices is more effective on their Z-Scores.

Another method suggested by P. Pedroni [57] is the FMOLS method. Similar results were obtained in this method. If the dependent variable is the Z-Score, the coefficient is calculated to be approximately 16.26. Since the results summarized in (*Table 4*) are positive and statistically significant at the 1% significance level, the 1% change in stock prices causes a change of 16.26% on the Z-Score in the long run. In the model where there is a dependent variable stock price, the coefficient is estimated at approximately 0.0025. The estimated result is positive and statistically significant at the 1% significance level; It shows that the 1% change (increase) in the Z-Score across 18 REIT companies causes a change (increase) of approximately 0.0025% in the long run on stock prices. The results obtained with the FMOLS method also show

that stock price changes are more effective on Z scores, as in the DOLS method. The fact that the coefficients obtained as a result of both DOLS and FMOLS methods are positive indicates a positive relationship between the series in the long term.

Dumitrescu and Hurlin Panel Causality

DH Panel Causality test developed by E. I. Dumitrescu and C. Hurlin [58] and considers the possible cross-sectional dependence between the horizontal sections that make up the panel. This test, which is insensitive to the size difference between time and section size, can yield effective results in both cases [68]. *Table 5* shows E. I. Dumitrescu and C. Hurlin Panel causality test results. According to the analysis results, since the probability values are lower than the 5% significance level, there is bidirectional causality between variables. (*Table 5*) also gives detailed information about the causality relationship between variables. Due to the probability values being less than 0.05, the null hypotheses that *"Z-Score does not homogeneously cause Price"* and *"Price does not homogeneously cause Z-Score"* can be rejected. This means that there is a significant conclusion that *Z-Score* influences stock prices and vice versa.

Springate S-Score, Unit Root, Long and Short-Term Relations

Springate S-Scores were calculated quarterly between 2010–2019 in the next stage of the study. S-Scores are shown in the table in Appendix 3. Data from 17 REIT companies that were continuously traded in Borsa Istanbul between 2010 and 2019 were used in the study.

The descriptive statistics of variables are shown in *Table 6*. In (*Table 6*), mean, median, maximum, and minimum values, standard deviation, skewness

Co-integration results

Pedroni				
Within-dimension (Panel)	**Statistic**	**Prob.**	**Within-Weighed**	**Prob.**
Panel v-Statistic	0.759129	0.2239	−2.553410	0.9947
Panel rho-Statistic	−4.946637	0.0000*	−9.039565	0.0000*
Panel PP-Statistic	−4.776949	0.0000*	−10.12467	0.0000*
Panel ADF-Statistic	−2.609403	0.0045*	−5.700882	0.0000*
Between- dimension (Group)	**Statistic**	**Prob.**		
Group rho-Statistic	−3.537513	0.0002*		
Group PP-Statistic	−4.679810	0.0000*		
Group ADF-Statistic	−1.607361	0.0540***		
Kao				
ADF			*t-Statistic*	*Prob.*
			1.901743	0.0286**
Residual variance			0.609277	
HAC variance			0.454198	
*The null hypothesis is that the variables are not co-integrated. Under the null hypothesis, all statistics are distributed as standard normal distributions. The finite sample distribution of seven statistics is tabulated in Pedroni (2004). Barlett Kerneli and Newey-West bandwidth criteria were used in both tests used to determine the co-integration relationship. SIC criterion was used in calculating the optimum lag lengths for the variables. The *, **, and *** signs indicate that the relevant statistical values are significant at the 1%, 5%, and 10% significance levels, respectively. Trend assumption is determined as the deterministic trend and constant.*				

Source: analysis output.

and kurtosis values, Jargue-Bera statistics, and total observations are seen.

Unit Root Tests

In this part of the study, where the relationship between Springate S-Score and the stock price was investigated, Fisher-Type ADF and PP tests were used again for unit root tests. As a result of the analysis, in (*Table 7*), the null hypothesis that the S-Score variable in the first difference contains the unit root in the level values of the share price variable is rejected.

Panel ARDL Bound Test Results

2The ARDL bound test approach introduced by M. Pesaran et al. [69] was used to investigate the relationship between the level of financial success and stock price in real estate investment trust companies. The ARDL co-integration approach has many advantages compared to other co-integration methods such as R. Engle and C. Granger [70], S. Johansen [71], and S. Johansen and K. Juselius [72]. First, the ARDL procedure can be applied regardless of whether the series is $I(0)$ or $I(1)$. This means that the ARDL procedure has the advantage of avoiding the classification of variables as $I(0)$ or $I(1)$ and that unit root pretesting is not required. Second, the validity of the Johansen co-integration techniques requires large data samples. At the same time, the ARDL procedure is a more statistically effective approach used in small samples to determine the co-integration relationship. Third, the ARDL procedure allows variables to have different optimal delays. Finally, while the ARDL procedure uses a single reduced form equation, they predict long-term relationships in the context of system equations in traditional co-integration procedures [73, 74].

In this study, since the Springate S-Score and stock price variables are stable at different levels, the advantages

DOLS and FMOLS Results

Method	Variable	Coefficient	Std. Error	t-Statistic
DOLS	Dependent: Z-Score, Independent: Price	24.46178 (0.0001)	6.053025	4.041250
	Dependent: Price, Independent: Z-Score	0.003585 (0.0001)	0.000921	3.893583
FMOLS	Dependent: Z-Score, Independent: Price	16.26137 (0.0002)	4.347447	3.740442
	Dependent: Price, Independent: Z-Score	0.002521 (0.0003)	0.000688	3.666585

Source: analysis output.

Dumitrescu-Hurlin Panel Causality Test Results

Null	W-Stat.	Zbar-Stat.	Prob.
Z-Score does not homogeneously cause Price	8.63114	12.1465	0.0000
Price does not homogeneously cause Z-Score	3.40894	2.39098	0.0168

Source: analysis output.

Descriptive Statistics

Statistics	Price	S-Score
Mean	2.309971	36.63462
Median	1.250000	26.95921
Maximum	22.98000	109.8168
Minimum	0.260000	0.779670
Std. Dev.	3.009476	30.11446
Skewness	3.135836	0.818395
Kurtosis	14.22471	2.517112
Jarque-Bera	4670.513	82.27134
Observations	680	680

Source: analysis output.

offered by the Panel ARDL method were used in the analysis. The ARDL boundary test approach is based on the least-squares estimator's estimation and the unbounded error correction model.

In the study, the co-integration relationship between variables was first tested with the help of the bounds test approach. *Table 8* shows the results of the margin test analysis. Critical values are valid for the independent variable and the 1% and 5% significance levels. Since the calculated F statistic is above the upper critical levels, it

is possible to say a co-integration relationship between variables. In other words, share prices and s-scores are integrated. That is, they act together in the long run. In this context, it can be said that any change in s-scores will have effects on share prices. Therefore, it was decided that the ARDL model can be used to determine the long and short-term dynamics between variables.

In order to estimate the long-term relationship between variables, the optimum lag length has been determined as one, and in this context, ARDL (1, 1)

Unit Root Tests

Tests	Price (Sta.)	S-Score (Sta.)
ADF — Fisher Chi-square	I(0) 33.5458 (0.4897) I(1) 212.150 (0.0000)	I(0)108.023 (0.0000)
PP — Fisher Chi-square	I(0) 35.6528 (0.3905) I(1) 484.322 (0.0000)	I(0)145.989 (0.0000)
Probabilities for Fisher-type tests are calculated using an asymptotic Chi-square distribution. The selection of lag levels for the Fisher-ADF test was determined by the Schwarz Information Criteria. In calculations that used the Fisher PP test, Newey-West automatic bandwidth selection, and Bartlett kernel. Contents in parentheses are probability values. Analyzes were carried out according to fixed-term models.		

Source: analysis output.

Bound Test Results

k*	F-statistic	1% Critical Values		5% Critical Values	
		Lower Bound	Upper Bound	Lower Bound	Upper Bound
1	6.350150	4.94	5.58	3.62	4.16
* k represents the number of independent variables. Critical values were obtained from the study made by Pesaran et al. (2001).					

Source: analysis output.

model is the most suitable. *Table 9* shows the results of the long-term dynamics between the share price and the S-Score. Lag lengths were determined by taking into account the values of Schwarz information criteria. The long-term dynamics results indicate a positive and significant relationship between share price and S-Score. Accordingly, a one-unit increase in the S-Score increases the share price by approximately 0.06 units in the long run. However, looking at the short-term dynamics, it is seen that there is no relationship.

In the next step, the analysis was repeated for the case where the dependent variable was the S-Score. The co-integration relationship between variables was tested with the help of the boundary test approach. (*Table 10*) shows the results of the bound test analysis. Since the calculated F statistic is above the upper critical levels, it is possible to say a co-integration relationship between variables. So, stock prices and S-Scores are integrated. That is, they act together in the long run. In this context, it can be said that any change in stock prices will have effects

on S-Scores. Therefore, it was decided that the ARDL model can be used to determine the long and short-term dynamics between variables.

In order to estimate the long-term relationship between variables, the optimum lag length has been determined as one. In this context, ARDL (1, 1) model is the most suitable. (*Table 11*) shows the results of the long-run dynamics between the stock price and the S-Score. The lag lengths were determined by taking into account the values of Schwarz information criteria. The long-term dynamics results indicate a negative and significant relationship between the S-Score and the stock price. Accordingly, a one-unit increase in the stock price decreases the S-Score by approximately –1.08 units in the long run. However, looking at the short-term dynamics, it is seen that there is no relationship.

Table 12 shows Dumitrescu and Hurlin Panel causality test results. Unlike the Altman Z-Score and stock price relationship, a one-way causality has been identified. According to (*Table 12*), since the probability values are

Results of ARDL (1, 1) (Dependent Variable: Stock Price)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
	Long Run Equation			
S-Score	0.058265	0.019276	3.022718	0.0026
	Short Run Equation			
COINTEQ01	−0.130080	0.039846	−3.264593	0.0012
D(S-Score)	−0.006103	0.003810	−1.601802	0.1097
C	0.000284	0.010530	0.026962	0.9785

Source: analysis output.

Bound Testing Results

k*	F-statistic	1% Critical Values		5% Critical Values	
		Lower Bound	Upper Bound	Lower Bound	Upper Bound
1	21.07600	4.94	5.58	3.62	4.16
* k represents the number of independent variables. Critical values were obtained from the study made by Pesaran et al. (2001).					

Source: analysis output.

Results of ARDL (1, 1) (Dependent Variable: S-Score)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
	Long Run Equation			
Price	−1.082561	0.383779	−2.820790	0.0049
	Short Run Equation			
Cointeq01	−0.407846	0.040539	−10.06063	0.0000
D(Price)	−0.650049	3.730520	−0.174252	0.8617
C	2.261466	0.962972	2.348423	0.0192

Source: analysis output.

lower than the 5% significance level, there is a one-way causality between variables. The direction of causality is from the S-Score to the stock price. Due to the probability values being less than 0.05, the null hypothesis that *"S-Score does not homogeneously cause Price"* can be rejected but *"Price does not homogeneously cause Z-Score"* null hypotheses can not be rejected. This means that there is a significant conclusion that *S-Score* influences stock prices but not true vice versa.

CONCLUSION AND DISCUSSION

Companies that do not pay attention to their financial performance may face the risk of financial failure or bankruptcy. As we see in the literature, companies' financial failure or bankruptcy risk can be measured using Altman Z-Score and Springate S-Score models frequently. However, the number of studies investigating the relationship between financial failure and stock performance is relatively limited in the literature. Therefore, in this study, the relationships between financial failure or bankruptcy predictions and stock prices were investigated to fill this gap.

Investors want to get the highest return by choosing the financial investment tools that are most suitable for them. Stocks have a significant place among financial investment instruments today. Investors are looking for ways to earn

Dumitrescu-Hurlin Panel Causality Test Results

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
S-Score does not homogeneously cause Price	3.26328	2.05820	0.0396
Price does not homogeneously cause S-Score	2.65511	0.95437	0.3399

Source: analysis output.

higher returns from stock investments, as is the case with all financial investment instruments. In this direction, investors try to achieve higher investment performance by considering the various characteristics of the companies and the stocks belonging to the companies in question.

In this study, the relationship between financial failure or bankruptcy risk score and stock price was investigated in companies operating in the REITs traded on Borsa Istanbul in Turkey. The results show that Z and S scores, which are considered indicators of bankruptcy or financial failure, affect stock prices positively and significantly in the long run. When the bankruptcy indicator improves, stock prices follow an upward trend. The causality relationships show a double-sided causality between the Z-Score and stock prices and a one-sided between the S-Score and stock prices. In addition, there is causality from S-Scores to stock prices. Empirical findings show that investors consider information about the economic and financial conditions of the companies they invest in.

The obtained results in this study are in harmony with the studies such as I.D. Dichev [45], J.D. Piotroski [75], J.M. Griffin and M.L. Lemmon [46], N. Apergis [51], I.B. Robu [52], E. Susilowati [53], G. Singh and R. Singla [54].

It has been suggested in the literature that companies with high levels of financial distress (low Z and S scores)

have a higher risk of investing in stocks. Investing in stocks of companies with scores below certain levels is riskier, as low Altman Z-Score and Springate S-Score are indicators of financial distress and bankruptcy risk. This situation reduces stock prices and returns [75]. However, in some of the studies in the literature, it is emphasized that higher risk in any investment brings together higher expected return. At the same time, scores from bankruptcy models are related to the company's market value and systematic risk. Therefore, N. Apergis et al. [51] stated that companies with high scores in terms of bankruptcy risk should be expected to provide more returns to shareholders to compensate for the high risk. However, the number of studies supporting these cases is quite limited.

The study results are important in revealing essential conclusions for both REITs and the investors of REITs. It is vital for sector representatives whether the stock prices are related to the financial failure probability of REITs and to what extent. This study can be developed by considering different sectors, focusing on developed and developing financial markets, and using different econometric methods with financial failure prediction models other than Altman Z-Score and Springate S-Score models.

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APPENDIX

Table 1

The REITs used in the study

Springate		Altman	
Stock Code	**T-REIT Name**	**Stock Code**	**T-REIT Name**
AKMGY	Akmerkez REIT	AKSGY	Akiş REIT
ALGYO	Alarko REIT	AKMGY	Akmerkez REIT
ATAGY	Ata REIT	ALGYO	Alarko REIT
AGYO	Atakule REIT	ATAGY	Ata REIT
DZGYO	Deniz REIT	AGYO	Atakule REIT
DGGYO	Doğuş REIT	AVGYO	Avrasya REIT
ISGYO	İş REIT	DZGYO	Deniz REIT
MRGYO	Martı REIT	DGGYO	Doğuş REIT
NUGYO	Nurol REIT	ISGYO	İş REIT
OZGYO	Özderici REIT	NUGYO	Nurol REIT
RYGYO	Reysaş REIT	OZGYO	Özderici REIT
SNGYO	Sinpaş REIT	PEGYO	Pera REIT
TRGYO	Torunlar REIT	RYGYO	Reysaş REIT
TSGYO	TSKB REIT	SNGYO	Sinpaş REIT
VKGYO	Vakıf REIT	TSGYO	TSKB REIT
YKGYO	Yapı Kredi Koray REIT	VKGYO	Vakıf REIT
YGYO	Yeşil REIT	YKGYO	Yapı Kredi Koray REIT

Source: developed by the author.

Z-Scores

Table 2

Stock Symbol	REIC Name	2010/03	2010/06	2010/09	2010/12	2011/03	2011/06	2011/09	2011/12	2012/03	2012/06	2012/09	2012/12	2013/03	2013/06	2013/09	2013/12	2014/03	2014/06	2014/09	2014/12
AKSGY	Akiş REIT	3,12	3,33	2,95	2,36	3,65	4,11	4,68	14,62	13,90	18,95	22,24	1,02	1,57	1,18	1,38	1,61	1,45	1,52	1,66	1,58
AKMGY	Akmerkez REIT	45,82	20,00	20,83	41,27	38,48	226,26	161,05	126,65	171,12	229,63	225,89	261,21	216,46	178,31	130,87	162,98	136,76	131,38	153,90	99,47
ALGYO	Alarko REIT	28,63	31,45	12,54	11,97	22,78	43,09	37,37	27,59	79,78	124,04	93,71	63,22	46,22	104,26	103,53	94,89	32,62	189,72	73,70	62,50
ATAGYO	Ata REIT	9,46	59,48	37,05	55,91	58,58	56,25	26,82	61,64	16,44	111,37	130,33	147,63	306,31	26,67	36,73	31,08	32,70	32,30	8,51	10,25
AGYO	Atakule REIT	34,24	48,85	73,63	77,81	28,98	51,16	55,11	45,33	65,94	56,39	69,42	58,40	45,86	48,89	55,68	53,30	42,37	42,05	49,18	55,34
AVGYO	Avrasya REIT	27,39	19,97	142,25	873,44	-3,49	272,28	1127,64	533,59	500,47	471,42	24,17	255,37	18,95	319,43	260,51	237,29	12,12	9,61	8,32	10,64
DZGYO	Deniz REIT	429,12	427,38	386,05	314,92	350,63	48,14	288,95	277,98	297,74	227,27	276,16	309,47	23,91	302,78	294,53	37,28	28,11	253,31	104,60	149,11
DGGYO	Doğuş REIT	71,17	91,79	91,24	127,28	112,15	134,73	73,23	167,48	142,18	291,33	171,48	135,07	148,85	773,35	307,61	3,89	10,76	11,26	10,19	10,88
ISGYO	İş REIT	14,26	12,94	15,76	8,30	8,01	7,42	6,77	5,59	5,45	5,43	4,43	3,61	3,24	2,98	3,56	2,98	2,62	2,62	2,37	2,90
NUGYO	Nurol REIT	36,90	47,56	74,39	77,34	56,03	1,67	5,44	5,54	5,27	5,59	6,06	5,42	5,48	4,35	3,14	2,70	2,95	2,87	3,25	3,07
OZGYO	Özderici REIT	3,52	6,53	0,63	30,42	38,29	19,88	14,72	14,14	13,47	11,35	9,10	7,52	8,27	6,94	6,08	7,66	7,30	7,82	7,96	7,25
PEGYO	Pera REIT	0,55	0,28	-0,03	2,93	3,64	3,94	3,71	1,35	2,32	2,02	1,96	1,46	1,54	1,24	1,05	0,84	-0,20	0,67	-0,35	1,23
RYGYO	Reysaş REIT	-2,02	-0,28	11,69	12,12	8,48	6,61	5,36	3,55	4,48	3,90	2,37	2,79	2,69	1,92	1,68	1,60	1,97	2,01	1,56	1,17
SNGYO	Sinpaş REIT	5,10	3,77	4,36	2,97	5,06	5,35	5,47	2,72	3,36	2,91	3,02	3,11	3,16	2,98	3,03	2,43	2,38	2,25	3,07	3,69
TSGYO	TSKB REIT	1,85	2,83	3,03	1,54	1,54	1,29	0,93	1,26	1,54	1,55	1,73	1,47	1,59	1,45	1,39	0,59	0,48	0,62	0,73	0,92
VKGYO	Vakıf REIT	140,26	167,52	212,27	127,09	19,82	1,12	1,98	105,11	174,29	149,18	173,21	250,50	213,95	243,14	557,70	802,01	496,05	371,54	387,64	390,16
YKGYO	Yapı Kredi Koray REIT	13,04	9,37	8,28	7,06	7,32	7,31	6,18	5,30	5,78	5,50	5,60	4,84	4,71	2,39	2,18	2,77	2,56	3,63	3,74	4,03
YGYO	Yeşil REIT	228,19	256,80	260,80	0,26	4,99	0,65	1,37	1,22	1,11	0,86	1,95	3,02	3,63	3,18	4,47	4,66	4,72	4,98	4,68	3,89

Table 2 (continued)

Stock Symbol	REIC Name	2015/03	2015/06	2015/09	2015/12	2016/03	2016/06	2016/09	2016/12	2017/03	2017/06	2017/09	2017/12	2018/03	2018/06	2018/09	2018/12	2019/03	2019/06	2019/09	2019/12
AKSGY	Akiş REIT	1,70	1,55	1,90	2,62	2,46	2,81	2,22	1,99	2,18	2,57	2,69	2,72	2,38	3,04	3,95	3,49	3,64	2,84	1,77	2,10
AKMGY	Akmerkez REIT	9,66	46,96	73,28	69,99	8,08	21,13	28,09	112,45	110,90	20,25	19,90	109,33	11,21	16,90	16,55	103,19	7,40	13,92	28,84	87,89
ALGYO	Alarko REIT	30,12	157,69	87,52	77,00	25,37	128,58	92,78	92,38	33,28	112,87	69,15	78,93	25,06	118,53	73,07	59,50	15,37	46,75	41,87	39,05
ATAGYO	Ata REIT	10,32	13,02	13,85	3,54	4,60	4,32	4,18	4,94	5,10	4,63	4,71	2,84	2,55	2,97	3,00	2,78	2,86	2,36	2,35	1,37
AGYO	Atakule REIT	41,40	22,77	53,37	34,83	50,87	52,14	54,43	18,00	14,91	18,34	6,87	14,81	10,98	4,80	3,96	1,84	9,61	10,75	11,00	7,52
AVGYO	Avrasya REIT	12,94	13,23	6,89	9,64	9,17	7,37	16,56	21,69	58,61	98,71	30,60	6,09	33,81	9,96	10,26	7,67	11,83	21,05	27,14	75,10
DZGYO	Deniz REIT	74,39	9,18	12,63	19,45	24,64	61,02	47,70	89,31	78,20	33,20	27,00	4,28	1,23	0,97	1,24	1,60	1,97	1,43	1,19	0,61
DGGYO	Doğuş REIT	11,49	10,03	8,18	10,06	11,18	10,48	5,24	5,74	4,07	4,28	4,51	4,70	4,62	3,93	2,39	1,19	1,07	1,31	1,82	1,96
ISGYO	İş REIT	3,45	2,85	2,33	2,59	2,49	2,67	2,27	1,88	1,72	1,76	1,73	1,23	1,26	1,39	1,54	1,93	1,90	1,94	1,86	1,77
NUGYO	Nurol REIT	2,64	2,38	1,92	2,04	1,46	1,99	2,49	2,75	2,15	1,50	1,64	1,17	0,72	0,05	-0,38	-0,08	-0,71	0,27	0,33	1,50
OZGYO	Özderici REIT	6,82	7,34	7,40	6,65	6,71	5,84	5,25	4,59	4,89	4,73	4,55	4,42	8,37	8,07	11,88	5,99	3,56	2,46	3,37	3,24
PEGYO	Pera REIT	0,98	1,17	1,08	1,57	1,61	1,47	1,44	1,32	2,17	2,21	2,31	-1,35	-0,99	-0,81	-1,17	2,27	1,59	1,16	1,56	-0,10
RYGYO	Reysaş REIT	1,44	1,23	0,88	2,01	3,15	3,31	3,48	1,89	1,89	2,02	2,08	1,38	1,68	1,34	1,03	1,94	2,01	1,99	2,23	3,41
SNGYO	Sinpaş REIT	3,30	2,86	2,90	2,47	2,56	2,82	2,63	2,42	2,32	3,16	2,87	3,61	3,39	3,17	3,16	4,19	4,09	3,90	3,99	4,03
TSGYO	TSKB REIT	0,74	0,64	0,44	1,22	1,28	1,41	1,31	0,56	0,48	0,42	0,54	0,80	0,76	0,49	-0,24	1,40	1,33	1,41	2,47	2,73
VKGYO	Vakıf REIT	250,85	298,27	334,32	15,18	7,19	4,94	4,08	3,50	3,97	4,96	3,65	3,44	2,58	1,86	1,65	0,97	1,16	1,20	1,14	1,23
YKGYO	Yapı Kredi Koray REIT	3,66	3,81	4,58	2,21	1,75	3,24	2,96	2,08	1,50	7,14	5,71	7,02	6,75	6,66	6,07	7,79	6,13	6,97	8,66	7,99
YGYO	Yeşil REIT	3,78	3,84	3,94	4,22	4,27	4,42	3,25	3,12	3,22	2,84	2,97	3,09	3,19	2,75	2,32	2,23	2,37	2,75	3,48	2,99

Source: Developed by the author.

Table 3

S-Scores

Stock Symbol	REIC Name	2010/03	2010/06	2010/09	2010/12	2011/03	2011/06	2011/09	2011/12	2012/03	2012/06	2012/09	2012/12	2013/03	2013/06	2013/09	2013/12	2014/03	2014/06	2014/09	2014/12
AKMGY	Akmerkez REIC	1,83	1,23	1,17	1,41	1,36	5,50	5,60	6,27	6,19	11,41	11,65	11,34	11,03	11,08	9,83	11,53	8,22	9,49	11,78	7,31
ALGYO	Alarko REIC	0,60	0,82	0,41	0,33	0,44	0,54	0,54	1,68	5,94	10,58	6,44	3,20	2,84	18,20	23,25	33,64	8,84	59,99	18,07	17,38
ATAGY	Ata REIT	8,41	12,61	5,96	10,15	11,86	13,41	3,48	-6,81	0,15	-4,72	2,73	5,06	0,13	-1,07	-4,50	0,29	-0,22	-0,02	-0,74	0,47
AGYO	Atakule REIT	2,25	4,73	6,98	15,32	3,26	7,65	12,43	7,97	10,44	18,37	35,55	28,22	15,09	18,02	20,66	-8,32	-1,54	0,81	0,19	6,62
DZGYO	Deniz REIT	123,31	67,18	43,48	64,82	56,86	5,83	8,00	-22,15	6,94	2,53	23,16	63,67	-15,74	67,91	163,40	5,82	11,16	42,28	12,15	4,48
DGGYO	Doğuş REIT	2,00	1,96	1,64	4,54	3,85	5,25	3,79	6,67	6,97	16,82	9,81	20,52	18,79	44,66	21,42	1,01	1,12	1,37	1,65	1,53
ISGYO	İş REIT	3,31	2,96	3,02	2,02	2,28	2,20	1,89	3,04	1,66	3,99	4,23	0,70	0,64	0,56	0,91	1,03	1,11	1,00	1,54	3,46
MRGYO	Marti REIT	0,28	0,44	0,75	0,64	0,47	0,32	0,28	0,17	0,28	0,29	0,23	0,40	0,45	0,50	0,33	0,85	0,91	0,79	0,75	2,59
NUGYO	Nurol REIT	1,08	1,92	1,92	3,93	2,15	0,84	1,07	0,93	0,74	0,81	0,81	0,72	0,73	0,55	0,40	0,35	0,38	0,39	0,46	0,32
OZGYO	Özderici REIT	0,24	0,11	-0,03	0,67	0,57	-1,03	0,64	1,49	5,43	1,44	1,38	0,77	0,72	0,78	0,74	1,49	1,33	1,30	1,49	1,42
RYGYO	Reysaş REIT	-0,37	-0,03	0,33	0,84	0,72	0,87	0,86	0,89	0,97	1,01	0,58	0,97	0,93	0,81	0,85	0,85	1,22	0,93	0,84	0,49
SNGYO	Sinpaş REIT	0,47	0,40	0,54	0,48	0,80	1,07	1,12	0,73	0,82	0,58	0,56	0,57	0,54	0,59	0,55	0,50	0,52	0,41	0,61	0,88
TRGYO	Torunlar REIT	1,40	1,58	1,99	0,65	0,63	0,31	0,32	0,60	0,56	0,63	0,51	0,44	0,41	0,39	0,38	0,41	0,54	0,63	0,65	1,23
TSGYO	TSKB REIT	1,13	1,64	1,86	0,25	0,31	0,68	0,77	1,31	1,40	1,48	1,59	0,97	1,06	0,90	0,87	0,23	0,24	0,24	0,23	0,21
VKGYO	Vakif REIT	2,96	3,53	3,52	2,02	0,86	0,64	0,90	29,97	15,01	1,56	2,81	4,53	3,90	3,25	3,54	2,47	1,23	1,53	1,44	18,44
YKGYO	Yapı Kredi Koray REIC	0,00	0,57	0,57	0,56	0,56	0,60	0,62	0,64	0,66	0,71	0,74	0,60	0,61	0,23	0,23	0,42	0,42	0,56	0,59	0,49
YGYO	Yeşil REIT	-16,07	-12,99	-15,17	0,02	0,69	0,03	0,31	0,29	0,25	0,23	0,26	0,53	0,62	0,55	0,88	0,93	0,96	0,98	0,82	0,52

Table 3 (continued)

Stock Symbol	REIC Name	2015/03	2015/06	2015/09	2015/12	2016/03	2016/06	2016/09	2016/12	2017/03	2017/06	2017/09	2017/12	2018/03	2018/06	2018/09	2018/12	2019/03	2019/06	2019/09	2019/12
AKMGY	Akmerkez REIC	1,32	4,20	6,34	6,69	1,29	2,75	3,15	9,93	8,99	2,22	2,12	9,30	1,60	2,17	2,09	11,63	1,37	1,90	3,00	7,90
ALGYO	Alarko REIC	8,31	67,64	37,02	25,60	5,61	36,08	19,07	24,11	6,98	38,16	17,50	17,99	5,17	65,33	46,50	24,28	5,66	27,86	5,39	23,76
ATAGY	Ata REIT	0,85	3,40	3,60	0,32	0,29	0,11	0,11	0,25	0,29	0,26	0,28	0,61	2,98	1,11	0,95	0,36	0,36	0,17	0,13	0,01
AGYO	Atakule REIT	2,22	0,46	-0,25	11,25	17,61	23,26	31,75	2,46	2,91	1,54	0,20	-1,20	-0,81	-0,41	-0,35	-0,03	1,06	1,14	1,51	1,73
DZGYO	Deniz REIT	2,85	0,21	0,33	1,73	2,26	6,36	5,06	8,79	7,94	2,88	1,81	0,76	0,65	0,30	0,20	0,32	0,31	0,20	0,17	0,09
DGGYO	Doğuş REIT	1,59	1,52	1,38	2,16	2,22	2,16	1,34	1,25	1,10	1,03	1,38	1,25	1,01	0,75	0,72	0,72	0,44	0,68	0,80	1,12
ISGYO	İş REIT	2,74	0,81	0,79	0,85	0,92	1,62	1,83	1,90	1,43	0,78	0,76	0,32	0,30	0,41	0,47	0,57	0,61	0,54	0,51	0,54
MRGYO	Marti REIT	1,60	1,53	1,38	-2,13	-1,69	-1,75	-2,00	-0,71	-1,08	-0,84	-0,77	-0,32	-0,28	-0,11	-0,12	0,13	0,15	0,22	0,23	0,25
NUGYO	Nurol REIT	0,28	0,39	0,37	0,41	0,33	0,30	0,42	0,64	0,56	0,48	0,50	0,33	0,25	0,19	0,11	0,12	0,04	0,23	0,17	0,44
OZGYO	Özderici REIT	1,16	1,78	1,77	1,72	1,68	1,28	1,03	0,79	0,84	0,83	0,79	0,73	0,78	0,67	0,65	0,09	0,24	0,06	0,02	0,19
RYGYO	Reysaş REIT	0,56	0,57	0,45	1,18	1,28	2,29	1,95	1,42	1,08	1,26	1,01	0,64	0,69	0,63	0,63	0,97	1,00	0,99	0,94	1,29
SNGYO	Sinpaş REIT	0,81	0,77	0,72	0,39	0,37	0,31	0,10	0,36	0,38	0,64	0,73	0,78	0,76	0,67	0,67	0,89	1,03	0,89	0,86	1,07
TRGYO	Torunlar REIT	1,50	0,87	0,69	0,93	0,91	1,11	1,56	0,62	0,55	0,52	0,53	0,47	0,70	0,80	0,71	1,11	0,96	0,87	0,98	0,73
TSGYO	TSKB REIT	0,19	0,16	0,22	0,23	0,53	0,53	0,44	0,23	0,23	0,22	0,23	0,28	0,29	0,28	0,23	2,41	2,60	2,04	2,36	3,05
VKGYO	Vakif REIT	12,11	14,79	20,21	23,09	12,31	6,67	3,96	1,27	1,00	1,32	0,08	0,19	0,18	0,22	0,29	0,17	0,24	0,21	0,08	0,27
YKGYO	Yapı Kredi Koray REIC	0,42	0,51	0,62	0,33	0,23	0,38	0,27	-0,03	-0,01	-0,08	-0,02	0,16	0,06	0,03	0,09	1,26	0,96	1,17	1,15	0,34
YGYO	Yeşil REIT	0,51	0,54	0,55	0,62	0,63	0,67	0,49	0,46	0,48	0,45	0,47	0,51	0,53	0,43	0,38	0,38	0,41	0,47	0,60	0,50

Source: Developed by the author.

New Risk Measures for Variance Distortion and Catastrophic Financial Risk Measures

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ABSTRACT

In recent years, expectation distortion risk measures have been widely used in financial and insurance applications due to their attractive properties. The author introduced two new classes of financial risk measures "*VaR* raised to the power of *t*" and "*ES* raised to the power of *t*" in his works and also investigated the issue of the belonging of these risk measures to the class of risk measures of expectation distortion, and described the corresponding distortion functions. The **aim** of this study is to introduce a new concept of variance distortion risk measures, which opens up a significant area for investigating the properties of these risk measures that may be useful in applications. The paper proposes a **method** of finding new variance distortion risk measures that can be used to acquire risk measures with special properties. As a **result** of the study, it was found that the class of risk measures of variance distortion includes risk measures that are in a certain way related to "*VaR* raised to the power of *t*" and "*ES* raised to the power of *t*" measures. The article describes the composite method for constructing new variance distortion functions and corresponding distortion risk measures. This **method** is used to build a large set of examples of variance distortion risk measures that can be used in assessing certain financial risks of a catastrophic nature. The author **concludes** that the study of the variance distortion risk measures introduced in this paper can be used both for the development of theoretical risk management methods and in the practice of business risk management in assessing unlikely risks of high catastrophe.

Keywords: catastrophic financial risks; expectation distortion risk measures; variance distortion risk measures, distortion functions; composite method; coherent financial risk measures; "*VaR* raised to the power of *t*" risk measures; "*ES* raised to the power of *t*" risk measures

INTRODUCTION

The risk measure shall be designated as the mapping ρ of the set of random variables *X*, associated with the risk portfolios of assets and / or liabilities (the resultant variables of these portfolios) into the real line *R*. In the following discussion, *X* will be represented as the value of the corresponding losses, i.e. positive values of the *X* variables will represent losses, while negative values represent gains.

Expectation distortion risk measures represent a special and important group of risk measures that are widely used in finance and insurance as the calculation of capital requirements and the principles for calculating indicators related to "risk appetite" for the regulator and company executive. Several popular risk measures have proven to belong to the family of expectations distortion risk measures. For example, value at risk (*VaR*), tail value at risk or expected shortfall (*ES*) (see, for example, [1–3]), and S.S. Wang distortion risk measure [4]. Expectation distortion

risk measures satisfy the most important properties that a "good" risk measure should have, including positive homogeneity, translational invariance, and monotonicity (see, for example, [5]).

As proved by D. Denneberg and S. Wang c J. Dhaene [6, 7], when the corresponding distortion function is concave, the distortion risk measure is also subadditive. *VaR* is one of the most popular risk measures used in risk management and banking supervision due to its computational simplicity and for some regulatory reasons, despite its shortcomings as a risk measure. For example, *VaR* is not a subadditive risk measure (see, for example, [8, 9]). The *ES* risk measure, being coherent (see, for example, [2, 3]), is interested only in losses exceeding *VaR* and ignores useful information about the distribution of losses below *Va* R.

L. Zhu and H. Li [10] presented and studied the distortion risk measure, which was reformulated by F. Yang [11].

C. Yin, D. Zhu [12] in particular, described three methods for constructing distortion risk measures: composite, mixing method and an approach based on copula (connective) theory.

Many researchers have proposed new classes of distortion measures. For example, as an extension of *VaR* and *ES*, J. Belles-Sampera, M. Guillén, M. Santolino [13] proposed a new class of distortion risk measures called risk measures Glue*VaR*, which can be expressed as a combination of *VaR* and *ES* indicators at different levels of confidence. They obtained closed-form analytical expressions for these measures with the most commonly used distribution functions in finance and insurance. The application of Glue*VaR* risk measures related to capital allocation was discussed in article [14].

V.B. Minasyan [15] introduced the *VaR* to the power of *t* risk measures, and in [16] it was proved that the family of measures *VaR* to the power of *t* is a subset of the set of risk measures for the expectation distortion. Thus, any measure of risk *VaR* to the power of *t*, for any $t \geq 1$, for any, is an expectation distortion risk measure with a certain distortion function. At the same time, this distortion function was presented.

In the latter work, a family of new risk measures was also introduced, called risk measures "*ES* to the power of *t*" ($ES_p^{(t)}[X]$), or any confidence probability *p* and any real $t \geq 1$. The work investigated the relationship between two classes of risk measures: expectation distortion risk measures and *ES* to the power of *t* risk measures it was proved that the family of measures *ES* to the power of *t* is a subset of the set of expectation distortion risk measures. That is, any *ES* to the power of *t* risk measure, for any $t \geq 1$, is a measure of the risk of expectation distortion with a certain distortion function. Moreover, this distortion function was presented.

Obviously, it is difficult to believe that there is a unique risk measure that can encompass all characteristics of risk. There is no such ideal measure. Moreover, since virtually every risk measure has one number associated with it, each risk measure cannot exhaust all the information about the risk. The families of risk measures *VaR* to the power of *t* and *ES* to the power of *t*, as shown in the works of V.B. Minasyan [15, 16], make it possible to study the right tail of the distribution of losses with any accuracy required for a given case, i.e. examine the tail of the distribution as thoroughly as necessary

under the circumstances. In general, during the research process, it is advisable to look for risk measures that are ideal for a particular problem. Since all the proposed risk measures are erroneous and limited in their application, the choice of the appropriate risk measure continues to be a hot topic in risk management.

In light of this, the development of new directions for the detection of new risk measures that have the ability to more accurately assess specific types of catastrophic risks, considering all kinds of necessary properties of such measures, seems legitimate. In this paper, an attempt is made to propose a new direction in the search for such measures with an appropriate methodology for their search. We propose a new concept for measuring the risk of variance distortion, which opens up a new area of such a search.

Distortion functions

The distortion function is a non-decreasing function $g: [0,1] \rightarrow [0,1]$ such that, $g(0) = 0$, $g(1) = 1$. Many distortion functions g have already been proposed in the literature. A summary of the various distortion functions used to construct expectation distortion risk measures can be found in [9, 16].

Expectation distortion risk measures

Let (Ω, *F, P*) — be a probability space on which all random variables representing the risks of interest to us are defined. Let F_x — be the integral distribution function of a random variable *X*, and the dual distribution function we denote as $\overline{F}_x$, i.e. $\overline{F}_X = 1 - F(x) = P\{X > x\}$. Let *g* be a distortion function.

Expectation distortion of a random variable X is denoted $\rho_g^E[X]$ and defined as

$$\rho_g^E[X] = \int_0^{+\infty} g(\overline{F}_X(x))dx + \int_{-\infty}^0 [g(\overline{F}_X(x)) - 1]dx, \quad (1)$$

provided that at least one of the two integrals indicated above is finite. If *X* is a non-negative random variable, then ρ_g^E simplifies to

$$\rho_g^E[X] = \int_0^{+\infty} g(\overline{F}_X(x))dx.$$

It should be noted that this definition implies that in the case when the distortion function is an identical

function, i.e. $g(x) = x$, then, and it is easy to check, the skewed expectation is the same as the normal expectation: $\rho_g^E[X] = E[X]$.

Due to the fact that the expected value of a random variable is considered the most important way of assessing the future value of a random variable X, it is natural to assume that, since risks arise due to one or another deviation of the value of a random variable from its expected value, the corresponding risk measures can be modeled as corresponding "distortion" of the expected value with the appropriate distortion function.

The distorted expectation $\rho_g^E[X]$ is called *the expectation distortion risk measure with the distortion function g* (see, for example, [17]).

As noted in [9], the well-known risk measure *VaR* (see, for example, [1–3]) is an expectation distortion risk measure corresponding to the distortion function $g(x) = 1_{\{x > 1-p\}}$, $p \in (0,1)$, $\rho_g^E[X] = \text{VaR}_p[X]$.

Expectation distortion risk measures are a special class of risk measures that were introduced by D. Denneberg [6] and revised by S. S. Wang [4, 18].

Expectation distortion risk measures satisfy a variety of properties, including positive homogeneity, translation invariance, and monotonicity.

It is known (see [17]) that another measure of risk after *VaR*, which is represented as an expectation distortion risk measure, is the well-known *ES* measure — a measure of the expected deficit, conditional *VaR* (see, for example, [1–3]). The corresponding distortion function is $g(x) = \min\{\frac{x}{1-p}, 1\}$, $p \in [0,1]$, and under the assumption of the continuity of the distribution function F_x the corresponding expectation distortion risk measure is

$$\rho_g^E[X] = \text{ES}_p[X].$$

V.B. Minasyan [16] proved (see *Statement 4*) that the risk measures *VaR* to the power of *t*, introduced by him in [15], $\text{VaR}_p^{(t)}[X]$ for any real number $t \geq 1$ are risk expectation distortion risk measures, and the corresponding distortion function can be described as follows.

We represent the number *t* as: $t = k + \alpha$, where k — natural number α — a real number, with $0 \leq \alpha < 1$. Then risk measure $VaR_p^{(t)}[X]$ will be an expectation distortion risk measure, which can be represented as a superposition of distortion functions

$$1_{\{x > 1-p\}}(x), \; g(x) = \min\{\frac{x}{1-p}, 1\}$$

$$\text{и } g_\alpha(x) = \min\{\frac{x}{1-\alpha p}, 1\} \text{ и } g_{k-1}(x) = x^{\frac{1}{k-1}}$$

in two ways:

$$h(x) = 1_{\{x > 1-p\}}(\underbrace{g(g(...(g(g_\alpha(x))}_{k-1-\text{times}}) = 1_{\{x > 1-p\}}(g_{k-1}(g_\alpha(x))),$$

i.e.

$$VaR_p^{(t)}[X] = \rho_h^E[X].$$

It was also proved in [16] (see *Statement 4*) that the introduced risk measures *ES* to the power of *t*, $ES_p^{(t)}[X]$ for any real $t \geq 1$ are expectation distortion risk measures, and the corresponding distortion function can be described as follows.

We represent the number *t* as: $t = k + \alpha$, where k — natural number and α — is a real number, with $0 \leq \alpha < 1$, then the risk measure $ES_p^{(t)}[X]$ will be an expectation distortion risk measure, and it is obtained as a risk measure corresponding to the distortion function obtained as a superposition of functions

$$g(x) = \min\{\frac{x}{1-p}, 1\}$$

and a function $g_\alpha(x) = \min\{\frac{x}{1-\alpha p}, 1\}$ of the following form:

$$h(x) = \underbrace{g(g(...(g(g_\alpha(x))}_{k-\text{раз}}),$$

i.e. $ES_p^{(t)}[X] = \rho_h^E[X].$

Variance distortion risk measures

The most established measure of the risk of any risk factor, which is a certain random variable *X*, is the variance of this value (or its standard deviation). Expectations distortion risk measures have arisen by "distorting" the expected value of *X*, and the study of this class of measures has led to significant progress in methods for assessing catastrophic risk measures. The question arises: is it possible to propose to "distort" the variance in a certain way with the hope that this approach will generate a new class of measures, which could be called variance distortion risk measures. We hope that they will have a rich structure that allows one to find risk measures in it

that meet certain needs of risk managers and are not satisfied with other classes of risk measures.

It should be noted that this definition should be such that in the case when the distortion function is an identical function, i.e. $g(x) = x$, the distorted value of the variance, which we will denote as ρ_g^D, coincides with the usual variance of a random variable, i.e. $\rho_g^D[X] = D[X]$.

To bring the variance to a form convenient for its "distortion", we transform its well-known expression:

$$D[X] = \int_{-\infty}^{+\infty} (x - E[X])^2 dF_X(x).$$

The transformation below is valid under the following assumptions:

A) $\lim_{x \to +\infty} x^2(1 - F_X(x)) = 0$.

B) $\lim_{x \to -\infty} x^2 F_X(x) = 0$.

Assumption A) means that $F_X(x) \to 1$ at $x \to +\infty$ with a sufficiently high speed. For continuous distributions, always $F_X(x) \to 1$ at $x \to +\infty$. But here it is necessary that $F_X(x)$ approaching 1 occurs faster than x^2 approaching infinity.

Assumption B) means that $F_X(x) \to 0$ at $x \to -\infty$ with a sufficiently high speed. For continuous distributions, always $F_X(x) \to 0$ at $x \to -\infty$. But here it is necessary that $F_X(x)$ approaching 0 occurs faster than x^2 approaching infinity.

Using integration by parts and assumptions A) and B), we have:

$$D[X] = -\int_{E[X]}^{+\infty} (x - E[X])^2 d(1 - F_X(x)) +$$

$$+ \int_{-\infty}^{E[X]} (x - E[X])^2 dF_X(x) =$$

$$-(x - E[X])^2(1 - F_X(x)) \Big|_{E[X]}^{+\infty} +$$

$$+2\int_{E[X]}^{+\infty} (1 - F_X(x))(x - E[X])dx +$$

$$+(x - E[X])^2 F_X(x) \Big|_{-\infty}^{E[X]} -$$

$$-2\int_{-\infty}^{E[X]} F_X(x)(x - E[X])dx =$$

$$= 2\int_{E[X]}^{+\infty} \overline{F}_X(x))(x - E[X])dx +$$

$$+2\int_{-\infty}^{E[X]} [\overline{F}_X(x) - 1](x - E[X])dx.$$

Based on the last expression, it is quite natural to introduce the following definition. Let g be a distortion function.

The distorted variance of the random variable X, corresponding to the distortion function g, is denoted as $\rho_g^D[X]$ and defined as

$$\rho_g^D[X] = 2\int_{E[X]}^{+\infty} g(\overline{F}_X(x))(x - E[X])dx +$$

$$+2\int_{-\infty}^{E[X]} [g(\overline{F}_X(x)) - 1](x - E[X])dx. \qquad (2)$$

provided that at least one of the two integrals above is finite.

It should be noted that when the distortion function is identical, i.e., $g(x) = x$, then the distorted variance coincides with the usual variance: $\rho_g^D[X] = D[X]$.

We will call the distorted variance $\rho_g^D[X]$ as *the variance distortion risk measure with the distortion function g.*

Using definition (2), it is easy to check that the variance distortion risk measure with any distortion function g from a constant (not random) value $X = \text{const} =$ is equal to zero. That is, $\rho_g^D[c] = 0$.

Search for risk measures from the class of risk measures for variance distortion

We will now look for measures of risk that are contained in various measures of risk of variance distortion.

We will seek appropriate measures by choosing a certain distortion function and obtaining a computational formula for the risk measure of variance distortion corresponding to a given distortion function.

Concave distortion function

$$g(x) = 1_{\{x > 1-p\}}, \quad p \in (0,1).$$

This distortion function in the set of expectation distortion risk measures led to the measurement of risk *VaR* (see [13]). What degree of risk will this lead to when constructing an appropriate measure of the risk of variance distortion?

Hereinafter, we will assume the continuity of the distribution function of the random variable X, which represents the corresponding risk factor.

According to formula (2), we have:

$$\rho_g^D[X] = 2 \int_{E[X]}^{+\infty} 1_{\{\bar{F}_X(x)>1-p\}}(x-E[X])dx +$$

$$+ 2 \int_{-\infty}^{E[X]} [1_{\{\bar{F}_X(x)>1-p\}} - 1](x-E[X])dx =$$

$$= 2 \int_{E[X]}^{+\infty} 1_{\{F_X(x)\leq p\}}(x-E[X])dx +$$

$$2 \int_{-\infty}^{E[X]} [1_{\{F_X(x)\leq p\}} - 1](x-E[X])dx .$$

Denoting by the F_X^{-1} function, inverse to the distribution function F_X, we obtain:

$$\rho_g^D[X] = 2 \int_{E[X]}^{+\infty} 1_{\{x\leq F_X^{-1}(p)\}}(x-E[X])dx +$$

$$+ 2 \int_{-\infty}^{E[X]} [1_{\{x\leq F_X^{-1}(p)\}} - 1](x-E[X])dx . \qquad (3)$$

In the further derivation of the formula for $\rho_g^D[X]$ we will have to consider two cases.

A) We assume that $F_X^{-1}(p) < E[X]$, i.e. $VaR_p[X] < E[X]$.

In this case, it is obvious that the first integral in formula (3) is equal to zero. And we obtain:

$$\rho_g^D[X] = 2 \int_{-\infty}^{E[X]} [1_{\{x\leq F_X^{-1}(p)\}} - 1](x-E[X])dx =$$

$$= -2 \int_{F_X^{-1}(p)}^{E[X]} (x-E[X])dx = -(x-E[X])^2 \big|_{F_X^{-1}(p)=VaR_p[X]}^{E[X]} =$$

$$= (VaR_p[X] - E[X])^2 .$$

We consider the second case.

B) We assume that $F_X^{-1}(p) \geq E[X]$, i.e. $VaR_p[X] \geq E[X]$.

In this case, it is obvious that the second integral in formula (3) is equal to zero. And we obtain:

$$\rho_g^D[X] = 2 \int_{E[X]}^{+\infty} 1_{\{x\leq F_X^{-1}(p)\}}(x-E[X])dx =$$

$$= 2 \int_{E[X]}^{F_X^{-1}(p)} (x-E[X])dx = (x-E[X])^2 \big|_{E[X]}^{F_X^{-1}(p)=VaR_p[X]} =$$

$$= (VaR_p[X] - E[X])^2 .$$

Thus, we have proved the following statement.

Statement 1

A variance distortion risk measure, corresponding to the distortion function $g(x) = 1_{\{x>1-p\}}$, $p \in (0,1)$, is the risk measure

$$\rho_g^D[X] = (VaR_p[X] - E[X])^2 .$$

Note that the value $\tilde{\rho}_g^D[X] = \sqrt{\rho_g^D[X]}$ can also serve as a measure of risk, and its dimension, in contrast to $\rho_g^D[X]$, coincides with the dimension of the random variable X.

Obviously,

$$\tilde{\rho}_g^D[X] = |VaR_p[X] - E[X]| = |VaR_p^{rel}[X]| ,$$

where through $VaR_p^{rel}[X]$ here denotes the relative value of VaR, i.e. the value of the maximum possible unfavorable deviation of a random variable X with a given probability p.

Concave distortion function

$$g(x) = \min\{\frac{x}{1-p}, 1\}, \ p \in [0,1] .$$

This distortion function in the set of risk measures for the distortion of expectations led to the *ES* risk measure (see [17]). Interestingly, to what degree of risk will it lead, applied to construct the corresponding risk measure of variance distortion?

To use formula (2), we first transform the expression $g(\bar{F}_X(x))$. We have:

$$g(\bar{F}_X(x)) =$$

$$= \min\{\frac{\bar{F}_X(x)}{1-p}, 1\} = \begin{cases} \dfrac{\bar{F}_X(x)}{1-p}, if \ \bar{F}_X(x) \leq 1-p , \\ 1, if \ \bar{F}_X(x) > 1-p \end{cases}$$

or

$$g(\bar{F}_X(x)) = \begin{cases} \dfrac{1-F_X(x)}{1-p}, if \ F_X(x) > p \\ 1, if \ F_X(x) \leq p , \end{cases}$$

which means,

$$g(\bar{F}_X(x)) = \begin{cases} \dfrac{1-F_X(x)}{1-p}, if \ x > F_X^{-1}(p) \\ 1, if \ x \le F_X^{-1}(p). \end{cases}$$

In the further derivation of the formula for $\rho_g^D[X]$ we will have to consider two cases.

A) We assume that $F_X^{-1}(p) < E[X]$, i.e. $VaR_p[X] < E[X]$.

In this case, the first integral in formula (2) has the form:

$$2\int_{E[X]}^{+\infty} g(\bar{F}_X(x))(x-E[X])dx =$$

$$= 2\int_{E[X]}^{+\infty} \frac{1-F_X(x)}{1-p}(x-E[X])dx.$$

The second integral in formula (2) can be transformed as follows:

$$2\int_{-\infty}^{E[X]} [g(\bar{F}_X(x))-1](x-E[X])dx =$$

$$= 2\int_{F_X^{-1}(p)}^{E[X]} [\frac{1-F_X(x)}{1-p}-1](x-E[X])dx.$$

Thus, according to formula (2), we obtain:

$$\rho_g^D[X] = 2\int_{E[X]}^{+\infty} \frac{1-F_X(x)}{1-p}(x-E[X])dx +$$

$$+2\int_{F_X^{-1}(p)}^{E[X]} [\frac{1-F_X(x)}{1-p}-1](x-E[X])dx =$$

$$= 2\int_{F_X^{-1}(p)}^{+\infty} \frac{1-F_X(x)}{1-p}(x-E[X])dx -$$

$$2\int_{F_X^{-1}(p)}^{E[X]} (x-E[X])dx =$$

$$= \frac{1}{1-p}\int_{F_X^{-1}(p)}^{+\infty} (1-F_X(x))d(x-E[X])^2 - (x-E[X])^2 |_{F_X^{-1}(p)}^{E[X]}.$$

Then, using integration by parts, we obtain:

$$\rho_g^D[X] = \frac{1}{1-p}(x-E[X])^2(1-F_X(x))|_{F_X^{-1}}^{+\infty} +$$

$$+\frac{1}{1-p}\int_{F_X^{-1}(p)}^{+\infty} (x-E[X])^2 dF_X(x) + (F_X^{-1}(p)-E[X])^2.$$

Using condition A), we obtain:

$$\rho_g^D[X] = -\frac{1}{1-p}(F_X^{-1}(p)-E[X])^2(1-F_X(F_X^{-1}(p))) +$$

$$+(F_X^{-1}(p)-E[X])^2 +$$

$$+\frac{1}{1-p}\int_{F_X^{-1}(p)}^{+\infty} (x-E[X])^2 dF_X(x). \quad (4)$$

Using the obvious relation $F_X(F_X^{-1}(p)) = p$, it is easy to see that the sum of the first two terms in formula (4) is equal to zero, which means that the formula is correct:

$$\rho_g^D[X] = \frac{1}{1-p}\int_{F_X^{-1}(p)}^{+\infty} (x-E[X])^2 dF_X(x).$$

Now we consider the second case.

B) We assume that $F_X^{-1}(p) > E[X]$, i.e. $VaR_p[X] > E[X]$.

In this case, obviously, the second integral in formula (2) is equal to zero, i.e.

$$2\int_{-\infty}^{E[X]} [g(\bar{F}_X(x))-1](x-E[X])dx = 0.$$

Therefore, according to formula (2), we have:

$$\rho_g^D[X] = 2\int_{E[X]}^{+\infty} g(\bar{F}_X(x))(x-E[X])dx =$$

$$= 2\int_{E[X]}^{F_X^{-1}(p)} (x-E[X])dx +$$

$$+2\int_{F_X^{-1}(p)}^{+\infty} \frac{1-F_X(x)}{1-p}(x-E[X])dx =$$

$$= (x-E[X])^2 |_{E[X]}^{F_X^{-1}(p)} +$$

$$+\frac{1}{1-p}\int_{F_X^{-1}(p)}^{+\infty} (1-F_X(x))d(x-E[X])^2.$$

Then, using integration by parts, we obtain:

$$\rho_g^D[X]=$$

$$=(F_X^{-1}(p)-E[X])^2+\frac{1}{1-p}(x-E[X])^2(1-F_X(x))\big|_{F_X^{-1}(p)}^{+\infty}+$$

$$+\frac{1}{1-p}\int_{F_X^{-1}(p)}^{+\infty}(x-E[X])^2dF_X(x).$$

Using condition A), we obtain:

$$\rho_g^D[X]=$$

$$=(F_X^{-1}(p)-E[X])^2-\frac{1}{1-p}(F_X^{-1}(p)-E[X])^2(1-F_X(F_X^{-1}(p)))+$$

$$+\frac{1}{1-p}\int_{F_X^{-1}(p)}^{+\infty}(x-E[X])^2dF_X(x).$$

Using the obvious relation $F_X(F_X^{-1}(p))=p$, it is easy to see that the sum of the first two terms in formula (4) is equal to zero, which means that the formula is valid:

$$\rho_g^D[X]=\frac{1}{1-p}\int_{F_X^{-1}(p)}^{+\infty}(x-E[X])^2dF_X(x). \tag{5}$$

Thus, we have proved that in all cases this measure of the risk of variance distortion is represented by formula (5).

This formula can be written in the following form:

$$\rho_g^D[X]=\frac{1}{1-p}\int_{VaR_p[X]}^{+\infty}(x-E[X])^2dF_X(x). \tag{6}$$

Remembering the variance formula:

$$D[X]=E[(X-E[X])^2]=\int_{-\infty}^{+\infty}(x-E[X])^2dF_X(x)$$

and comparing it with formula (6), and also, considering that, $P\{X>VaR_p[X]\}=1-p$, we obtain the following representation for this risk measure:

$$\rho_g^D[X]=E[(X-E[X])^2\,|\,X>VaR_p[X]], \tag{7}$$

where E[Y|A] denotes the conditional expected value of the random variable Y, subject to the implementation of the random event A.

Or, if you define the conditional variance, provided $X>VaR_p[X]$ by the expression:

$$D[X\,|\,X>VaR_p[X]]=E[(X-E[X])^2\,|\,X>VaR_p[X]],$$

we obtain the following representation for this variance distortion risk measure:

$$\rho_g^D[X]=D[X\,|\,X>VaR_p[X]]. \tag{8}$$

Thus, we have proved the following statement.
Statement 2

the variance distortion risk measure corresponding to the distortion function

$$g(x)=\min\{\frac{x}{1-p},1\},\ p\in[0,1],\ \text{is the risk measure}$$

$$\rho_g^D[X]=\frac{1}{1-p}\int_{VaR_p[X]}^{+\infty}(x-E[X])^2dF_X(x)\,;$$

b) this risk measure can also be represented as

$$\rho_g^D[X]=D[X\,|\,X>VaR_p[X]],$$

where

$$D[X\,|\,X>VaR_p[X]]=E[(X-E[X])^2\,|\,X>VaR_p[X]].$$

That is, this measure of the risk of losses represents the conditional variance of the random factor X, which represents a risk, provided that the value of these losses exceeded the value $VaR_p[X]$.

As known, the *ES* risk measure, in the case of the continuity of the distribution function of the random variable *X*, can also be represented in two ways:

$$ES_p[X]=\frac{1}{1-p}\int_p^1VaR_q[X]dq \tag{9}$$

and

$$ES_p[X]=E[X\,|\,X>VaR_p[X]]. \tag{10}$$

Comparing formula (10) and the presentation of our new risk measure for variance distortion $\rho_g^D[X]$ in section b) *Statement 2*, we see that in the class of risk measures for variance distortion, the new risk measure $\rho_g^D[X]$ the same significance as the measure $ES_p[X]$ in the class of expectation distortion risk measures.

Hence, we can conclude that the significance of this measure for the theory and practice of risk

management can be no less than the significance of the *ES* risk measure.

And yet, looking at formula (9), we would like to have a formula for our variance distortion risk measure $\rho_g^D[X]$ in a form similar to formula (9) for the *ES* risk measure.

The following proposition can be proved.

Statement 3

The variance distortion risk measure $\rho_g^D[X]$, corresponding to the distortion function

$$g(x) = \min\{\frac{x}{1-p}, 1\}, \ p \in [0,1], \text{ can be represented as:}$$

$$\rho_g[X] = \frac{1}{1-p} \int_p^1 (VaR_q^{rel}[X])^2 dq, \qquad (11)$$

where

$VaR_q^{rel}[X] = VaR_q[X] - E[X]$, the value of the corresponding relative risk measure *Va* R.

Proof

According to formula (6), we have:

$$\rho_g^D[X] = \frac{1}{1-p} \int_{VaR_p[X]}^{+\infty} (x - E[X])^2 dF_X(x).$$

Let us change the variable in this integral: $x = F_X^{-1}(q) = VaR_q[X]$ aking into account the fact that for $q = 1$ the variable x takes on the value $+\infty$, and at $q = p$ the variable x takes on the value $VaR_p[X]$. Then we get:

$$\rho_g^D[X] = \frac{1}{1-p} \int_p^1 (VaR_q[X] - E[X])^2 dq =$$

$$= \frac{1}{1-p} \int_p^1 (VaR_q^{rel}[X])^2 dq.$$

The statement is proven.

Note that the value $\tilde{\rho}_g^D[X] = \sqrt{\rho_g^D[X]}$ can also serve as a measure of risk, and its dimension, in contrast to $\rho_g^D[X]$, coincides with the dimension of the random variable *X*.

It follows from *Statement 2* that this variance distortion risk measure is a new measure of catastrophic risks.

It is of interest to compare the risk estimates obtained using this measure and the risk measure

of variance distortion obtained in the previous consideration using the distortion function $g(x) = 1_{\{x > 1-p\}}, \ p \in (0,1)$.

The following proposition can be proved.

Proposition 1

The following inequality is valid:

$$\rho_g^D[X] \geq (VaR_p[X] - E[X])^2,$$

and hence

$$\tilde{\rho}_g^D[X] \geq |VaR_p[X] - E[X]| = |VaR_p^{rel}[X]|,$$

where through $VaR_p^{rel}[X]$ the relative value of *VaR* is denoted, i.e. the value of the maximum possible unfavorable deviation of a random variable *X* with a given probability *p*.

Proof

Formula (6) obviously implies the inequality

$$\rho_g^D[X] \geq \frac{(VaR_p[X] - E[X])^2}{1-p} \int_{VaR_p[X]}^{+\infty} dF_X(x).$$

But

$$\int_{VaR_p[X]}^{+\infty} dF_X(x) = F_X(+\infty) - F_X(F_X^{-1}(p)) = 1 - p.$$

Whence follows the validity of the required inequality:

$$\rho_g^D[X] \geq (VaR_p[X] - E[X])^2,$$

and hence

$$\tilde{\rho}_g^D[X] \geq |VaR_p[X] - E[X]| = |VaR_p^{rel}[X]|.$$

The proposition is proven.

The meaning of this proposition is that this variance distortion risk measure always gives risk estimates that exceed (or equal) the risk estimates obtained using the first proposed measure of the risk of variance distortion corresponding to the distortion function

$$g(x) = 1_{\{x > 1-p\}}, \ p \in (0,1).$$

COMPOSITE METHOD OF CREATING NEW DISTORTION FUNCTIONS AND VARIANCE DISTORTION RISK MEASURES

The distortion functions can be viewed as a starting point for constructing a family of distortion risk measures. Thus, the construction and selection of distortion functions play an important role in the development of different families of risk measures with different properties. C. Yin, D. Zhu [12] consider three methods: the composite method, mixing methods and copula, which allow constructing new classes of functions and distortion risk measures using the available distortion functions and measures.

In this paper, we will discuss and develop only the first of them — the composite method and apply it to obtain new variance distortion risk measures.

The composite method uses a composition of distortion functions to construct new distortion functions.

Suppose that $h_1, h_2, \ldots$ are distortion functions, we define $f_1(x) = h_1(x)$ and complex functions $f_n(x) = f_{n-1}(h_n(x))$, $n = 1, 2, \ldots$ It is easy to check that $f_n(x)$, $n = 1, 2, \ldots$ are also distortion functions. If $h_1, h_2, \ldots$ the concave distortion functions, then each $f_n(x)$ is concave and they satisfy the conditions:

$$f_1 \le f_2 \le f_3 \le \ldots$$

We will now construct the distortion functions using the composite method, in the form of a superposition of the known distortion functions, which led to the construction of interesting expectation distortion risk measures. We hope that when applied to the construction of variance distortion risk measures, it will be possible to construct new risk measures with interesting properties.

Examples of variance distortion risk measures obtained using the composite method

Example 1. Let us consider a convex distortion function $g(x) = \dfrac{e^x - 1}{e - 1}$ and a distortion function obtained as the following superposition of distortion functions:

$$h(x) = 1_{\{x > 1 - p\}}(g(x)).$$

It is obvious that

$$h(x) = 1_{\{g(x) > 1 - p\}}(x) = 1_{\{x > \ln(1 + (e-1)(1-p))\}}(x) =$$

$$= 1_{\{x > 1 - (1 - \ln(1 + (e-1)(1-p)))\}}(x).$$

Then, using *Statement 1*, the last expression yields a formula for the variance distortion risk measure corresponding to a given distortion function $h(x)$:

$$\rho_h^D[X] = (VaR_{1 - \ln(1 + (e-1)(1-p))}[X] - E[X])^2 =$$

$$= (VaR_{1 - \ln(1 + (e-1)(1-p))}^{rel}[X])^2,$$

where through $VaR_{1 - \ln(1 + (e-1)(1-p))}^{rel}[X]$ the corresponding measure of the relative value *VaR* is denoted. $p = 0.95$ we obtain $\rho_h^D[X] = (VaR_{0.032}^{rel}[X])^2$.

Example 2. Let us consider a concave distortion function $g(x) = \sin \dfrac{\pi}{2} x$ and and a distortion function obtained as the following superposition of distortion functions:

$$h(x) = 1_{\{x > 1 - p\}}(g(x)).$$

It is obvious that

$$h(x) = 1_{\{g(x) > 1 - p\}}(x) = 1_{\{x > \frac{2}{\pi} \arcsin(1 - p)\}}(x) =$$

$$= 1_{\{x > 1 - (1 - \frac{2}{\pi} \arcsin(1 - p))\}}(x).$$

Then, using *Statement 1*, the last expression yields a formula for the risk measure of variance distortion corresponding to a given distortion function $h(x)$:

$$\rho_h^D[X] = (VaR_{1 - \frac{2}{\pi} \arcsin(1 - p)}[X] - E[X])^2 =$$

$$= (VaR_{1 - \frac{2}{\pi} \arcsin(1 - p)}^{rel}[X])^2,$$

where through $VaR_{1 - \frac{2}{\pi} \arcsin(1 - p)}^{rel}[X]$ the corresponding measure of the relative value *VaR* is denoted.

For $p = 0.95$ we obtain $\rho_h^D[X] = (VaR_{0.9682}^{rel}[X])^2$.

Example 3. Let us consider a concave distortion function $g(x) = \dfrac{\ln(x + 1)}{\ln 2}$ and a distortion function obtained as the following superposition of distortion functions:

$$h(x) = 1_{\{x > 1 - p\}}(g(x)).$$

It is obvious that

$$h(x) = 1_{\{g(x) > 1 - p\}}(x) = 1_{\{x > 2^{1-p} - 1\}}(x) = 1_{\{x > 1 - (2 - 2^{1-p})\}}(x).$$

Then, using *Statement 1*, the last expression yields a formula for the risk measure of variance distortion corresponding to a given distortion function $h(x)$:

$$\rho_h^D[X] = (VaR_{2-2^{1-p}}[X] - E[X])^2 = (VaR_{2-2^{1-p}}^{rel}[X])^2,$$

where through $VaR_{2-2^{1-p}}^{rel}[X]$ the corresponding measure of the relative value VaR is denoted.

For $p = 0.95$ we obtain $\rho_h^D[X] = (VaR_{0.97}^{rel}[X])^2$.

Example 4. Let us consider a concave distortion function $g(x) = x^\alpha, 0 < \alpha < 1$ and a distortion function obtained as the following superposition of distortion functions:

$$h(x) = 1_{\{x>1-p\}}(g(x)).$$

It is obvious that

$$h(x) = 1_{\{g(x)>1-p\}}(x) = 1_{\{x>(1-p)^{\frac{1}{\alpha}}\}}(x) =$$
$$= 1_{\{x>1-(1-(1-p)^{\frac{1}{\alpha}})\}}(x).$$

Then, using *Statement 1*, the last expression yields a formula for the risk measure of variance distortion corresponding to a given distortion function $h(x)$:

$$\rho_h^D[X] = (VaR_{1-(1-p)^{\frac{1}{\alpha}}}[X] - E[X])^2 =$$
$$= (VaR_{1-(1-p)^{\frac{1}{\alpha}}}^{rel}[X])^2,$$

where through $VaR_{1-(1-p)^{\frac{1}{\alpha}}}^{rel}[X]$ the corresponding measure of the relative value VaR is denoted.

For $\alpha = \dfrac{1}{2}$ and $p = 0.95$ we obtain $\rho_h^D[X] = (VaR_{0.9975}^{rel}[X])^2$.

Example 5. Let us consider a concave distortion function $g(x) = xe^{1-x}$ and a distortion function obtained as the following superposition of distortion functions:

$$h(x) = 1_{\{x>1-p\}}(g(x)).$$

It is obvious that

$$h(x) = 1_{\{g(x)>1-p\}}(x) = 1_{\{x>-W(-\frac{1-p}{e})\}}(x) =$$
$$= 1_{\{x>1-(1+W(-\frac{1-p}{e}))\}}(x),$$

where through $W(x)$ the well-known Lambert function is denoted (for the Lambert function and its

properties, see [19], an example of its application, see [16]).

Then, using *Statement 1*, the last expression yields the formula for the variance distortion function corresponding to the given distortion function $h(x)$:

$$\rho_h^D[X] = (VaR_{1+W(-\frac{1-p}{e})}[X] - E[X])^2 =$$
$$= (VaR_{1+W(-\frac{1-p}{e})}^{rel}[X])^2,$$

where through $VaR_{1-W(-\frac{1-p}{e})}^{rel}[X]$ the corresponding measure of the relative value VaR is denoted (see [16]). For $p = 0.95$ we obtain $\rho_h^D[X] = (VaR_{0.9813}^{rel}[X])^2$.

Variance distortion risk measure obtained by superposition of distortion functions:

$$1_{\{x>1-p\}}(x), g(x) = \min\{\frac{x}{1-p}, 1\},$$
$$g_\alpha(x) = \min\{\frac{x}{1-\alpha p}, 1\}, p \in [0,1] \text{ and } g_n(x) = x^{\frac{1}{n}}.$$

Let us first study the variance distortion risk measures, which can be obtained using the distortion function $h(x)$, obtained using the following superpositions:

$$h(x) = 1_{\{x>1-p\}}(\underbrace{g(g(...(g(x))}_{n-1-\text{раз}}) = 1_{\{x>1-p\}}(g_n(x)).$$

This concave distortion function is represented as:

$$h(x) = \begin{cases} 1, \text{если } x > (1-p)^n \\ 0, \text{если } 0 \le x \le (1-p)^n \end{cases} = 1_{\{x>(1-p)^n\}}(x).$$

As it was shown in [16], this distortion function, in the class of expectation distortion risk measure, corresponds to the risk measure "*ES* to the power of n", $\rho_h[X] = ES_p^{(n)}[X]$, where n — any natural number.

Let us consider a variance distortion risk measure, which corresponds to a distortion function of a given type.

According to formula (2), we have:

$$\rho_g^D[X] = 2 \int_{E[X]}^{+\infty} 1_{\{\bar{F}_X(x)>(1-p)^n\}}(x - E[X])dx +$$
$$+ 2 \int_{-\infty}^{E[X]} [1_{\{\bar{F}_X(x)>(1-p)^n\}} - 1](x - E[X])dx =$$

$$= 2 \int\limits_{E[X]}^{+\infty} 1_{\{F_X(x)\le 1-(1-p)^n\}}(x - E[X])dx +$$

$$+ 2 \int\limits_{-\infty}^{E[X]} [1_{\{F_X(x)\le 1-(1-p)^n\}} - 1](x - E[X])dx .$$

Denoting by the F_X^{-1} function, nverse to the distribution function F_X, we obtain:

$$\rho_g^D[X] = 2 \int\limits_{E[X]}^{+\infty} 1_{\{x\le F_X^{-1}(1-(1-p)^n)\}}(x - E[X])dx +$$

$$+ 2 \int\limits_{-\infty}^{E[X]} [1_{\{x\le F_X^{-1}(1-(1-p)^n)\}} - 1](x - E[X])dx . \quad (12)$$

In the further derivation of the formula for $\rho_g^D[X]$ we will have to consider two cases.

A) Suppose that, $F_X^{-1}(1-(1-p)^n) < E[X]$, i.e. $VaR_p^{(n)}[X] < E[X]$.

In this case, it is obvious that the first integral in formula (12) is equal to zero. And we obtain:

$$\rho_g^D[X] = 2 \int\limits_{-\infty}^{E[X]} [1_{\{x\le F_X^{-1}(1-(1-p)^n)\}} - 1](x - E[X])dx =$$

$$= -(x - E[X])^2 \Big|_{F_X^{-1}(1-(1-p)^n)=VaR_p^{(n)}[X]}^{E[X]} =$$

$$= (VaR_p^{(n)}[X] - E[X])^2 .$$

Let us now consider the second case.

B) Suppose that, $F_X^{-1}(1-(1-p)^n) \ge E[X]$, т.е. $VaR_p^{(n)}[X] \ge E[X]$.

In this case, it is obvious that the second integral in formula (12) is equal to zero. And we obtain:

$$\rho_g^D[X] = 2 \int\limits_{E[X]}^{+\infty} 1_{\{x\le F_X^{-1}(1-(1-p)^n)\}}(x - E[X])dx =$$

$$= 2 \int\limits_{E[X]}^{F_X^{-1}(1-(1-p)^n)} (x - E[X])dx =$$

$$= (x - E[X])^2 \Big|_{E[X]}^{F_X^{-1}(1-(1-p)^n)=VaR_p^{(n)}[X]} =$$

$$= (VaR_p^{(n)}[X] - E[X])^2 .$$

Thus, we have proved the following statement.

Statement 4

The variance distortion risk measure corresponding to the distortion function

$$h(x) = 1_{\{x>1-p\}} \underbrace{(g(g(...(g(x)))}_{n-1-\text{times}} = 1_{\{x>1-p\}}(g_n(x)),$$

$p \in (0,1)$, is the risk measure

$$\rho_g^D[X] = (VaR_p^{(n)}[X] - E[X])^2 .$$

Note that the value $\tilde{\rho}_g^D[X] = \sqrt{\rho_g^D[X]}$ can also serve as a measure of risk, and its dimension, in contrast to $\rho_g^D[X]$, coincides with the dimension of the random variable X.

And, obviously,

$$\tilde{\rho}_g^D[X] = |VaR_p^{(n)}[X] - E[X]| = |VaR_p^{(n)rel}[X]|,$$

where through $VaR_p^{(n)rel}[X]$ the relative value of "*VaR* to the power of *n*" is denoted, i.e. the deviation of the risk measure $VaR_p^{(n)}[X]$ of the random variable *X* from the expected value *X*.

Now let us study the risk measures of variance distortion, which can be obtained using the distortion function $h(x)$, obtained using the following superpositions:

$$h(x) = 1_{\{x>1-p\}} \underbrace{(g(g(...g(g_\alpha(x)...)}_{k-1-\text{раз}} = 1_{\{x>1-p\}}(g_{k-1}(g_\alpha(x)))$$

This concave distortion function is represented as:

$$h(x) = \begin{cases} 1, & \text{if } x > (1-p)^k(1-\alpha p) \\ 0, & \text{if } 0 \le x \le (1-p)^k(1-\alpha p) \end{cases} =$$
$$= 1_{\{x>(1-p)^k(1-\alpha p)\}}(x).$$

As shown in [16], this distortion function, in the class of expectation distortion risk measures, corresponds to the risk measure "*VaR* to the power of *t*", $\rho_h[X] = VaR_p^{(t)}[X]$ (see also [15]), where *t* — any real number represented in the following form: $t = k + \alpha$, where *k* — a natural number, and α — a real number, and $0 \le \alpha < 1$.

Let us consider a measure of the risk of variance distortion, which corresponds to a distortion function of a given type.

According to formula (2), we have:

$$\rho_g^D[X] = 2 \int\limits_{E[X]}^{+\infty} 1_{\{\bar{F}_X(x)>(1-p)^k(1-\alpha p)\}}(x - E[X])dx +$$

$$+2 \int_{-\infty}^{E[X]} [1_{\{\bar{F}_X(x)>(1-p)^k(1-\alpha p)\}} - 1](x - E[X])dx =$$

$$= 2 \int_{E[X]}^{+\infty} 1_{\{F_X(x)\leq 1-(1-p)^k(1-\alpha p)\}}(x - E[X])dx +$$

$$+2 \int_{-\infty}^{E[X]} [1_{\{F_X(x)\leq 1-(1-p)^k(1-\alpha p)\}} - 1](x - E[X])dx.$$

Denoting by the F_X^{-1} function, inverse to the distribution function F_X, we get:

$$\rho_g^D[X] = 2 \int_{E[X]}^{+\infty} 1_{\{x\leq F_X^{-1}(1-(1-p)^k(1-\alpha p))\}}(x - E[X])dx +$$

$$+2 \int_{-\infty}^{E[X]} [1_{\{x\leq F_X^{-1}(1-(1-p)^k(1-\alpha p))\}} - 1](x - E[X])dx. \quad (13)$$

In the further derivation of the formula for $\rho_g^D[X]$ we will have to consider two cases.

A) Suppose that

$$F_X^{-1}(1-(1-p)^k(1-\alpha p)) < E[X],$$

i.e. $VaR_p^{(t)}[X] < E[X]$.

In this case, it is obvious that the first integral in formula (13) is equal to zero. And we obtain:

$$\rho_g^D[X] = 2 \int_{-\infty}^{E[X]} [1_{\{x\leq F_X^{-1}(1-(1-p)^k(1-\alpha p))\}} - 1](x - E[X])dx =$$

$$= -2 \int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{E[X]} (x - E[X])dx =$$

$$= -(x - E[X])^2 |_{F_X^{-1}(1-(1-p)^k(1-\alpha p))=VaR_p^{(t)}[X]}^{E[X]} =$$

$$= (VaR_p^{(t)}[X] - E[X])^2.$$

Let us now consider the second case.
B) Suppose that

$$F_X^{-1}(1-(1-p)^k(1-\alpha p)) \geq E[X],$$

i.e. $VaR_p^{(t)}[X] \geq E[X]$.

In this case, it is obvious that the second integral in formula (13) is equal to zero. And we obtain:

$$\rho_g^D[X] = 2 \int_{E[X]}^{+\infty} 1_{\{x\leq F_X^{-1}(1-(1-p)^k(1-\alpha p))\}}(x - E[X])dx =$$

$$= 2 \int_{E[X]}^{F_X^{-1}(1-(1-p)^k(1-\alpha p))} (x - E[X])dx =$$

$$= (x - E[X])^2 |_{E[X]}^{F_X^{-1}(1-(1-p)^k(1-\alpha p))=VaR_p^{(t)}[X]} =$$

$$= (VaR_p^{(t)}[X] - E[X])^2.$$

Thus, we have proved the following statement.
Statement 5
The risk measure of the variance distortion corresponding to the distortion function

$$h(x) = 1_{\{x>1-p\}}(\underbrace{g(g(...(g(g_\alpha(x)))}_{k-1-\text{times}} = 1_{\{x>1-p\}}(g_{k-1}(g_\alpha(x)),$$

$p \in (0,1)$, is the risk measure

$$\rho_g^D[X] = (VaR_p^{(t)}[X] - E[X])^2,$$

for any real number t, represented in the following form: $t = k + \alpha$, where k — a natural number, and α — a real number, and $0 \leq \alpha < 1$.
Note that the value $\tilde{\rho}_g^D[X] = \sqrt{\rho_g^D[X]}$ can also serve as a measure of risk, and its dimension, in contrast to $\rho_g^D[X]$, coincides with the dimension of the random variable X.

It is obvious that

$$\tilde{\rho}_g^D[X] = |VaR_p^{(t)}[X] - E[X]| = |VaR_p^{(t)rel}[X]|,$$

where through $VaR_p^{(t)rel}[X]$ the relative value "VaR to the power of t" is denoted, i.e. the deviation of the risk measure $VaR_p^{(t)}[X]$ of the random variable X from the expected value X.

Now let us study the variance distortion risk measure, which can be obtained using the distortion function $h(x)$, obtained using the following superpositions:

$$h(x) = 1_{\{x>1-p\}}(\underbrace{g(g(...g(x)...)}_{n-\text{times}}$$

This concave distortion function is represented as:

$$h(x) = \begin{cases} 1, if\ x > (1-p)^n \\ \dfrac{x}{(1-p)^n}, if\ 0 \leq x \leq (1-p)^n \end{cases}$$

As shown in [16], this distortion function, in the class of expectation distortion risk measures, corresponds to the risk measure "*VaR* to the power of *n*", $\rho_h[X] = VaR_p^{(n)}[X]$ (see also [16]), where n — any natural number.

Let us consider a variance distortion risk measure, which corresponds to a distortion function of a given type.

We note that

$$h(\bar{F}(x)) = \begin{cases} 1, & \text{if } \bar{F}_X(x) > (1-p)^n \\ \dfrac{\bar{F}_X(x)}{(1-p)^n}, & \text{if } 0 \le \bar{F}_X(x) \le (1-p)^n, \end{cases}$$

or

$$h(\bar{F}_X(x)) = \begin{cases} 1, & \text{if } F_X(x) \le 1-(1-p)^n \\ \dfrac{1-F_X(x)}{(1-p)^n}, & \text{if } F_X(x) > 1-(1-p)^n, \end{cases}$$

which means

$$h(\bar{F}_X(x)) = \begin{cases} 1, & \text{if } x \le F_X^{-1}(1-(1-p)^n) \\ \dfrac{1-F_X(x)}{(1-p)^n}, & \text{if } x > F_X^{-1}(1-(1-p)^n). \end{cases}$$

In the further derivation of the formula for $\rho_g^D[X]$ we will have to consider two cases.

A) Suppose that, $F_X^{-1}(1-(1-p)^n) < E[X]$, i.e. $VaR_p^{(n)}[X] < E[X]$.

Then, according to (2), we obtain:

$$\rho_g^D[X] = 2\int_{E[X]}^{+\infty} \frac{1-F_X(x)}{(1-p)^n}(x-E[X])dx +$$

$$+ 2\int_{F_X^{-1}(1-(1-p)^n)}^{E[X]} \left[\frac{1-F_X(x)}{(1-p)^n} - 1\right](x-E[X])dx =$$

$$= 2\int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} \frac{1-F_X(x)}{(1-p)^n}(x-E[X])dx -$$

$$- 2\int_{F_X^{-1}(1-(1-p)^n)}^{E[X]} (x-E[X])dx =$$

$$= \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (1-F_X(x))d(x-E[X])^2 -$$

$$- (x-E[X])^2 \Big|_{F_X^{-1}(1-(1-p)^n)}^{E[X]}.$$

By applying integration by parts in this expression, we obtain:

$$\rho_g^D[X] = \frac{1}{(1-p)^n}(x-E[X])^2(1-F_X(x))\Big|_{F_X^{-1}(1-(1-p)^n)}^{+\infty} +$$

$$+ \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (x-E[X])^2 dF_X(x) +$$

$$+ (F_X^{-1}(1-(1-p)^n) - E[X])^2.$$

Then, using assumption A) about the distribution function, we obtain:

$$\rho_g^D[X] =$$

$$= -\frac{1}{(1-p)^n}(F_X^{-1}(1-(1-p)^n) - E[X])^2(1-F_X(F_X^{-1}(1-(1-p)^n))) +$$

$$+ (F_X^{-1}(1-(1-p)^n) - E[X])^2 +$$

$$+ \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (x-E[X])^2 dF_X(x).$$

Then using that

$$F_X(F_X^{-1}(1-(1-p)^n))) = 1-(1-p)^n, \text{ we obtain}$$

$$\rho_g^D[X] = \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (x-E[X])^2 dF_X(x) =$$

$$= \frac{1}{(1-p)^n} \int_{VaR_p^{(n)}[X]}^{+\infty} (x-E[X])^2 dF_X(x).$$

Let us now consider the second case.

B) Suppose that, $F_X^{-1}(1-(1-p)^n) \ge E[X]$, т.е. $VaR_p^{(n)}[X] \ge E[X]$.

In this case, it is obvious that the second integral in formula (2) is equal to zero. And we obtain:

$$\rho_g^D[X] = 2\int_{E[X]}^{+\infty} h(\bar{F}_X(x))(x-E[X])dx =$$

$$= 2\int_{E[X]}^{F_X^{-1}(1-(1-p)^n)} (x-E[X])dx +$$

$$+ 2\int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} \frac{1-F_X(x)}{(1-p)^n}(x-E[X])dx =$$

$$(x-E[X])^2 \Big|_{E[X]}^{F_X^{-1}(1-(1-p)^n)=VaR_p^{(n)}[X]} +$$

$$+ \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (1-F_X(x))d(x-E[X])^2.$$

By integrating the integral in this expression by parts, we get:

$$\rho_g^D[X] = (F_X^{-1}(1-(1-p)^n) - E[X])^2 +$$

$$+ \frac{1}{(1-p)^n}(x - E[X])^2(1 - F_X(x))\Big|_{F_X^{-1}(1-(1-p)^n)}^{+\infty} +$$

$$+ \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (x - E[X])^2 dF_X(x).$$

Then, using assumption A) about the distribution function, we get:

$$\rho_g^D[X] = (F_X^{-1}(1-(1-p)^n) - E[X])^2 -$$

$$- \frac{1}{(1-p)^n}(F_X^{-1}(1-(1-p)^n) - E[X])^2(1 - F_X(F_X^{-1}(1-(1-p)^n))) +$$

$$+ \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (x - E[X])^2 dF_X(x).$$

Then using that

$$F_X(F_X^{-1}(1-(1-p)^n)) = 1 - (1-p)^n, \text{ we obtain}$$

$$\rho_g^D[X] = \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (x - E[X])^2 dF_X(x) =$$

$$= \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (x - E[X])^2 dF_X(x). \quad (14)$$

Remembering the variance formula:

$$D[X] = E[(X - E[X])^2] = \int_{-\infty}^{+\infty} (x - E[X])^2 dF_X(x)$$

and comparing it with formula (14), and also taking into account that $P\{X > VaR_p^{(n)}[X]\} = (1-p)^n$, we obtain the following representation for this risk measure:

$$\rho_g^D[X] = E[(X - E[X])^2 \mid X > VaR_p^{(n)}[X]], \quad (15)$$

Or, if you define the conditional variance, provided $X > VaR_p^{(n)}[X]$ by the expression:

$$D[X \mid X > VaR_p^{(n)}[X]] = E[(X - E[X])^2 \mid X > VaR_p^{(n)}[X]],$$

we obtain the following representation for this variance distortion risk measures:

$$\rho_g^D[X] = D[X \mid X > VaR_p^{(n)}[X]]. \quad (16)$$

Thus, we have proved the following statement.

Statement 6

the variance distortion risk measure corresponding to the distortion function $h(x) = \underbrace{g(g(...(g(x)))}_{n-\text{раз}}, p \in (0,1)$, is the risk measure

$$\rho_g^D[X] = \frac{1}{(1-p)^n} \int_{F_X^{-1}(1-(1-p)^n)}^{+\infty} (x - E[X])^2 dF_X(x);$$

this risk measure can also be represented as

$$\rho_g^D[X] = D[X \mid X > VaR_p^{(n)}[X]],$$

where

$$D[X \mid X > VaR_p^{(n)}[X]] = E[(X - E[X])^2 \mid X > VaR_p^{(n)}[X]].$$

That is, this risk measure of losses represents the conditional variance of the random factor X, which represents a risk, provided that the value of these losses exceeded the value $VaR_p^{(n)}[X]$.

In [16] the risk measure "*ES* to the power of *n*" was introduced, which turned out (see [16]) to be an expectation distortion risk measure, which we will denote as $ES_p^{(n)}[X]$. It represents the magnitude of the expected tail losses exceeding $VaR_p^{(n)}[X]$, i.e. by definition

$$ES_p^{(n)}[X] = E[X \mid X > VaR_p^{(n)}[X]]. \quad (17)$$

Hence, assuming the continuity of the distribution of losses, the following useful representation was obtained for $ES_p^{(n)}[X]$:

$$ES_p^{(n)}[X] = \frac{1}{(1-p)^n} \int_{[1-(1-p)^n,1]} VaR_q[X]dq. \quad (18)$$

Comparing formula (17) and the presentation of our new risk measure for variance distortion $\rho_g^D[X]$ in section b) *Statement 6*, we see that in the class of risk measures for variance distortion, the new risk measure $\rho_g^D[X]$ has the same significance as the measure $ES_p^{(n)}[X]$ as the measure in the class of expectation distortion risk measures.

Hence, we can conclude that the significance of this measure for the theory and practice of risk management is not less than the significance of risk measures $ES_p^{(n)}[X]$.

Also, looking at formula (18), I would like to have a formula for our variance distortion risk measure $\rho_g^D[X]$ in a form similar to formula (17) for the risk measure *ES*.

The following proposition can be proved.

Statement 7

The variance distortion risk measure $\rho_g^D[X]$, corresponding to the distortion function

$$h(x) = 1_{\{x > 1-p\}}(\underbrace{g(g(...g(x)...)}_{n-\text{раз}},$$

where $g(x) = \min\{\frac{x}{1-p}, 1\}$, $p \in [0,1]$, can be represented as:

$$\rho_g[X] = \frac{1}{(1-p)^n} \int_{[1-(1-p)^n,1]} VaR_q^{(n)rel}[X]dq, \quad (19)$$

where

$VaR_q^{(n)rel}[X] = VaR_q^{(n)}[X] - E[X]$, the value of the corresponding relative risk measure $VaR_q^{(n)}[X]$.

Proof

According to formula (6), we have:

$$\rho_g^D[X] = \frac{1}{(1-p)^n} \int_{VaR_p^{(n)}[X]}^{+\infty} (x - E[X])^2 dF_X(x).$$

Let us change the variable in this integral: $x = F_X^{-1}(1-(1-q)^n) = VaR_q^{(n)}[X]$ taking into account the fact that for $q = 1$ the variable x takes on the value $+\infty$, and for $q = p$ the variable x takes on the value

$VaR_p^{(n)}[X]$. Than we obtain:

$$\rho_g^D[X] = \frac{1}{(1-p)^n} \int_{1-(1-p)^n}^{1} (VaR_q^{(n)}[X] - E[X])^2 dq =$$

$$= \frac{1}{(1-p)^n} \int_{[1-(1-p)^n,1]} VaR_q^{(n)rel}[X] dq.$$

The statement is proven.

Note that the value $\tilde{\rho}_g^D[X] = \sqrt{\rho_g^D[X]}$ can also serve as a measure of risk, and its dimension, in contrast to $\rho_g^D[X]$, coincides with the dimension of the random variable X.

It follows from *Statement 6* that this variance distortion risk measure represents a new measure of catastrophic risks.

It is of interest to compare the risk estimates obtained using this measure and the variance distortion risk measure obtained in the previous consideration using the distortion functions of the form $h(x) = 1_{\{x>1-p\}}(\underbrace{g(g(...g(x)...)}_{n-1-\text{times}} = 1_{\{x>1-p\}}(g_n(x)).$

The following proposition can be proved.

Proposition 2

The following inequality is valid:

$$\rho_g^D[X] \geq (VaR_p^{(n)}[X] - E[X])^2,$$

and hence

$$\tilde{\rho}_g^D[X] \geq |VaR_p^{(n)}[X] - E[X]| = |VaR_p^{(n)rel}[X]|,$$

where through $VaR_p^{(n)rel}[X]$ a relative value

$VaR_p^{(n)}[X]$, is denoted, i.e. the value of the deviation of the risk measure $VaR_p^{(n)}[X]$ of the random variable X from its expected value.

Proof

Formula (13) obviously implies the inequality

$$\rho_g^D[X] \geq \frac{(VaR_p^{(n)}[X] - E[X])^2}{(1-p)^n} \int_{VaR_p^{(n)}[X]}^{+\infty} dF_X(x).$$

But

$$\int_{VaR_p^{(n)}[X]}^{+\infty} dF_X(x) = F_X(+\infty) - F_X(F_X^{-1}(1-(1-p)^n)) = (1-p)^n.$$

Whence follows the validity of the required inequality:

$$\rho_g^D[X] \geq (VaR_p^{(n)}[X] - E[X])^2,$$

and hence

$$\tilde{\rho}_g^D[X] \geq |VaR_p^{(n)}[X] - E[X]| = |VaR_p^{(n)rel}[X]|.$$

The proposition is proven.

The meaning of this proposition is that this variance distortion risk measure always gives risk estimates that exceed (or equal) the risk estimates obtained using the first proposed variance distortion risk measure corresponding to the distortion function

$$h(x) = 1_{\{x>1-p\}}(\underbrace{g(g(...g(x)...)}_{n-1-\text{times}} = 1_{\{x>1-p\}}(g_n(x))$$

$$p \in (0,1).$$

Now let us study the variance distortion risk measure, which can be obtained using the distortion function $h(x)$, obtained in the form of any superposition of functions $g(x) = \min\{\frac{x}{1-p},1\}$ and a function

$g_\alpha(x) = \min\{\frac{x}{1-\alpha p},1\}$ of the following form:

$$h(x) = \underbrace{g(g(...(g(g_\alpha(x))...)}_{k-\text{times}}. \text{ For any real } t \geq 1, \text{ rep-}$$

resented in the from where $t = k + \alpha$, where k — a natural number, and α — a real number, $0 < \alpha < 1$, in the class of the expectation distortion risk measure, this distortion function corresponds to theexpectation

distortion risk measure "*ES* to the power of *t*", i.e.
$ES_p^{(t)}[X] = \rho_h[X]$ (see [9]).

Let us examine the question: what functions
of the variance distortion correspond to the given
distortion functions *h*?

We note that

$$h(\overline{F}_X(x)) = \begin{cases} 1, if \ \overline{F}_X(x) > (1-p)^k(1-\alpha p) \\ \dfrac{\overline{F}_X(x)}{(1-p)^k(1-\alpha p)}, \\ if \ 0 \le \overline{F}_X(x) \le (1-p)^k(1-\alpha p), \end{cases}$$

or

$$h(\overline{F}_X(x)) = \begin{cases} 1, if \ F_X(x) \le 1-(1-p)^k(1-\alpha p) \\ \dfrac{1-F_X(x)}{(1-p)^k(1-\alpha p)}, \\ if \ F_X(x) > 1-(1-p)^k(1-\alpha p), \end{cases}$$

Which means

$$h(\overline{F}_X(x)) = \begin{cases} 1, if \ x \le F_X^{-1}(1-(1-p)^k(1-\alpha p)) \\ \dfrac{1-F_X(x)}{(1-p)^k(1-\alpha p)}, \\ if \ x > F_X^{-1}(1-(1-p)^k(1-\alpha p)), \end{cases}$$

In the further derivation of the formula for $\rho_g^D[X]$

we will have to consider two cases.

A) Suppose that

$$F_X^{-1}(1-(1-p)^k(1-\alpha p)) < E[X],$$

i.e. $VaR_p^{(t)}[X] < E[X]$.

Then, according to (2), we obtain:

$$\rho_g^D[X] = 2\int_{E[X]}^{+\infty} \frac{1-F_X(x)}{(1-p)^k(1-\alpha p)}(x-E[X])dx +$$

$$+ 2\int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{E[X]} [\frac{1-F_X(x)}{(1-p)^k(1-\alpha p)} - 1](x-E[X])dx =$$

$$= 2\int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty} \frac{1-F_X(x)}{(1-p)^k(1-\alpha p)}(x-E[X])dx -$$

$$-2\int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{E[X]} (x-E[X])dx =$$

$$= \frac{1}{(1-p)^k(1-\alpha p)}\int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty}(1-F_X(x))d(x-E[X])^2 -$$

$$-(x-E[X])^2 \ |_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{E[X]}.$$

By applying integration by parts in this expression,
we obtain:

$$\rho_g^D[X] =$$

$$= \frac{1}{(1-p)^k(1-\alpha p)}(x-E[X])^2(1-F_X(x))|_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty} +$$

$$+\frac{1}{(1-p)^k(1-\alpha p)}\int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty}(x-E[X])^2 dF_X(x)+$$

$$+(F_X^{-1}(1-(1-p)^k(1-\alpha p))-E[X])^2.$$

Then, using assumption A) about the distribution
function, we get:

$$\rho_g^D[X] =$$

$$= -\frac{1}{(1-p)^k(1-\alpha p)}(F_X^{-1}(1-(1-p)^k(1-\alpha p))-$$

$$-E[X])^2(1-F_X(F_X^{-1}(1-(1-p)^k(1-\alpha p))))+$$

$$+ (F_X^{-1}(1-(1-p)^k(1-\alpha p))-E[X])^2 +$$

$$+\frac{1}{(1-p)^k(1-\alpha p)}\int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty}(x-E[X])^2 dF_X(x).$$

And then, using that

$$F_X(F_X^{-1}(1-(1-p)^k(1-\alpha p)))) = 1-(1-p)^k(1-\alpha p),$$

we get

$$\rho_g^D[X] =$$

$$\frac{1}{(1-p)^k(1-\alpha p)}\int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty}(x-E[X])^2 dF_X(x) =$$

$$= \frac{1}{(1-p)^k(1-\alpha p)}\int_{VaR_p^{(t)}[X]}^{+\infty}(x-E[X])^2 dF_X(x).$$

Let us now consider the second case.
B) Suppose that

$$F_X^{-1}(1-(1-p)^k(1-\alpha p)) \ge E[X],$$

i.e. $VaR_p^{(t)}[X] \ge E[X]$.

In this case, it is obvious that the second integral in formula (2) is equal to zero. And we get:

$$\rho_g^D[X] = 2 \int_{E[X]}^{+\infty} h(\overline{F}_X(x))(x - E[X])dx =$$

$$= 2 \int_{E[X]}^{F_X^{-1}(1-(1-p)^k(1-\alpha p))} (x - E[X])dx +$$

$$+ 2 \int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty} \frac{1-F_X(x)}{(1-p)^k(1-\alpha p)}(x - E[X])dx =$$

$$= (x - E[X])^2 \Big|_{E[X]}^{F_X^{-1}(1-(1-p)^k(1-\alpha p))=VaR_p^{(t)}[X]} +$$

$$+ \frac{1}{(1-p)^k(1-\alpha p)} \int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty} (1-F_X(x))d(x - E[X])^2.$$

By integrating the integral in this expression by parts, we obtain:

$$\rho_g^D[X] = (F_X^{-1}(1-(1-p)^k(1-\alpha p)) - E[X])^2 +$$

$$+ \frac{1}{(1-p)^k(1-\alpha p)}(x - E[X])^2(1-F_X(x))\Big|_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty} +$$

$$+ \frac{1}{(1-p)^k(1-\alpha p)} \int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty} (x - E[X])^2 dF_X(x).$$

Then, using assumption A) about the distribution function, we get:

$$\rho_g^D[X] = (F_X^{-1}(1-(1-p)^k(1-\alpha p)) - E[X])^2 -$$

$$- \frac{1}{(1-p)^k(1-\alpha p)}(F_X^{-1}(1-(1-p)^k(1-\alpha p)) -$$

$$- E[X])^2(1-F_X(F_X^{-1}(1-(1-p)^k(1-\alpha p)))) +$$

$$+ \frac{1}{(1-p)^k(1-\alpha p)} \int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty} (x - E[X])^2 dF_X(x).$$

And then using, that

$$F_X(F_X^{-1}(1-(1-p)^k(1-\alpha p))) = 1-(1-p)^k(1-\alpha p),$$

we obtain

$$\rho_g^D[X] =$$

$$\frac{1}{(1-p)^k(1-\alpha p)} \int_{F_X^{-1}(1-(1-p)^k(1-\alpha p))}^{+\infty} (x - E[X])^2 dF_X(x).$$

T.e.

$$\rho_g^D[X] = \frac{1}{(1-p)^k(1-\alpha p)} \int_{VaR_p^{(t)}[X]}^{+\infty} (x - E[X])^2 dF_X(x). \quad (20)$$

Remembering the variance formula:

$$D[X] = E[(X - E[X])^2] = \int_{-\infty}^{+\infty} (x - E[X])^2 dF_X(x)$$

and comparing it with formula (20), and also considering that $P\{X > VaR_p^{(t)}[X]\} = (1-p)^k(1-\alpha p)$, we obtain the following representation for this risk measure:

$$\rho_g^D[X] = E[(X - E[X])^2 \mid X > VaR_p^{(t)}[X]], \quad (21)$$

Or, if you define the conditional variance, provided $X > VaR_p^{(t)}[X]$ by the expression:

$$D[X \mid X > VaR_p^{(t)}[X]] = E[(X - E[X])^2 \mid X > VaR_p^{(t)}[X]],$$

we obtain the following representation for this variance distortion risk measures:

$$\rho_g^D[X] = D[X \mid X > VaR_p^{(t)}[X]]. \quad (22)$$

Thus, we have proved the following statement.
Statement 8
the variance distortion risk measure corresponding to the distortion function

$$h(x) = \underbrace{g(g(...(g(g_\alpha(x))...)}_{k-\text{times}}, \text{ is the risk measure}$$

$$\rho_g^D[X] = \frac{1}{(1-p)^k(1-\alpha p)} \int_{VaR_p^{(t)}[X]}^{+\infty} (x - E[X])^2 dF_X(x).$$

this risk measure can also be represented as

$$\rho_g^D[X] = D[X \mid X > VaR_p^{(t)}[X]],$$

where

$$D[X \mid X > VaR_p^{(t)}[X]] = E[(X - E[X])^2 \mid X > VaR_p^{(t)}[X]].$$

That is, this risk measure of losses represents the conditional variance of the random factor X, which represents a risk, provided that the value of these losses exceeded the value $VaR_p^{(t)}[X]$.

In [16], the risk measure "*ES* to the power of t" was introduced, which turned out (see [16]) to be an expectation distortion risk measure, which we will denote as $ES_p^{(t)}[X]$. It represents the magnitude of the expected tail losses, exceeding $VaR_p^{(t)}[X]$, i.e. by definition

$$ES_p^{(t)}[X] = E[X \mid X > VaR_p^{(t)}[X]]. \qquad (23)$$

Hence, under the assumption of continuity of the distribution of losses, the following useful representation was obtained for $ES_p^{(n)}[X]$:

$$ES_p^{(t)}[X] = \frac{1}{(1-p)^k(1-\alpha p)} \int_{[1-(1-p)^k(1-\alpha p),1]} VaR_q[X]dq. \quad (24)$$

Comparing formula (23) and the presentation of our new variance distortion risk measure $\rho_g^D[X]$ in section b) of *Statement 8*, we see that in the class of variance distortion risk measures, the new risk measure $\rho_g^D[X]$ has the same significance as the measure $ES_p^{(t)}[X]$ in the class of expectation distortion risk measures.

Hence, we can conclude that the significance of this measure for the theory and practice of risk management is not less than the significance of risk measures $ES_p^{(t)}[X]$.

Looking at formula (24), I would like to have a formula for our variance distortion risk measure $\rho_g^D[X]$ in a form similar to formula (23) for the risk measure *ES*.

The following proposition can be proved.

Statement 9

The variance distortion risk measure $\rho_g^D[X]$, corresponding to the distortion function

$$h(x) = \underbrace{g(g(...(g(g_\alpha(x))...)}_{k-\text{times}}, \text{ can be represented as:}$$

$$\rho_g[X] = \frac{1}{(1-p)^k(1-\alpha p)} \int_{[1-(1-p)^k(1-\alpha p),1]} VaR_q^{(t)rel}[X]dq, (25)$$

where

$VaR_q^{(t)rel}[X] = VaR_q^{(t)}[X] - E[X]$, the value of the corresponding relative risk measure $VaR_q^{(t)}[X]$.

Proof

According to formula (20), we have:

$$\rho_g^D[X] = \frac{1}{(1-p)^k(1-\alpha p)} \int_{VaR_p^{(t)}[X]} (x - E[X])^2 dF_X(x).$$

Let us change the variable in this integral: $x = F_X^{-1}(1-(1-q)^k(1-\alpha q)) = VaR_q^{(t)}[X]$ taking into account the fact that for $q = 1$ the variable x takes on the value $+\infty$, and for $q = p$ the variable x takes on the value $VaR_p^{(t)}[X]$. Then we obtain:

$$\rho_g^D[X] =$$

$$\frac{1}{(1-p)^k(1-\alpha p)} \int_{1-(1-p)^k(1-\alpha p)}^{1} (VaR_q^{(t)}[X] - E[X])^2 dq =$$

$$= \frac{1}{(1-p)^k(1-\alpha p)} \int_{[1-(1-p)^k(1-\alpha p),1]} VaR_q^{(t)rel}[X]dq.$$

The statement is proven.

Note that the value $\tilde{\rho}_g^D[X] = \sqrt{\rho_g^D[X]}$ can also serve as a measure of risk, and its dimension, in contrast to $\rho_g^D[X]$, coincides with the dimension of the random variable X.

It follows from *Statement 8* that this variance distortion risk measure represents a new measure of catastrophic risks.

It is of interest to compare the risk estimates obtained using this measure and the risk measure of variance distortion obtained in the previous consideration using the distortion functions of the form $h(x) = 1_{\{x>1-p\}}(\underbrace{g(g(...g}_{k-1-\text{times}}(g_\alpha(x)...) = 1_{\{x>1-p\}}(g_{k-1}(g_\alpha(x))).$

The following proposition can be proved.

Proposition 3

The following inequality is valid:

$$\rho_g^D[X] \geq (VaR_p^{(t)}[X] - E[X])^2,$$

and hence

$$\tilde{\rho}_g^D[X] \geq |VaR_p^{(t)}[X] - E[X]| = |VaR_p^{(t)rel}[X]|,$$

where through $VaR_p^{(t)rel}[X]$ a relative value $VaR_p^{(t)}[X]$, is denoted, the value of the deviation of the risk measure $VaR_p^{(t)}[X]$ of the random variable X from its expected value.

Proof

From formula (20), obviously, the inequality follows:

$$\rho_g^D[X] \geq \frac{(VaR_p^{(t)}[X] - E[X])^2}{(1-p)^k(1-\alpha p)} \int\limits_{VaR_p^{(t)}[X]}^{+\infty} dF_X(x).$$

But

$$\int\limits_{VaR_p^{(t)}[X]}^{+\infty} dF_X(x) = F_X(+\infty) -$$

$$-F_X(F_X^{-1}(1-(1-p)^k(1-\alpha p)) = (1-p)^k(1-\alpha p).$$

Whence follows the validity of the required inequality:

$$\rho_g^D[X] \geq (VaR_p^{(t)}[X] - E[X])^2,$$

and hence

$$\tilde{\rho}_g^D[X] \geq |VaR_p^{(t)}[X] - E[X]| = |VaR_p^{(t)rel}[X]|.$$

The proposition is proven.

The meaning of this proposition is that this variance distortion risk measure always gives risk estimates that exceed (or equal) the risk estimates obtained using the first proposed variance distortion risk measure corresponding to the distortion function

$$h(x) = 1_{\{x>1-p\}}(\underbrace{g(g(...g}_{k-1-\text{times}}(g_\alpha(x)...) = 1_{\{x>1-p\}}(g_{k-1}(g_\alpha(x))),$$

$p \in (0,1)$, i.e. risk measures $(VaR_p^{(t)}[X] - E[X])^2$.

CONCLUSIONS

In the last decade, there has been a vigorous theoretical study of a class of risk measures called distortion risk measures, and they have become widely used in financial and insurance applications due to their attractive properties. This paper introduces a new concept of variance distortion risk measures and explores some of their properties. A large number of examples of variance distortion risk measures are considered and the possibility of their application for assessing risks of various degrees of catastrophicity is investigated. In this paper, the authors introduced and investigated the risk measures "*VaR* to the power of *t*" and risk measures "*ES* to the power of *t*" into scientific circulation. In them, using the composite method, it was proved that these measures also belong to the class of the expectation distortion risk measures, and the corresponding distortion functions are described. In this paper, we search for the variance distortion risk measures using the same distortion functions that were used to construct risk measures "*VaR* to the power of *t*" and "*ES* to the power of *t*" as subsets of the expectation distortion risk measures. At the same time, such variance distortion risk measures were identified as the square of the relative value of the risk measure "*VaR* to the power of *t*" $\rho_g^D[X] = (VaR_p^{(t)}[X] - E[X])^2$ and the risk measure, which represents the conditional variance of the random factor *X* provided that the value of these losses exceeded the value $VaR_p^{(t)}[X]$, and various formulas were obtained to represent these variance distortion risk measures. The paper investigates the question of the relationship between these variance distortion risk measures.

The expectation distortion risk measures are currently well studied and have many useful and convenient properties. This paper opens up an interesting area of research in assessing variance distortion risks. It seems interesting both to study the general properties of variance distortion risk measures and to find new variance distortion risk measures with special properties that make it possible to identify financial risks of varying degrees of catastrophicity.

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Practical Aspects and Prospects for Formation of Financial and Industrial Groups in Uzbekistan

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ABSTRACT

This article examines the conditions for the formation of financial and industrial groups in Uzbekistan and the participation of commercial banks in their activities. The purpose of the study is to formulate recommendations for creating the necessary conditions for the formation and organization of the activities of financial and industrial groups. The authors used the following research methods: grouping, abstraction, comparative analysis, structural analysis, and scientific forecasting. This article also describes the role of financial and industrial groups in the development of the economy and assesses the possibility of creating financial and industrial groups with the participation of commercial banks. In addition, the features and prospects for the creation of financial and industrial groups in Uzbekistan have been identified. The authors conclude that there are the following grounds for the formation of financial and industrial groups with the participation of commercial banks in Uzbekistan: the volume of commercial bank loans allocated to the real sector of the economy is increasing, there is a great need for financial resources to modernize production, as well as technical and technological re-equipment of enterprises. The formation of financial and industrial groups in the national economy will lead to the sustainable development of the industrial sector, ensuring the stability of the financial and banking system and increasing the competitiveness of the national economy.

*Keywor*ds*:* financial and industrial group; innovation; integration of industrial and financial capital; horizontal and vertical integration; capitalization; financial structure

INTRODUCTION

As global practice shows, the creation of financial and industrial groups as one of the types of integrated corporate structures is important for increasing production potential and ensuring its sustainability in the national economy. Modern financial and industrial groups will undoubtedly be able to turn into large economic and financial institutions in the country and in the world. The contribution they make to the national and world economy is important for the creation of new economic zones, the development of industrial production and financial markets. According to the European Commission and the United Nations Conference on Trade and Development, nearly half of international trade takes place in large integrated structures. The annual turnover of large financial and industrial groups in many countries exceeds the volume of the gross national product. In addition, these structures account for the bulk of industrial production and the employed population in developed and developing countries.[1]

In world practice, it is known that most of the funds of banks are directed to the creation of high-tech and science-intensive industries, which, in turn, contributes to the implementation of new projects in the production sector, as well as to increase the innovative potential and competitiveness of the economy. In addition, it is desirable to form an ideal integration system resulting from the establishment of strong ties between financial institutions and industrial enterprises to increase the production efficiency of the national economy and ensure its continuity, as well as support sustainable economic development, since in the context of globalization of the world economy, it is necessary to ensure a high level of competitiveness of entities operating in the national economy. For this, it is necessary to strengthen the integration of financial and industrial capital, to form a highly integrated corporate structure, and also to improve the efficiency of the corporate governance system.

Scientific research on the creation of financial and industrial groups by strengthening the integration of financial and industrial capital, increasing the stability of highly integrated corporate structures is carried out in leading research centers and higher educational institutions of the world, such as Erasmus University Rotterdam, University of Amsterdam (Netherlands), Brigham Young University, World bank (USA), Korea Economic research institute (Korea), Dalian Maritime University, Xiamen University (China), University of Hamburg (Germany), Kobe University, Institute of Developing Economies Japan External Trade Organization (Japan), Association of Financial and Industrial Groups of Russia, Central Economics and Mathematics Institute RAS (Russia).

Global research on the creation of financial and industrial groups in the economy and the development of their activities have yielded results that confirm:

• the possibility of increasing the stability of the national economy through the formation of financial and industrial groups (Erasmus University, Netherlands);

• ways of creating corporate governance in integrated structures and increasing their efficiency (Brigham Young University, USA);

• the possibility of forming integrated corporate structures by ensuring the integration of financial and industrial capital into the development of the economy (Korea Economic research institute, Korea);

• effective methods of integrating financial and industrial capital into the economy (Xiamen University, China);

• conclusions that as a result of the participation of banks in financial and industrial groups, their investment activity, the level of diversification of activities and effective management of financial risks increases (University of Hamburg, Germany);

• the need to form financial and industrial groups and create highly integrated corporate

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[1] European Commission. Innovation Policy. 2016. URL: http://ec.europa.eu; http://unctad.org (accessed on 12.11.2021).

structures to improve the financial stability of the banking system and industrial sectors, technical and technological renovation of industrial enterprises (Kobe University, Japan);

• strategic directions for achieving sustainability of production in industrial sectors and increasing the investment potential of banks, as well as the development of financial and industrial groups through financial and industrial integration (Central Economics and Mathematics Institute RAS, Russia).

In the world, research in the field of improving the scientific, theoretical, methodological and practical foundations of the formation and development of the activities of financial and industrial groups is carried out in the following priority areas:

• increasing the stability of the economy and international competitiveness through the formation of highly integrated structures based on ensuring the integration of financial and industrial capital;

• improvement of investment mechanisms of financial and industrial groups;

• improvement of investment mechanisms of financial and industrial groups;

• increasing the efficiency of corporate governance through the formation of financial and industrial groups.

There are various approaches to substantiating the economic essence of the concept of financial and industrial groups. Thus, W. Yao [1], K. Young [2], E. A. Utkin, M. A. Eskindarov [3], I. Yu. Belyaeva [4], A. E. Dvoretskaya [5], V. A. Tsvetkov [6], as well as the Uzbek scientist-economist M. B. Khamidulina [7] give different definitions of financial and industrial groups. For example, according to Wei Yao, a financial-industrial group is understood as a new type of integration resulting from the mutual pooling of capital and management between financial and industrial organizations [1]. In addition, I. Yu. Belyaeva defines financial and industrial groups as the result of the movement of combined capital, i.e. suitable only from the point of view of

capital, without paying attention to the unification of legal structures and its main goals [4].

In our opinion, financial and industrial groups are a form of integration of free legal entities, including production, trade enterprises and financial and credit institutions, which have centralized management, and have also fully or partially pooled their resources (material, intangible, financial, etc.) in order to ensure the efficiency of production, economic, financial and other activities.

The combination of financial capital with industrial capital in financial and industrial groups not only effectively influences the activation of investment processes but also increases the competitiveness of the economy. Solving the set tasks requires improving the practical aspects of the formation of financial and industrial groups in Uzbekistan.

The scientific significance of the study lies in the possibility of using the analysis and generalization of advanced foreign experience in the formation of financial and industrial groups, as well as scientific conclusions, practical recommendations aimed at creating the necessary financial and economic prerequisites for the formation of financial and industrial groups (FIGs) in Uzbekistan.

The practical significance of the study is in the possibility of using proposals for the formation of financial and industrial groups by strengthening the integration of financial and industrial capital developed in the research process, while increasing the investment activity of banks, creating a regulatory framework for the system of this business, as well as developing measures, aimed at the formation of financial and industrial groups in the economy of Uzbekistan.

MATERIALS AND METHODS

The authors apply methods such as grouping, abstraction, comparative analysis, structural analysis and scientific forecasting. To

determine the effectiveness of the formation of FIGs and the most rational balance of interests between group members, it is advisable to apply a model analysis of financial and industrial groups. The authors investigate the necessary conditions for the formation of FIGs, which determine their strategic competitive advantages, associated both with ensuring demand for new products from partners in the group and with financing innovative activities by financial institutions of FIGs. This is the task of modeling the economic effect of the integration of banking and industrial capital.

Many scientific studies have identified three types of models: representative, regression, and conceptual.

Conceptual models help to reveal the nature of economic phenomena on the basis of identifying the key prerequisites for their existence and to establish the nature of dependencies. Therefore, we consider it appropriate to use this model in the article.

The research hypothesis is that the formation of financial and industrial groups in the national economy will lead to the sustainable development of the industrial sector, ensuring the stability of the financial and banking system and increasing the competitiveness of the national economy.

ANALYSIS AND RESULTS

Financial and industrial groups can be called one of the main types of large integrated structures, widespread in the world, which is explained by the following facts [8]:
• financial and industrial group — a corporate structure that unites economic entities with the status of a legal entity, in particular industrial enterprises;
• financial structures, banks and other credit organizations participate in financial and industrial groups;
• property relations between members of the group should be regulated by real control and include the implementation of the group's strategy.

Based on the global experience of financial and industrial groups, it should be noted that they contribute to the strengthening of integration between financial institutions and industrial enterprises, the sustainable development of industrial sectors, and also serve as an effective tool for increasing the economic potential of the country.

In our opinion, based on foreign experience in the formation and implementation of activities of financial and industrial groups, the following can be noted as the main principles of their formation:
• the project for the creation of each group on the basis of a unified regulatory framework has its own characteristics;
• the presence in the groups of a leader who determines the main financial flows and product flows. In this case, the leader can be an industrial enterprise, as well as a financial and credit organization;
• the main factor in ensuring the management of members of financial and industrial groups by the central company is shareholder control and relations specified in the agreement;
• the emergence of groups with concrete real vertical and horizontal cooperation of enterprises that produce products that are competitive in the domestic and foreign markets, as well as produce or are capable of producing products necessary for state needs;
• groups for investment in ongoing projects are selected by financial and credit organizations with sufficient capital;
• the presence of various forms of state support for the creation and implementation of activities of financial and industrial groups.

Studies show that the Anglo-American, German, Latin and Japanese models of the development of financial and industrial groups are widespread in the world economy. These models differ from each other in the organizational and economic mechanism, the process of organizing and implementing financial relations, mutual coordination and management of the activities of enterprises that are part of a single structure.

Based on international experience, we consider it possible to use the Japanese and German models when organizing the
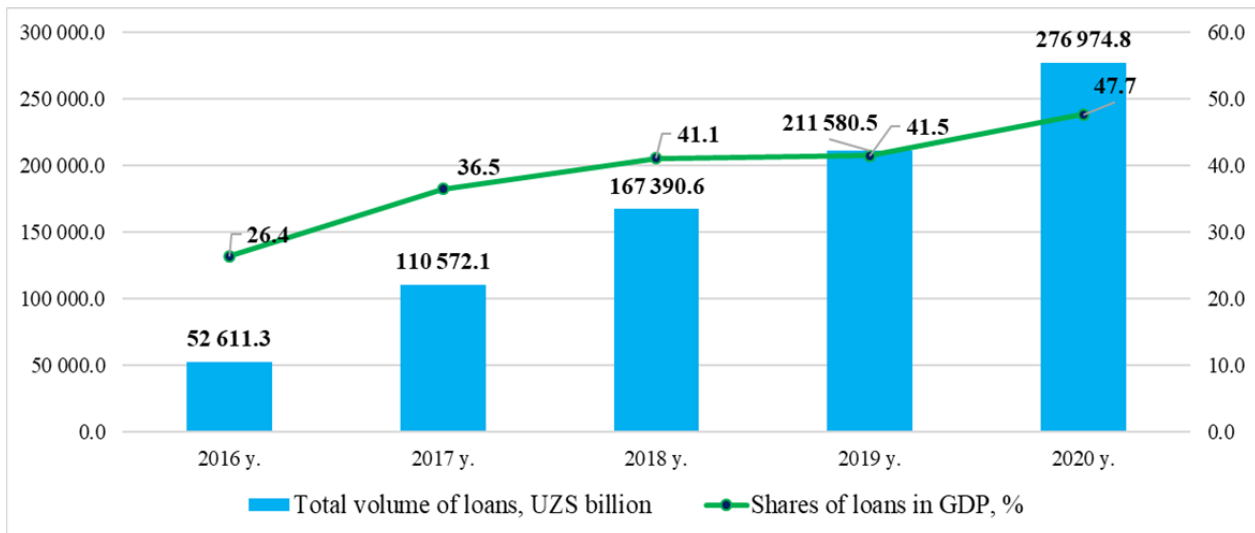
Fig. 1. **The volume of loans directed by commercial banks to the real sector of the economy and their share in GDP**

Source: compiled by the authors based on data from the Central Bank of the Republic of Uzbekistan and the State Committee on Statistics. URL: https://cbu.uz/oz/statistics/bankstats/; https://stat.uz/en/quarterly-reports (accessed on 05.03.2021).

activities of financial and industrial groups in the Republic of Uzbekistan.

In Germany, large banks own most of the capital of many highly integrated German corporations. In particular, Deutsche Bank, which owns a controlling stake in the leading national companies Daimler-Benz, Philipp Holzmann, Karstadt, exercises financial management in them [9].

In the Japanese model, business units, creating corporate groups, establish close ties with each other through the mechanism of counter-ownership of shares. Large financial and industrial groups in Japan include such companies as Mitsubishi, Mitsui, Sumitomo, Dai-Ichi Kangyo, Fuyo, Sanwa. Their main feature is financing from the main bank [10, 11].

The peculiarity of these two models is that they effectively organize the mutual coordination of the activities of industrial enterprises, financial and other organizations that are part of the integrated structures. In addition, the close relationship between the bank and industrial enterprises plays an important role in the continuous development of the activities of financial and industrial groups and the implementation of promising projects.

In our opinion, it is necessary to create the necessary conditions for commercial banks to show initiative in the formation of financial and industrial groups and their active participation.

To create financial and industrial groups with the participation of commercial banks, it is first of all necessary to study the financial position of the banking system. The positive indicators achieved in Uzbekistan from an economic point of view, in turn, create favorable conditions for the integration of financial and industrial capital.

Achievement of high rates of macroeconomic growth in recent years has led to an increase in lending to sectors of the economy. Thus, in 2020, the balance of loans issued by banks compared to 2016 increased fivefold, or by 224.3 trillion soums, as of January 1, 2021, this figure reached 276.9 trillion soums (*Fig. 1*).

According to research, the bulk of the bank's assets is loans. The correct organization of the practice of lending in commercial banks, on the one hand, provides the bank with a stable profit, on the other hand, bank loans, being a financial source of the country's economic development, ensure the growth of macroeconomic indicators. In

Table 1

Growth rates of capital and loans of the banking system in relation to the previous year in %

Indicators	2016	2017	2018	2019	2020
Capital	120.2	221.1	129.0	191.3	114.3
Loans	125.1	207.1	151.4	126.4	130.9

Source: compiled by the authors based on data from the Central Bank of the Republic of Uzbekistan. URL: https://cbu.uz/oz/statistics/ bankstats/ (accessed on 05.03.2021).

Table 2

The share of some commercial banks in the total volume of credit investments directed to the real sector of the economy by the banks of the Republic of Uzbekistan

Indicators	2016	2017	2018	2019	2020
Uzmilliybank	24.4	31.8	27.8	26.0	23.7
Asaka Bank	10.0	14.3	14.8	13.9	12.3
Uzsanoatqurilishbank	16.2	18.3	16.3	12.4	14.4
Agrobank	5.6	3.1	5.2	7.5	9.0
Qishloq Qurilish Bank	8.8	5.2	5.1	5.4	5.0
Other commercial banks	35.1	27.4	30.8	34.7	35.6
Total	100.0	100.0	100.0	100.0	100.0

Source: compiled by the authors based on data from the Central Bank of the Republic of Uzbekistan. URL: https://cbu.uz/oz/statistics/ bankstats/ (accessed on 05.03.2021).

this regard, there is a tendency to an increase in the share of bank loans in the country's GDP in the period 2016–2020, which, in turn, is important in the process of ensuring macroeconomic growth and development of industrial production (*Table 1*).

Analytical data on the growth rates of capital and loans in the banking system in the period 2016–2020 may affect the increase in the level of risk in the banking system.

Strengthening the integration of commercial banks and industrial enterprises is the only effective mechanism to reduce credit and investment risks without losses for the sustainable development of the financial system. In addition, the increase in the volume of loan investments and the share

of long-term loans in the loan portfolio of commercial banks indicates a great demand for financial resources in the real sector of the economy. In this regard, we consider it expedient to ensure the integration of financial and industrial capital.

A fairly large part of credit investments directed to the real sector of the economy in Uzbekistan falls on leading commercial banks such as Uzmilliybank, Uzsanoatqurilishbank, Asaka Bank, Agrobank, Qishloq Qurilish Bank (*Table 2*). The share of these five commercial banks in 2005 was 93.4%, by 2020 this figure was 64.4% and decreased by 29%. This situation is considered a positive process, as it means the formation of a competitive environment

Structure of credit investments of commercial banks of the Republic of Uzbekistan by sectors of the economy, %

Sectors of the economy	2016	2017	2018	2019	2020
Industry	34.9	40.9	39.8	35.7	36.9
Agriculture	5.8	4.3	5.6	8.1	10.1
Transport and communications	13.6	14.7	12.5	11.1	9.6
Construction	4.2	3.1	3.5	2.8	2.7
Trade and catering	7.7	4.7	6.4	6.8	7.2
Logistics support	1.2	0.4	1.6	1.7	1.4
Housing and utilities	0.9	0.9	1.1	1.2	1.4
Other industries	31.7	31.0	29.4	32.6	30.7
Total	100.0	100.0	100.0	100.0	100.0

Source: compiled by the authors based on data from the Central Bank of the Republic of Uzbekistan. URL: https://cbu.uz/oz/statistics/bankstats/ (accessed on 05.03.2021).

in the banking services market. However, these banks account for a large share of the total volume of credit investments directed by commercial banks into the real sector of the economy.

Table 3 data show that in the structure of credit investments of commercial banks by sectors of the economy, it is the industrial sector that occupies the largest share, and this trend has persisted for a number of years, in particular, the share of bank loans allocated to the industrial sector in the structure of total loan investments in 2010 amounted to 32.4%, while in 2020 this figure reached 36.9%, which is 4.5% more.

In our opinion, it is advisable to form financial and industrial groups with the participation of commercial banks with a high level of capitalization. The analysis shows that in order to meet the need for financial resources of enterprises that are part of integrated corporate structures, to own their shares and implement promising investment projects within a group, commercial banks must have a large capital. The total capital of commercial banks of the

Republic of Uzbekistan in relation to 2017 increased almost three times, or by 37.7 trillion soums, and as of January 1, 2021, amounted to 58.4 trillion soums.[2]

A large share in the total capital of banks belongs to the leading commercial banks Uzmilliybank, Uzsanoatqurilishbank, Asaka Bank, Agrobank, Qishloq Qurilish Bank, in 2012 it amounted to 37.8%, and in 2020–61.6%, an increase of 23.8%. Considering the financing of large investment projects within the framework of financial and industrial groups and the high need for funds from enterprises, it is necessary to strengthen measures aimed at stimulating the level of capitalization of banks.

In our opinion, on the basis of the above data, we can assume that the possibilities of creating financial and industrial groups with the participation of Asaka Bank, Uzsanoatqurilishbank, Uzmilliybank and Agrobank, together with industrial enterprises, are enormous. In addition,

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[2] Data of the Central Bank of the Republic of Uzbekistan. URL: https://cbu.uz/ru/statistics/bankstats/436580/ (accessed on 25.01.2021).
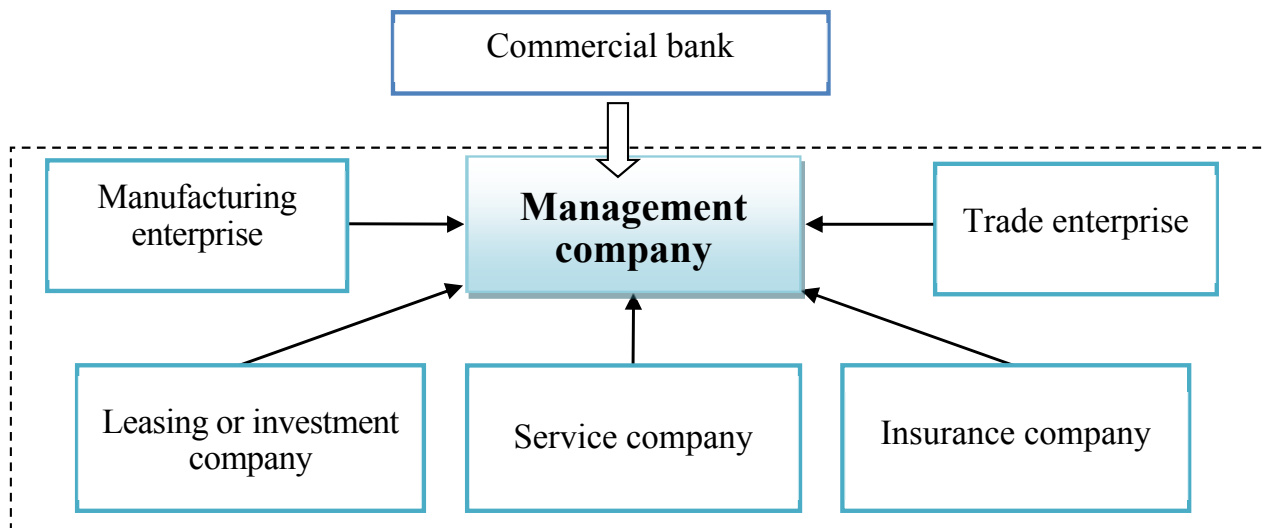
Fig. 2. **Typical organizational structure of the formation of financial and industrial groups**
Source: compiled by the authors.

these commercial banks provide financial services to industrial enterprises in a specific area and attract huge investments in them. These industrial enterprises, in turn, by purchasing shares of the bank, participate in its corporate governance.

In our opinion, the organizational structure of the formation of financial and industrial groups with the participation of a commercial bank in Uzbekistan can be represented as in *Fig. 2.* At the same time, the management company of the financial and industrial group unites around itself industrial enterprises, trade, insurance, investment, and leasing companies, and also coordinates their activities. Commercial banks within the group carry out activities such as financing promising projects, controlling cash flows and managing financial risks.

Research shows that as a result of joint activities of commercial banks and industrial enterprises within the framework of an integrated structure, a high synergetic effect can be achieved. This effect will arise as a result of increased production volumes, savings in operating costs, improved product quality, shorter delivery times to consumers, efficient cash flow management, and increased investment activities by preventing financial risks.

The formation and implementation of a unified scientific, technical and investment policy within the framework of financial and industrial groups have a positive effect on increasing the innovative potential since the issue of introducing new research and development and innovation directly depends on funding. As a result of combining financial and industrial capital, the need for financial resources of enterprises operating in the real sector of the economy is satisfied.

According to the research, to assess the effectiveness of the creation of vertical integrated corporate structures in the national economy, it is recommended to apply the modified Altman model [12]:

$$R = X_1 + X_2 + X_3 + X_4 + X_5 > 0,$$

where R is an indicator for assessing the financial stability of an enterprise; X_1 is an indicator of the overall solvency of the enterprise; X_2 is the return on equity of the enterprise; X_3 is the capitalization ratio of the enterprise; X_4 is the management coefficient; X_5 is the ratio of the enterprise's equity capital.

Comparison of the R value before merging into a single corporate structure and after merging makes it possible to draw a conclusion about the effectiveness of creating integrated corporate structures.
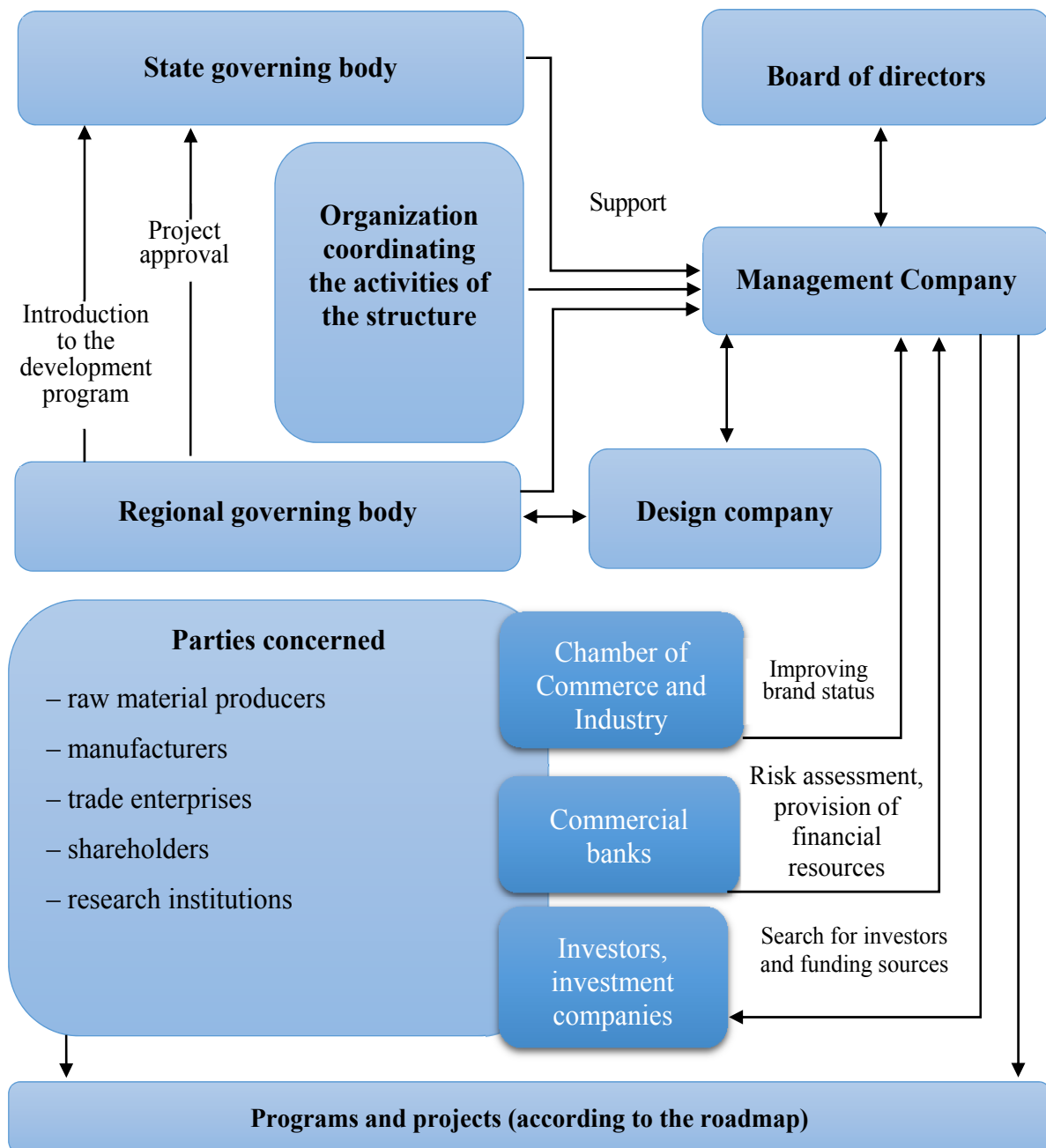
Fig. 3. **Organizational structure of financing and project management of an integrated structure**
Source: compiled by the authors.

It is important to develop a roadmap for financial support for projects to form integrated financial and industrial structures in the regions of Uzbekistan through the use of benchmarking technologies, as well as to determine the procedure for financing projects. It is advisable to organize the organizational structure of financial support and project management as shown in *Fig. 3*.

To financially support the formation of regional integrated financial and industrial structures, it is recommended to use the following roadmap:

1) ensuring the investment attractiveness of integration structures;

2) organization of the process "production — research — innovative development";

3) creation of a value chain, entry into a competing process;

4) support in attracting related and service industries to the structure, the use of business outsourcing;

5) ensuring the integration of financial and industrial capital;

6) increasing the level of competition;

7) creation of a single regional infrastructure complex;

8) implementation of promising projects aimed at the sustainability of the activities of participants in the structure;

9) creation of a system for providing industrial production with modern technologies.

The board of directors of the integrated structure performs the tasks of coordinating the activities of the participants in the implementation of programs and projects within the structure. The management company is engaged in the implementation of all programs of the integrated structure and measures for their development. The tasks of managing cash flows within the framework of the structure and direction of the necessary funds for financing projects are performed by commercial banks.

To effectively organize financial relations between the management company and organizations that are part of the structure of regional integrated corporate structures, in particular in industrial clusters, the functions of accumulating and distributing financial resources of the organizations included in the structure should be performed by the management company.

In our opinion, the advantages of the proposed organizational structure of financing and project management of the integrated structure lie in the possibility of strengthening interregional and intersectoral cooperation in organizing and managing the activities of industrial clusters in the regions, the mutual coordination of financial interests, the composition of the participants, as well as the effective organization of financial relations.

One of the main issues in the process of forming integrated financial and industrial groups is the determination of the principles of building the structure and mutual coordination of the activities of the participants, while the activities of the

industrial enterprises that are part of the structure should be technologically similar. Such financial and industrial groups can be effectively created on the basis of clusters.

The formation of financial and industrial groups on the basis of a cluster begins with the selection of industrial enterprises. At the same time, the innovativeness of enterprises from a regional point of view and full coverage of all stages of the production process are of great importance.

Industrial clusters occupy an important place in the socio-economic development of regions since the mutual activity of participants in it creates conditions for the formation of additional competitive advantages within the structure [13].

In order to enhance the integration of financial and industrial capital in the future, it is advisable to form integrated structures in certain regions, in particular, clusters with the participation of industrial enterprises with a high level of the regional index of industrial production specialization (Specialization Index). Since a large share in the volume of industrial production by type of economic activity in Uzbekistan is occupied by the manufacturing industry, it is necessary to assess the regional specialization of industries that make up this industry.

The regional industrial production specialization index ($I_{special}$) is calculated using the following formula [14]:

$$I_{special} = \frac{V_r}{V_c} * \frac{P_c}{P_r},$$

where V_r — the volume of production in a certain area of industry in the region; V_c — the volume of production in a certain area of industry in the country; P_r — the volume of total industrial production in the region; P_c — the volume of total industrial production in the country.

As Table 4 data show, the great value of the index of the level of specialization in the industries of food production, beverages

Table 4

Index of the level of specialization for some branches of industrial production in 2020 in the context of regions

	Food, beverage and tobacco manufacturing	Manufacture of textiles, clothing and leather products	П Manufacture of chemical products, rubber and plastic products	Metals production	Manufacture, repair and installation of machinery and equipment, car production
Republic of Karakalpakstan	0.76	0.64	5.24	0.001	0.08
Andijan	0.74	1.62	0.34	0.11	3.56
Bukhara	1.12	1.21	0.43	0.08	0.42
Jizzakh	1.24	2.18	0.48	0.34	1.08
Kashkadarya	1.08	1.44	2.74	0.14	0.12
Navoi	0.54	0.76	0.96	5.24	0.36
Namangan	1.28	1.84	0.48	0.35	0.81
Samarkand	1.74	1.08	0.62	0.11	1.28
Surkhandarya	1.34	1.75	0.14	0.09	0.59
Syrdarya	1.45	1.84	0.34	0.08	0.42
Tashkent	1.14	0.72	1.06	2.63	0.61
Fergana	0.87	1.63	0.96	0.037	0.34
Khorezm	1.26	1.48	0.14	0.032	2.31
Tashkent	0.94	0.56	1.18	1.06	1.81

Source: compiled by the authors.

and tobacco products falls on the Samarkand and Syrdarya regions, in the industries of production of textile products, clothing and leather products — on the Jizzakh, Syrdarya and Namangan regions. This can be explained by the fact that the enterprises of these industries are working on modernization and technical re-equipment.

DISCUSSIONS

Problems hindering the process of strengthening the integration of financial and industrial capital are being positively resolved as a result of consistently carried out economic reforms in the economy of Uzbekistan.

Based on foreign experience, the formation of financial and industrial groups can be carried out as follows:

• members of the group create joint-stock companies, including holdings, in the manner prescribed by law;

• the participants of the financial and industrial group being created transfer the block of shares to the bank or financial and credit organization included in this group for trust management;

• one of the group members owns shares in another company, including in the institutions and organizations that are part of the group.

Based on the best foreign experience, considering the peculiarities of the development of the national economy, in our opinion, Uzbekistan has opportunities for the formation of financial and industrial groups in the future in the following areas:

• at the macro level, i.e. on the basis of the creation of holdings in certain large industries;

• at the micro level, based on the formation of clusters by ensuring regional integration of industrial enterprises;

• on the basis of investment companies, management companies, which have a large share of commercial banks in the authorized capital.

Uzbekistan has great opportunities and potential for the formation of integrated corporate structures in industries such as food and textile production. Since the necessary raw materials for production in these industries are available in almost all regions, it is recommended to gradually form modern integrated structures operating in these industries.

Integrated corporate structures created in industrial sectors should include all stages of the production process, including the technological chain, from the purchase of raw materials to the production and sale of finished products with high added value.

CONCLUSIONS

In the course of the research, the following scientific conclusions were formed:

1. By forming and organizing the activities of financial and industrial groups, firstly, the problem of channeling bank capital into industry will be solved; secondly, confidence in the banking system will increase and its structure will improve; thirdly, the process of competition between financial and industrial groups for attracting new large organizations will intensify, and between banks for servicing the most profitable members of the group; fourthly, the profitability of the enterprises included in the structure will increase.

2. Financial and industrial groups are modern economic structures, as their positive aspects can be noted effective management of financial resources, increased competitiveness and rational management. The process of formation of financial and industrial groups contributes to the development of industry in the country, the development of market relations, as well as the strengthening of the process of integration into the world economy.

3. High rates of growth in the volume of commercial bank loans provided to the real sector of the economy and the share of long-term loans in the total volume of the loan portfolio can create a certain degree of risk. At the same time, ensuring the integration of banking and industrial capital is the only effective mechanism for repaying loans for

sustainable development of the financial system and reducing investment risks. In addition, the increase in the volume of credit investments of commercial banks and the share of long-term loans in the loan portfolio indicates a great need for financial resources on the part of the real sector of the economy. In this regard, it is advisable to ensure the integration of financial and industrial capital.

4. The authors believe that there are the following grounds for the formation of financial and industrial groups with the participation of commercial banks in Uzbekistan: firstly, the volume of commercial bank loans provided to the real sector of the economy is increasing, in particular, there is a great need for financial resources to modernize production, as well as technical and technological re-equipment of enterprises. Secondly, a large share of loans in the structure of credit investments of commercial banks is directed specifically at the industrial sector. Thirdly, there is practical experience in the functioning of banks and industrial enterprises on the basis of mutual integration. Fourthly, the increase in the volume of investment loans directed by commercial banks to enterprises creates an opportunity for further strengthening the integration of financial and industrial capital.

5. It can be considered that the possibilities of creating financial and industrial groups with the participation of Asaka Bank, Uzsanoatqurilishbank, Uzmilliybank and Agrobank, together with industrial and agricultural enterprises, are enormous.

6. As a result of the integration of the real sector of the economy and the banking and financial system by strengthening the integration of financial and industrial capital, it is possible to achieve an increase in industrial production and the provision of financial services as well as gross domestic product.

7. To enhance the integration of financial and industrial capital in the future, it is necessary to form vertical integrated corporate structures in the regions — industrial clusters with the participation of enterprises specializing in product processing, manufacturing of finished goods, trade and the provision of other modern market services, as well as equipped with high technologies, similar in the technological period of production.

8. It is advisable to form in certain regions integrated corporate structures with the participation of industrial enterprises with a high level of specialization, based on the specialization of industrial production in the regions. There is great scope and potential for the formation of integrated corporate structures in industries such as food and textiles.

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Social Impact Bonds: Financing Grassroots Sports

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ABSTRACT

This paper **aims** to analyze the foreign experience of using social impact bonds (SIB) and formulate proposals for the application of this tool in financing projects aimed at developing mass sports and increasing physical activity on a national scale. The **scientific novelty** of the article is confirmed by the limited application of such a mechanism in Russia and its insufficient study. This research aims to fill this academic and applied gap. The author uses the **methods** of deconstruction and aspect analysis. The article analyzes in detail the foreign experience of using social impact bonds, reveals the advantages and disadvantages of this model. In the absence of SIB sports projects, the model of social impact bonds is considered through the example of a New York City-based program aimed at reducing the recidivism rate among young people. This example allowed the author to describe the interaction scheme for all participants and stakeholders and to illustrate related advantages and disadvantages. In the future, this model can be introduced into Russian practice and used as a model for launching a similar project in the field of grassroots sports. The analysis of successful projects implemented abroad allowed the author to substantiate the possibility of using social impact bonds in financing programs aimed at increasing population levels of physical activity. A system of target indicators is proposed, including such a metric as social return on investment (SROI). The author describes in detail the methodology for calculating SROI and provides examples of calculating this indicator for mass sports projects. The author **concludes** that the advantages of SIB prevail over the disadvantages and about the high potential of this tool. Further research in this area can be aimed at clarifying the methodology for calculating the SROI for sport interventions promoting physical activity at the population level and evaluating specific projects in the field.

Keywords: sports economics; social return on investment; sports development strategy; sports financing; SIB; SROI

INTRODUCTION

The Presidential Decree of the Russian Federation has determined the national development goals for the period up to 2030.[1]:

- ensuring sustainable population growth;
- increasing life expectancy up to 78 years;
- increasing the share of the population engaged in physical culture and sports on a regular basis, up to 70%.

Interestingly, achieving the third goal will ensure the first two. According to the World Health Organization (hereinafter referred to as "WHO"), insufficient physical activity is one of the leading risk factors for death and the development of non-communicable diseases.[2]

According to the Ministry of Sports of Russia, in 2012 the share of the population regularly engaged in physical culture and sports amounted to 22.5% (32.2 million people). By 2030, it is planned to increase more than threefold — up to 70%.

At the same time, the basic values of the target indicators differ from the assessment of the Accounts Chamber,[3] obtained on the basis of Rosstat data, by 2–2.5 times. There are also a number of inaccuracies. For example, according to the Ministry of Sports, the number of people engaged in sports at the age of 15–18 in 2018 exceeded the actual number of people of this age by 194 thousand people (according to Rosstat). A similar issue was identified with respect to the consistency of data on the use of sports facilities.

The main set of measures aimed at the development of mass sports is implemented within the framework of the state program "Development of physical culture", as well as the federal target program "Development of physical culture and sports for 2016–2020", the federal program "Sports — the norm of life" and related regional programs. In addition, to develop physical culture and mass sports, a number of events are envisaged within the framework of the national projects "Accessible environment", "Development of education", NP "Demography" and "Education".

According to the Accounts Chamber of the Russian Federation, for the period 2018–2020 spending on funding mass sports amounted to 249.9 billion rubles. Both at the federal and regional levels, the bulk of the budget funds is directed to the development of sports infrastructure.

Despite a number of programs and impressive amounts of funding, there are not enough funds in Russia for the development of mass sports.

The strategy for the development of physical culture and sports for the period up to 2030 provides for ensuring the availability of sports and physical culture and health services through a public-private partnership (PPP) model. According to the Ministry of Sports of Russia, in the period 2018–2020 using PPP mechanisms, 13 projects were implemented in 11 regions.

Expanding the use of PPP practice for the creation of sports facilities will not only ensure the commissioning of new sports facilities, increase the level of provision of the population with sports facilities, but also create conditions for the availability of sports facilities and services for privileged categories of the population. One of the instruments that is widespread abroad, but is not entirely used in Russia, may become social impact bonds (SIB).

SOCIAL IMPACT BONDS

Social impact bonds involve the financing of a specific program ordered by the state. At the same time, investors can count on payments provided pre-agreed results are achieved.

Typically, a government agency enters into an agreement with a financial intermediary who coordinates the development of the

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[1] Presidential Decree of the Russian Federation of July 21, 2020 No. 474 "On the national development goals of the Russian Federation for the period up to 2030" (hereinafter referred to as "Decree No. 474").

[2] WHO Global Action Plan to Increase Physical Activity 2018–2030. Increasing the level of activity of people to promote health in the world. URL: https://apps.who.int/iris/bitstream/handle/10665/279655/WHO-NMH-PND-18.5-rus.pdf?ua=1 (accessed on 11.10.2021).

[3] Report on the results of the expert and analytical event "Assessment of the availability in 2018–2019 and the expired period of 2020 of physical culture, health, and sports services". URL: https://ach.gov.ru/upload/iblock/6e5/6e511dc47c06c51ed264d685900538a8.pdf (accessed on 11.10.2021).

program and attracts investments. The mediator, in turn, turns to a service provider, usually a charitable (non-profit) organization that implements the program [1].

To implement a social program, as a rule, a separate legal entity is created, whose employees are engaged in its direct implementation. The target group of the program is agreed upon prior to its launch with the aim of further substantiating the result. Other intermediaries, often invisible in standard models, are the accountants and lawyers needed to launch and implement the SIB [2].

Results, i.e. the number of positive changes in a specific metric, measured by an independent evaluator, compared with approved benchmarks determined by best practices and past experience, and recorded in strategic development documents. How close the program's results are to meeting benchmarks will determine the income paid to investors by the government agency that ordered the program. If the targets are not met, investors get nothing (in the "classic" scheme). The main rationale for using the SIB is shifting all financial risks associated with the implementation of social programs onto the supplier: the state will have to pay only for the results achieved.

Most often, social impact bonds target specific groups of the population in the following areas: fighting unemployment and poverty, helping the homeless, welfare of children and families, health care, education and fighting crime. To date, 138 social impact bonds worth $ 441 million have been issued worldwide, helping more than 1.7 million people.[4] The maturity of social impact bonds varies from 3 to 10 years [3].

The income on social impact bonds is determined based on the savings in government spending — the budget will not have to pay for social services that would have to be financed "without the program" [4].

Social impact bonds were first issued in the UK in 2010 as part of Prime Minister David Cameron's Greater Society program. The first

program implemented was the Peterborough SIB program aimed at combating crime [5].

New Zealand economist Horesh [6] suggested that governments use the so-called "social policy bonds" back in 2000. In his example, the government could issue a bond with a maturity of $ 10 that would be paid off to the bondholder whenever the crime rate drops 50% from the current level. Due to the fact that the target at the time of the issue is very distant, investors will be able to buy these bonds at a large discount. An additional incentive to purchase can be the achievement of important social results, i.e. the investor not only gets the opportunity to earn money but also helps society. An alternative option could be self-financing of a certain social program, but in this case, the volume of investments will be much larger, and profitability is not provided at all.

Interest in social impact bonds has been driven by various macroeconomic trends over the past decade. Recurring (since 2008) crises lead to two oppositely directed consequences: on the one hand, the emergence of new and more acute social needs, often accompanied by a decrease in the population's income and an increase in the unemployment rate, and on the other, a reduction in government spending. This situation has highlighted the urgent need to change the government's approach to the provision and purchase of social services, prompting policymakers to view non-profit organizations and private sector companies as viable external providers that can be more efficient. At the same time, the financial market is witnessing the growth of a new generation of investors who want to consciously seek social impact along with financial profit [3].

Despite the growing interest in social connections and the positive reaction of politicians at the international level, it is worth noting that they cannot and do not seek to replace traditional methods of funding social projects.

Social impact bonds can be defined as hybrid instruments with elements of capital and debt [7, 8], which are characterized by

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[4] URL: https://sibdatabase.socialfinance.org.uk (accessed on 11.10.21).

three distinctive features: (1) emphasis on preventive interventions; (2) pay by performance; (3) the development of a complex network of stakeholders, including public and private organizations.

The advantages of the social impact bond model include (*Table 1*):

• firstly, it does not rely on the government to cover the initial cost of providing services;

• secondly, the SIB model changes the relationship between partners involved in the provision of social services [9, 10], and promotes the alignment of the interests of many stakeholders with different experiences and powers — the state, non-profit organizations, financial intermediaries and investors [9, 11]. Through this new network of relationships, SIBs can foster innovation by empowering service providers to develop new initiatives to achieve expected social outcomes, leveraging synergies between different actors, restructuring service delivery, creating opportunities for mutual growth between different sectors of government [12].

On the other hand, opponents of the SIB model highlight several problems associated with this tool [13]. The measurement of results is doubtful — primarily its objectivity and possible manipulations. In addition, it can be difficult to establish a link between a program and its outcome, due to the influence of external factors and possible alternative measures. Several government departments may be interested in the same result at once, which complicates funding and distribution of powers. Finally, the cost of capital of private investors is higher than that of the state, and the complexity and high cost of this partnership may not be balanced by sufficient benefits [14].

Given the aforementioned requirements of the SIB model, few programs and population groups actually have the prerequisites for its application [12, 14].

M. Arena et al. [3] distinguish several aspects that make it possible to characterize SIB:

1. The uniqueness of a social problem: SIB can be aimed at solving a social problem, which (1) cannot be solved due to a lack of resources; (2) it is not solved due to the absence of such a task at the level of federal, regional or local strategic documents/programs; (3) is resolved, but the results cannot be considered satisfactory.

2. Level of program implementation: the geographic area targeted by the SIB: macro (nationwide), meso (regional), micro (local).

3. Nature of the promoter: this parameter indicates whether the SIB was promoted by (1) government administrations at different levels or (2) by private organizations.

4. Mediator involvement: high or low level of involvement.

5. Risk sharing: the risk is borne by private investors or it can be shared among different actors (public and private).

6. Allocation of potential savings: (1) reduction of a specific cost item, (2) reduction of several cost items related to different departments.

The same authors identify several potential problems preventing the implementation of the prototype (classical) SIB structure:

1. Legislative framework — in many countries, organizations with social goals have to change their legal status. These restrictions reduce the number and types of organizations that can be involved in the SIB.

2. Prevailing approach to public procurement — current public social procurement rules tend to favor the "lowest price" criterion over quality. Critical aspects such as innovation, user orientation, and community relations, which typically characterize organizations with a clear social purpose, may not be considered at all. Obviously, this circumstance reduces the possibility of involving subjects seeking to innovate in the provision of social services or expand their range.

3. Measurement infrastructure — an underdeveloped culture and practice of social performance measurement, which means that program initiators will have to develop suitable metrics and indicators from scratch.

To overcome these barriers, the SIB developers were forced to make significant changes

Advantages of SIB projects

For non-profit organizations	For investors	For the state (regions)
1. The ability to scale up activities 2. Stable source of funding for the entire duration of the project 3. Implementation of methods for measuring social effects	1. Possibility of earning income (upon reaching the target indicators). 2. Ability to contribute to positive social change and the accompanying image effect. 3. Formation of an administrative resource, GR tools	1. Payment only in case of proven effect. 2. Budget funds savings. 3. Formation of a number of indirect effects: the creation of new jobs in the region, an increase in tax revenues

Source: compiled by the author based on VEB.RF data.

to the original structure. At the same time, the absence of a reference model slows down or prevents the spread of SIB.

EXAMPLE OF IMPLEMENTING A SOCIAL PROGRAM USING SIB

As noted by Pandey et al. [15], the public as a whole benefit from improved social outcomes of the target population. This can manifest itself in a decrease in crime or morbidity, a decrease in the number of homeless people, employment of young people, or vulnerable groups of the population. The financial driver is the predicted cost savings, for example, in the maintenance of prisons or the treatment of certain diseases.

Using the example of a program implemented in New York and aimed at reducing the crime rate among young people, the amount of payments depends on:

(а) the total number of juvenile offenders enrolled in the program;

(б) a percentage reduction in the number of young offenders who would otherwise re-offend and require additional remedies;

(в) the marginal cost of "fixing" each juvenile delinquent.

In the contract of this program, the main controllable indicator is the number of bed-days in prisons: if it can be reduced by 40% (199,293 bed-days), this will lead to budget savings of $ 22 million ($ 110.30). per bed-day). At this level of efficiency, the proposed program will pay off based on the estimated

costs. The projected $ 22 million in fiscal savings should reflect savings on margins rather than average costs. However, the contract does not explicitly state whether the cost savings are minimal or average.

To assess the effectiveness of the program, a classical approach to the analysis of investment projects is used, which involves forecasting and discounting generated cash flows. In the project described above, the flow is projected for 7 years and discounted at a rate of 3%, which is the usual discount rate used to evaluate social programs.[5] At the same time, a higher discount rate (for example, 4%) leads to a negative value of the net present value (NPV).

The project described above involved the following participants (*Fig. 1*):

4. Roca is an "innovative and experienced social service provider ..." whose mission is "to help disadvantaged, disenfranchised young people moved out of violence and poverty through their cognitive-behavioral interventions.

5. YSI is a non-profit subsidiary of Third Sector Capital Partners, Inc. formed to operate the program; financial and information intermediary between investors, the Massachusetts Department of Labor and Roca.

6. Third Sector Capital is a non-profit organization that advises government

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[5] Office of Management and Budget. (2017). Regulatory impact analysis: A primer. URL: https://obamawhitehouse.archives (accessed on 01.10.2021).

agencies, service providers, investors and other stakeholders on social projects.

Roca and YSI will work with several government departments at the regional level: administration and finance, youth affairs, health and human services, public safety, labor and human development.

Roca receives $ 27 million upfront funding. The Government of Massachusetts will pay YSI money only if Roca can reduce prison bed days.

Funding for the main loan is provided by Goldman Sachs (through the Social Performance Fund), and financing for the junior loan is provided by the Kresge Fund and Living Cities, each providing $ 1.5 million. The interest rate on the first loan is 5% per annum, on junior loans — 2%. Financial support also includes charitable donors Laura and John Arnold Foundation ($ 3.7 million), New Profit Inc. ($ 2 million), and The Boston Foundation ($ 300 thousand). The US Department of Labor has provided a compensation grant of $ 11.7 million. Additional funding from the US Department of Labor is also provided to extend the project by 2 years to support an additional 391 young people (if the program is successful).

The cost structure is as follows ($ 20.3 million[6]):

1. Roca Services: Roca's projected program-related costs ($ 18.5 million).

2. YSI — Program Manager/Advisor ($ 0.329 million).

3. Evaluation ($ 0.51 million).

4. Validation — analysis of the results obtained by the appraiser ($ 0.085 million).

5. Auditing and legal services — audit of YSI financial statements ($ 0.59 million).

6. Financial Consulting: YSI one-time payment ($ 0.25 million).

7. Department of Labor Fees: a one-time payment to the US Department of Labor ($ 0.025 million).

8. Meetings: organizing meetings between stakeholders ($ 0.014 million).

9. Unforeseen expenses YSI ($ 0.03 million).

Among the limitations of the considered project S. Pandey et al. [15] highlight the following points.

First, the 3% discount rate used for social services is low and applies to projects where benefits are realized over a longer period of time. Even a small increase in this rate to 4% results in a negative NPV.

Second, the aggregate cost of issuing and servicing social impact bonds will be higher compared to direct funding. One potential offsetting benefit is that the tool can provide the necessary funding for programs that would otherwise not be available to cash-strapped governments or local governments. Even with additional transaction costs, the fact that SIB funding comes from private, voluntary funding sources means there is no undue tax burden associated with fundraising for social programs.

According to M. E. Warner [1], the inability of the SIB to attract significant private venture capital may be associated with tight payback schemes and significant transfer of risk to the private investor. In the example described, a private investor, Goldman Sachs, received a $ 7 million guarantee from Bloomberg Philanthropies, a fund backed by New York Mayor Bloomberg.

SOCIAL INVESTMENT AS A TOOL FOR FUNDING MASS SPORT DEVELOPMENT PROGRAMS

Analysis of foreign literature did not reveal any issues of social impact bonds issued to finance programs aimed at the development of mass sports. At the same time, a number of international sports associations are actively implementing social projects. For example, the Union of European Football Associations (UEFA) is implementing the grassroots football Social Return on Investment (UEFA Grow SROI),[7] model, which aims to analyze the costs and benefits of such investments, and allows governments and national football associations to assess the social benefits of the most

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[6] Here and further — in 7 years of project implementation.

[7] URL: https://www.uefa.com/insideuefa/football-development/news/0264–10fe1ac0497c-ffe49c301d3e-1000—explainer-football-s-social-value/ (accessed on 01.10.2021).
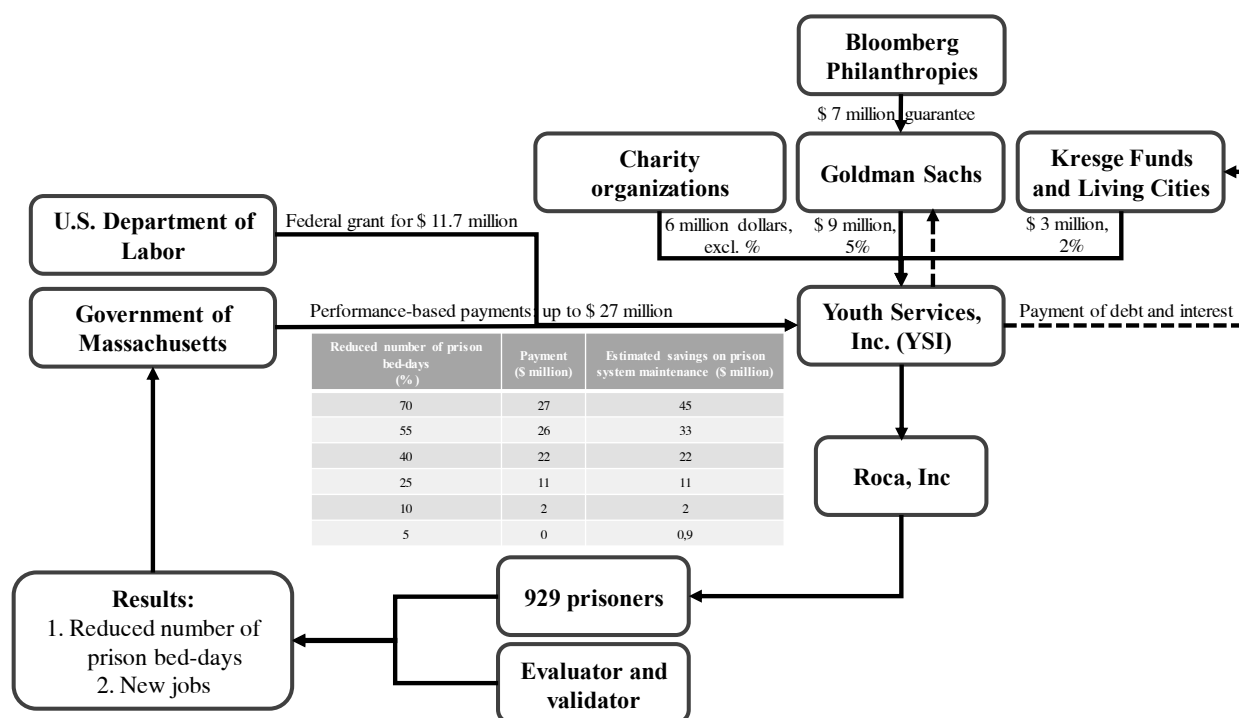
Fig. **Interaction scheme of the main participants
in the social program to reduce the recidivism rate among young people in Massachusetts**

Source: compiled by the author based on S. Pandey's study [15].

popular sports in Europe. This approach was pioneered in the UEFA Grow program, which brings together a number of strategic development programs. To date, the model shows that 8.6 million registered amateur players from 25 European countries bring cumulative savings of € 39.4 billion to EU countries annually in the following areas:

1. Economy: € 10.8 billion from football, travel, food and drink, equipment and gear, and infrastructure investments.

2. Society: € 12.3 billion from the positive social impact of football on communities: improved educational achievement, increased volunteering, reduced crime.

3. Health: € 16.3 billion in health care cost savings due to football's role in reducing the risk of type II diabetes, cardiovascular disease and improving mental health and wellbeing).

The model, developed with support from nine European universities, is based on grassroots football data from 25 UEFA member countries, as well as over 100 peer-reviewed research papers in various disciplines such as health, education, employment, sociology and sports. The European Union, the Council of Europe, the World Health Organization and the United Nations have confirmed the validity of this approach.

The developed Social Return on Investment Calculator enables associations to measure the economic, social and health benefits of amateur football for local communities. For example, spending on football kits at local stores; investments in football facilities (training equipment, fields, etc.); in-kind contribution of volunteer coaches to physical education.

The UEFA model proves that amateur football creates more added value for the national economy than professional football. The effect generated by German amateur teams is three times the revenues of all 18 clubs playing in the top division of the Bundesliga.

However, more than a third (35%) of UEFA member associations currently do not receive government support to develop grassroots football. Instead, these countries tend to place more emphasis on investing in professional football.

For example, in Eastern Europe, there is on average one registered amateur football club for every 44,000 inhabitants; in Western Europe, the equivalent ratio is one club per 6,500 people.

UEFA estimates that for every € 1 invested in football through the HatTrick funding program, national associations, governments, local authorities and clubs contributed an additional € 3.63.

In 2017, UEFA created an advisory group of academics and representatives from eight national associations to oversee the development and implementation of a social return on investment in European football. The group, including the author of this paper, develops a methodology for assessing the generated effects and monitors the results of the UEFA member countries.

The largest development institution — VEB. RF[8] — announced its readiness to participate in the implementation of social impact projects in Russia. It is interesting that in addition to such "classic" areas of support as the employment of young people and people with disabilities, family support, early childhood development, improving the quality of education, VEB.RF identifies programs aimed at engaging them in regular sports activities.

Russia is implementing the Concept for Increasing the Efficiency of Budget Expenditures for 2019–2024 (Order of the Government of the Russian Federation No. 117-r dated January 31, 2019), within the framework of which the Resolution of the Government of the Russian Federation No. 1491 of November 21, 2019, "On the pilot testing of social impact projects by the subjects of the Russian Federation in 2019–2024" was adopted. This Resolution entrusts VEB.RF with the function of the operator of social impact projects in Russia, whose functions include structuring the project, preparing a financial model to assess the effects created, searching for investors, monitoring project implementation and organizing an independent assessment.

In June 2019, the first social impact project in Russia was announced, aimed at improving the educational results of schoolchildren in the Republic of Sakha (Yakutia). It is planned that about 5 thousand students from 27 schools of the municipal district "Khangalassky ulus" will take part in the project. VEB's portfolio of projects also includes programs aimed at developing mass sports, at the initial stage of implementation.

Guided by the experience of foreign countries, we can conclude that the main problem of the social impact bonds is the control of results, namely the formation of objective target indicators and control of their achievement (including the reliability of the information provided).

As a basis for the development of such indicators, the Strategy for the Development of Physical Culture and Sports in the Russian Federation for the period up to 2030 can be used, which sets the target indicators presented in *Table 2*.

The issuance of social impact bonds will contribute to the achievement of the target value for such an indicator as the share of extra-budgetary funds in the total expenditures on the financing of physical culture and sports.

As noted earlier, measuring these metrics objectively can be a major challenge. This problem was noted in the report of the Accounts Chamber, published at the beginning of 2021, and can be solved only through regular and independent monitoring, which should be carried out in the context of the constituent entities of the Russian Federation.

An additional effective solution can be equipping sports grounds under construction with an electronic access system, combined into a single database. Among other things, registration in the system may provide for a number of benefits, including the recently approved personal income tax deduction.[9]

However, an increase in the number of people engaged in physical culture and sports is far from the only result that can be achieved and

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[8] URL: https://вэб.рф/ustojchivoe-razvitie/socialnoe-finansirovanie/veb-i-socialnoe-finansirovanie/ (accessed on 01.10.2021).

[9] URL: http://duma.gov.ru/news/50599/ (accessed on 01.10.2021).

Table 2

Target indicators set in the Strategy for the Development of Physical Culture and Sports in the Russian Federation for the period up to 2030

No.	Indicator	Target value, 2030
1	The level of population satisfaction with the created conditions for physical culture and sports, %	70
2	The share of children and youth aged 3–29 years, regularly engaged in physical culture and sports in the total number of children and youth, %	90
3	The share of middle-aged people (women 30–54 years old, men 30–59 years old) regularly engaged in physical culture and sports in the total number of middle-aged people, %	70
4	The share of senior people (women aged 55–79 years, men aged 60–79 years) regularly engaged in physical culture and sports in the total number of senior citizens, %	45
5	The level of provision of people with sports facilities, based on the one-time capacity of sports facilities, %	74

Source: compiled by the author based on the Strategy for the development of physical culture and sports in the Russian Federation for the period up to 2030.

used as a target in the framework of the issuance of social impact bonds. As with the UEFA project, it is worth considering measuring the overall social return on investment — SROI.

SOCIAL RETURN ON INVESTMENT IN MASS SPORT DEVELOPMENT

Most scientific studies have linked the beneficial effects of exercise to reduced morbidity. Their results show that physical activity brings primary (preventive) and secondary (therapeutic) benefits to the physical and mental health of the general population. This includes the prevention and treatment of chronic diseases, including cardiovascular disease, stroke, diabetes, obesity, certain types of cancer, various neurological conditions, and clinical depression [16–19]. The available data suggest that there are also such negative effects as sports injuries [20].

There is also strong evidence that sports and volunteering can have a positive impact on people's subjective wellbeing. Research shows that active people tend to be more satisfied and happier than people who are not physically active [21].

In other areas of social activity, including education, crime and social capital, there is sufficient evidence, albeit of lower quality, to suggest that sports and physical activity have net positive effects.

The literature suggests a positive relationship between physical activity and intermediate learning outcomes (such as behavior and attendance) and outcomes (such as achievement and progress) [22, 23].

Sport also has a positive effect on reducing antisocial behavior, especially in young men [24]. Nevertheless, some negative consequences are also highlighted, such as alcohol consumption by young people, and in some sports — aggressive behavior [25, 26].

There is evidence that physical activity and volunteering may increase social capital [17, 27].

Guided by all these effects, individual countries are investing in the development of mass

sports and setting appropriate goals. For example, in Quebec, $ 64 million has been invested in various activities to promote physical activity with a focus on schoolchildren. The main goal was to provide 60 minutes of daily physical activity for all children and to improve the following indicators: cognitive skills, educational achievement, wellbeing, physical and mental health, social skills and relationship skills [28].

> *Guided by the experience of foreign countries, we can conclude that the main problem of the social impact bonds is the control of results, namely the formation of objective target indicators and control of their achievement (including the reliability of the information provided).*

SROI is used to measure the social, economic and environmental value created by social programs for all stakeholders, and characterizes the performance of investments by comparing the value of all benefits with the value of the resources invested. For example, a 2:1 ratio means that $ 1 invested generates $ 2 of social value [29].

There are two types of SROIs: estimated, based on results achieved, and predictive. The first step for both types is to develop an impact map for all stakeholders (also called a theory of change or logic model) that shows the relationship between inputs and outputs and allows for the identification of target indicators. The next step is to evaluate the value of each result or monetize it. This is one of the main problems of the method since most of the generated effects are intangible (for example, subjective wellbeing or increased self-esteem). Financial proxies are used for calculations: they provide an estimate of the financial value of results or benefits that have no market value. The proxies themselves are justified by the use of a willingness to pay methodology, as

well as through an assessment of cost savings. For example, changes in health care costs or increases in income due to changes in employment status. Sometimes the results of the conducted research are combined into databases containing financial instruments for monetizing the results. For example, the HACT[10] database helps determine how increased self-confidence or good overall health affects a person's wellbeing and how much needs to be invested to improve results. Finally, to establish a real effect on investments, it is necessary to consider all additional factors that may affect the target indicators even without the implementation of the assessed program.

A study conducted by V. Gosselin, D. Boccanfuzo, S. Laberge [28] identified 17 SROI projects that were implemented in the field of mass sports and physical activity in the period from 2010 to 2018. Almost all of them have been fulfilled in the UK (76%) by private consulting firms (41%). The results highlight the wide range of impacts of levels of physical activity on society, primarily social inclusion, but also physical health and economic development. The SROI for mass sports projects ranges from 1.7:1 to 124:1. This confirms that each intervention analyzed provides a positive return on investment for the community. If we exclude the highest ratio and select only high-quality studies, the ratio would range from 3:1 to 12.5:1. In comparison, the public health SROI ranges from 1.1:1 to 65:1.

L. E. Davis et al. [30] used the SROI model to measure the impact of sports and physical activity in 12 public sports and leisure facilities in Sheffield. The main effects were measured using surveys and measurements. The sample consisted of more than 15 thousand people. Following medical examinations, they completed a 12-week, instructor-led, individualized exercise program that included a gym exercise program. Five face-to-face consultations were held throughout the program. The study found that for every £ 1 invested, an SROI of £ 1.20 to £ 3.42 was generated.

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[10] HACT: Value calculator. URL: https://www.hact.org.uk/value-calculator (2018) (accessed on 01.10.2021).

An earlier study by Davies et al. [31] has already affected the whole of the UK and showed that the social value of physical activity is £ 44.8 billion, and the total financial and non-financial spending on sports was £ 23.5 billion, which is equivalent to an SROI ration of 1.91.

The main purpose of the SROI model is to justify the financing of individual projects by the monetary valuation of all the benefits of sport to society. This will prove extremely useful in the context of social impact bond issuance and target setting. The main limitation remains the difficulty of assessing intangible effects, which leaves room for the manipulation of net profit.

CONCLUSIONS AND RECOMMENDATIONS

This paper considers the phenomenon of social impact bonds and provides an assumption about the possibility of using this tool in funding projects aimed at developing mass sports and increasing the level of physical activity.

The author analyzed in detail the foreign experience of issuing social impact bonds and revealed the following advantages of this model:

10. Possibility of attracting private capital for the implementation of social projects.

11. Larger volumes of funding, especially in comparison with regional budgets.

12. The need to pay only if the result is achieved.

13. Budget funds savings.

14. Formation of a number of indirect effects: the creation of new jobs, an increase in tax revenues.

The main limitations of the SIB model are related to the measurement and validation of the results of the implementation of social programs. Additional difficulties are caused by assessing the relationship between the program and its result: it is necessary to consider the influence of all external factors that can potentially affect the achievement of target indicators. Finally, it becomes necessary to pay additional costs, which would not happen in the case of direct financing from the state: profitability and guarantees for private investors.

The SIB model was examined using a specific example — a program implemented in New York and aimed at reducing the crime rate among young people. This example described the scheme of interaction of all participants and stakeholders and illustrated the accompanying advantages and disadvantages. In the future, this model can be transferred to the Russian experience and used as a model for launching a similar project, but for the development of sports projects.

Based on foreign experience, it can be concluded that the advantages of SIB prevail over the disadvantages and high potential of this tool. This conclusion allowed the author to suggest the possibility of using social impact bonds to finance programs for the development of mass sports. Among other things, a system of target indicators was proposed, including such a metric as social return on investment — SROI.

For Russian conditions, the following recommendations can be formulated for launching the mechanism of social impact bonds:

1. Collection of up-to-date information on the number of people engaged in physical culture and sports in terms of gender and age; kinds of sports; duration and frequency of classes; health status; associated costs and willingness to pay; regions.

2. Justification of *real* target values for the period up to 2030.

3. Amendments to the relevant regulations governing the financing of mass sports.

4. Selection of regions for the implementation of pilot projects.

5. Search and attraction of private investors.

Particular attention should be paid to the reasonable spending of budgetary funds and control over payments when the target indicators are achieved.

Further research in this field may be aimed at clarifying the methodology for calculating the SROI for programs implying an increase in the level of physical activity of the population, and evaluating specific projects in this area.

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Phishing Schemes in the Banking Sector: Recommendations to Internet Users on Protection and Development of Regulatory Tasks

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ABSTRACT

The **aim and objectives** of the article are to analyze fraudulent phishing schemes and develop recommendations for Internet use and relevant regulatory tasks. The **relevance** of the article is due to the peculiarities of working in cyberspace with the emergence of new sources of banking risks, both for customers and organizations. The **scientific novelty** of the manuscript consists of a detailed analysis of phishing schemes, the development of recommendations and directions in relation to the Russian Federation. The **object** of the study is cyber fraud in the credit and financial sphere; the **subject** is social engineering and phishing schemes. The **methodology** of the paper includes a systematic analysis of the literature and sources on the research topic, general scientific methods (analysis, synthesis, deduction, analogy, classification), correlation analysis of data, graphical visualization of information. The authors **consider** the main methods of phishing and the most common techniques used by cybercriminals. Based on the critical analysis of the literature the authors determined a promising direction for the scientific and technical potential of Russia. A correlation analysis of the relationship between the number of cybercrimes and commercial banks is performed. The study offers **recommendations** to Internet users (how to recognize the signs of fraud), and to regulatory bodies on improving the system of supervision over the dissemination of information in cyberspace. The authors **concluded** that it is necessary to increase the level of cyber literacy and general literacy of the population, on the one hand, and to modernize the methods of supervision and control of the information posted on the Internet, on the other hand, to effectively counter financial and cybercrime. The research **results** can be used in the further development of remote banking services for the population to increase competitiveness in the banking services market. **Prospects** for further research on this topic lie in expanding its structure, developing the competencies of specialists in the field of remote banking technologies, as well as developing the scientific and technical potential of Russia.

Keywords: cyberspace; phishing; cybersecurity; cyber literacy; remote banking services; risks; attacker; user; fictitious organization

INTRODUCTION

In today's world, the amount of time spent on the Internet is increasing. The Internet not only provides access to the required information, but also allows making online purchases, bank transfers and payments. The global amount of information generated by people, governments and businesses will more than fivefold to 175 zettabytes by 2025 (1 zettabyte requires 34.4 billion 32GB drives), up from 33 zettabytes today.[1]

The active development of information and communication technologies and their use in most spheres of human activity makes new cybersecurity issues and information protection in cyberspace relevant. There is a need to develop new algorithms and methods for assessing risks (examples of such developments can be found in [1]). Algorithms and methods should be associated with certain features of the functioning of corporate information systems of commercial banks, including various options for electronic banking (Internet banking, mobile banking, etc.).

The ISO/IEC 27032:2012 standard describes cyberspace as "a complex environment resulting from the interaction of users connected to the global Internet, hardware and software, and the services provided on this network. This environment exists in a virtual (constructed), and not in a material (physical) form". At the same time, cybersecurity is "maintaining the confidentiality, integrity and availability of information in cyberspace".[2]

Robert Metcalfe's Law can be applied to cyberspace, which determines the growth in value (utility) of a network with an increase in the number of devices connected to each other via the Internet:

$$V_n \approx n^2/2.$$

This is explained by the fact that the graph K_n contains $n \cdot (n-1)/2$ edges (links) at the n vertices (technologies). This value approaches $n^2/2$ asymptotically. It is worth adding that in economics, Metcalfe's law is a characteristic of a positive network effect. Today, more than half of the world's population (more than 4.6 billion people) uses the Internet (*Fig. 1*).

The use of "master keys" by a hacker not to the computer, but to the user's logic is informational and psychological impact (IPI, social engineering). In the book [2], the arsenal of basic tools and psychological techniques of a social hacker (transactional analysis, neuro-linguistic programming) is characterized by numerous examples, methods of protection against social hacking are considered. Despite some obsolescence of the book, the advice given are still relevant to this day. The peculiarities of the provision of financial services in cyberspace were analyzed in a collective work [3]. The book highlights the methodology of ensuring cybersecurity in electronic banking technologies and reducing the risks arising from the use of remote banking services.

In the monograph [4], the author (an employee of the Institute of the USA and Canada of the Russian Academy of Sciences) creates an extensive and fact-filled picture of the risks of information security breaches in the social, military, political and economic life of the USA, the growth of which entails a sharp increase in the impact of cyberspace objects on real life. The book is interdisciplinary in nature: it touches on issues related to various sciences (sociology, political science, economics), and convinces readers to apply a multidimensional approach to analyzing the problems of the information society.

In the human brain there are nerve cells that are activated not only when performing a certain action, but also when a person observes the performance of this action by others — these are mirror neurons [5]. Knowledge of mirror neurons helped Chinese researchers in the early 21st century, when they sent a delegation to the US corporations (Apple, Microsoft, Google) to ask inventors

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[1] Expert: The volume of data in the world by 2025 will grow more than fivefold. URL: https://tass.ru/ekonomika/6209822 (accessed on 10.01.2021).

[2] ISO/IEC 27032:2012. Information technology. Security techniques. Guidelines for cybersecurity. International Organization for Standardization. URL: http://www.iso.org/standard/44375.html (accessed on 05.01.2021).
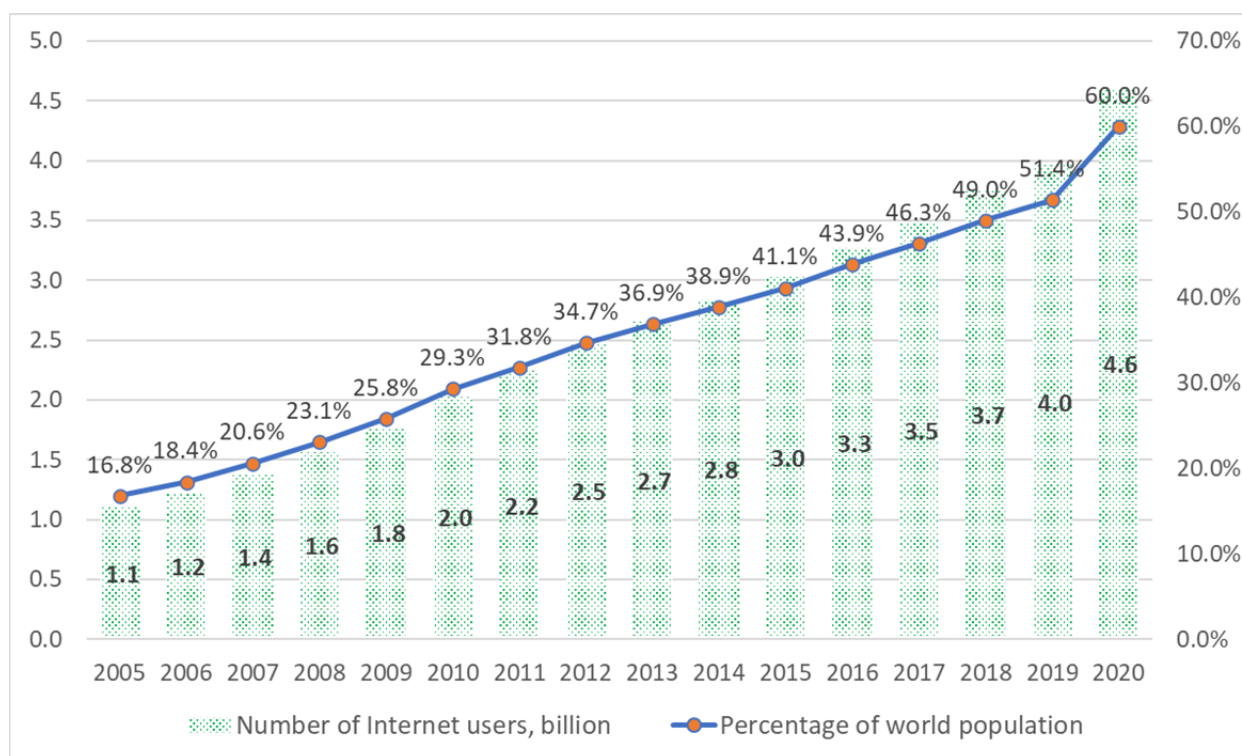
Fig. 1. Dynamics of the number of Internet users and their share of the world population
Source: Internet access (global market). URL: https://www.tadviser.ru/a/53635 (accessed on 10.01.2021).

about their lifestyle. After that, works of the favorite genre of literature of inventors (science fiction) were included in the educational program of China on literature, and today the developments of Alibaba, Xiaomi, Huawei are among the world leaders [6–7]. Human exposure to the mood healing works of Georgy Sytin and Dale Carnegie is also associated with the effect of mirror neurons, which was first noted in this article.

The authors of the article propose to add the utopian HSF novel[3] by the Soviet scientist I. A. Efremov "Andromeda Nebula" to the list of "100 books for schoolchildren" from the Ministry of Education and Science of Russia. As in the case of China, attention to the HSF literature (in parallel with the development of fundamental and applied sciences) will lead to competitive import substitution in the field of digital technologies, and Russia will become famous not only for military equipment

(which was mainly developed in the USSR [8]), but also peaceful electronics (computers, smartphones, household appliances). We emphasize that without observance of *formal logic* and *financial literacy*, both science fiction and phishing remain just a set of sophisms.

Motivational and informative but by no means a fantastic book telling about the history of Russian startups in the Republic of Sakha (Yakutia) is [9]. The author (founder and CEO) characterizes the emergence and development of the Sinet Team IT company, the Ykt.Ru information portal and the international Internet aggregator of taxi services inDriver through the prism of historical events in Russia and his own life experience. Cybersecurity issues (chargeback — demanding a refund of a payment not authorized by the current cardholder) for the inDriver Yakut taxi arose only in New York.

Popular science book [10] characterizes risk factors in various areas: from financial systems and nuclear power plants to aircraft

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[3] Hard science fiction (HSF) is a sub-genre of science fiction that focuses on scientific and technological progress.

and digital platforms. The authors use the concepts of the complexity of the system and the rigidity of the connectivity of its elements to determine the causes of failures and disruptions in the operation of systems. Developing the theory of "normal accidents" by Charles Perrow, the authors analyze the disasters that have occurred, offering specific tools and practical recommendations that can prevent unwanted consequences.

Thus, the analysis of information and cybersecurity is now considered quite widely, as cyberspace has become the fifth theater of warfare after land, sea, air and space.

CYBERCRIME IN BANKING: PHISHING

Along with the emergence of the conveniences provided by cyberspace, new methods of fraud have emerged. The most active fraudulent activity on the Internet is carried out in the credit and financial sector and in the retail sector. First of all, this is due to the fact that in these areas attackers can get the greatest material benefit.

Phishing is one of the most common methods of committing fraud in cyberspace, which is used to steal passwords and confidential information by misleading the client. Usually, a fraudster copies the source code of the official page (this function is available in any browser) and saves it in a text editor. Further, in the source code, the original URL for logging into the system is replaced with the address of the program (script), which specifies the conditions for substituting addresses, the algorithm of actions after entering the registration data, and the way the fraudster receives this data. The main work of creating a phishing page is now complete. With a domain and hosting, a hacker places his page on the Internet and redirects users to it [11].

In Q1 2020, phishing emails were linked to the COVID-19. At the same time, almost half of them (44%) were sent to individuals and every fifth — to government organizations.[4]

Let us determine the closeness of the relationship between the statistics of the Ministry of Internal Affairs of Russia on crimes in the field of computer information, the preliminary investigation of which is mandatory, and the data of the Central Bank of the Russian Federation on the number of credit institutions in Russia (*Table 1*).

Let us determine the standard deviation

$$\sigma_x \approx \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n} - \bar{x}^2} \text{ and } \sigma_y \approx \sqrt{\frac{\sum_{i=1}^{n} y_i^2}{n} - \bar{y}^2}:$$

$$\sigma_x = \sqrt{\frac{17812989}{18} - 950,2^2} \approx 294,5$$

and $\sigma_y = \sqrt{\dfrac{712122038}{18} - 5354,2^2} \approx 3300,7.$

And find the covariance $C_{xy} \approx \dfrac{\sum_{i=1}^{n} x_i y_i}{n} - \bar{x} \cdot \bar{y}:$

$$C_{xy} = 5\,774\,002 - 950,2 \cdot 5354,2 \approx 686\,441,16.$$

The correlation coefficient $r_{xy} = \dfrac{C_{xy}}{\sigma_x \sigma_y}$ is

$$r_{xy} = \frac{686\,441,16}{294,5 \cdot 3300,7} \approx 0,71.$$

The correlation value $r_{xy} \approx 0,71$ confirms the progress and optimization results.[5] The elimination of financial "vacuum cleaners" that attract depositors with risky transactions to transfer their money abroad leads to the optimization of financial activities and an increase in the reliability of banking information protection means due to the development of telecommunication technologies and a gradual transition from traditional banking to online platforms.

These phenomena are constantly changing, which complicates the process of detecting and solving crimes committed in cyberspace. As information technology develops, special tools and programs appear to detect and prevent attacks on users on the Internet.

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[4] Positive Technologies: About 13% of all phishing attacks are related to the COVID-19. URL: https://www.securitylab.ru/news/509238.php (accessed on 08.01.2021).

[5] Calculations can be carried out automatically in programs for processing statistical data [12], but for clarity, a manual calculation is given.

Data of the Bank of Russia and the Ministry of Internal Affairs of Russia

Year	Banks (X)	Crimes (Y)	X^2	Y^2	$X \cdot Y$
2003	1,329	7,540	1,766,241	56,851,600	10,020,660
2004	1,329	8,739	1,766,241	76,370,121	11,614,131
2005	1,299	10,214	1,687,401	104,325,796	13,267,986
2006	1,253	8,889	1,570,009	79,014,321	11,137,917
2007	1,189	7,236	1,413,721	52,359,696	8,603,604
2008	1,136	9,010	1,290,496	81,180,100	10,235,360
2009	1,108	11,636	1,227,664	135,396,496	12,892,688
2010	1,058	7,398	1,119,364	54,730,404	7,827,084
2011	1,012	2,698	1,024,144	7,279,204	2,730,376
2012	978	2,820	956,484	7,952,400	2,757,960
2013	956	2,563	913,936	6,568,969	2,450,228
2014	923	1,739	851,929	3,024,121	1,605,097
2015	834	2,382	695,556	5,673,924	1,986,588
2016	733	1,748	537,289	3,055,504	1,281,284
2017	623	1,883	388,129	3,545,689	1,173,109
2018	490	2,500	240,100	6,250,000	1,225,000
2019	442	2,883	195,364	8,311,689	1,274,286
2020	411	4,498	168,921	20,232,004	1,848,678
Total	17,103	96,376	17,812,989	712,122,038	103,932,036
Average	950.2	5,354.2	989,610.5	39,562,335.4	5,774,002

Source: Information about the banking system of the Russian Federation. Central Bank of the Russian Federation (Bank of Russia). URL: https://www.cbr.ru/statistics/? PrtId=lic (accessed on 21.01.2021). The state of crime (archival data). Ministry of Internal Affairs of the Russian Federation. URL: https://mvd.ru/folder/101762 (accessed on 21.01.2021).

Information security specialists divide cyberattacks into the following main groups:
- phishing;
- social engineering (IPI);
- malware [13].

Phishing attacks combine social engineering and the use of malware, making them one of the main and most dangerous ways to carry out attacks on the Internet [14].

For the purposes of this article, phishing will mean an information system used to obtain confidential information from third parties (system users) by misleading them as to its authenticity due to the similarity

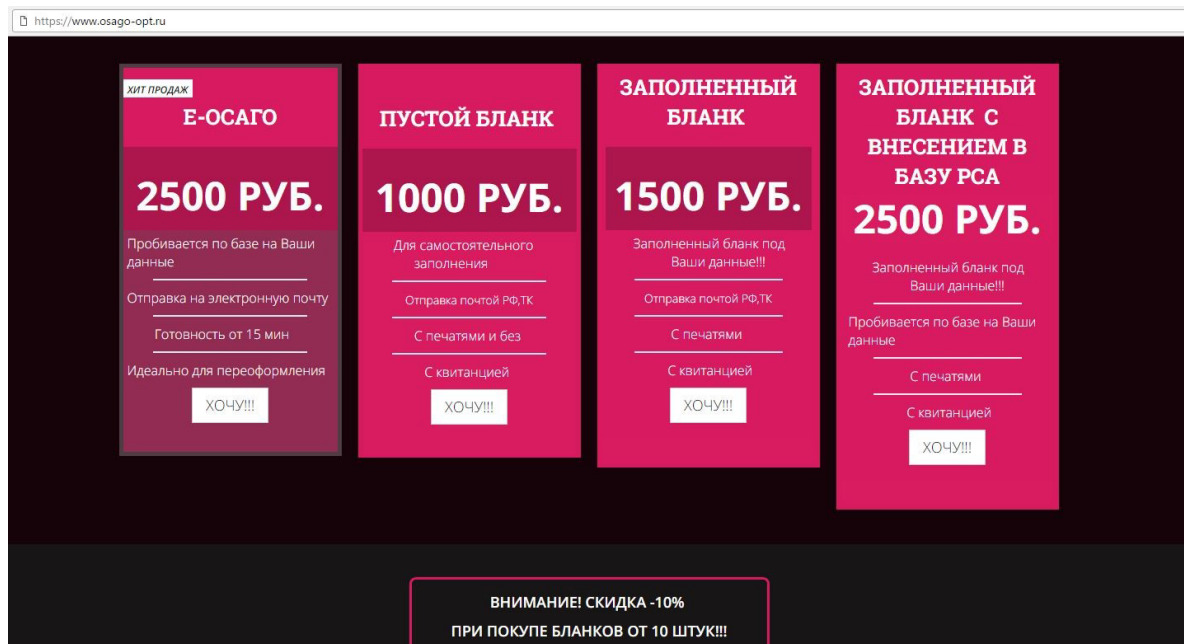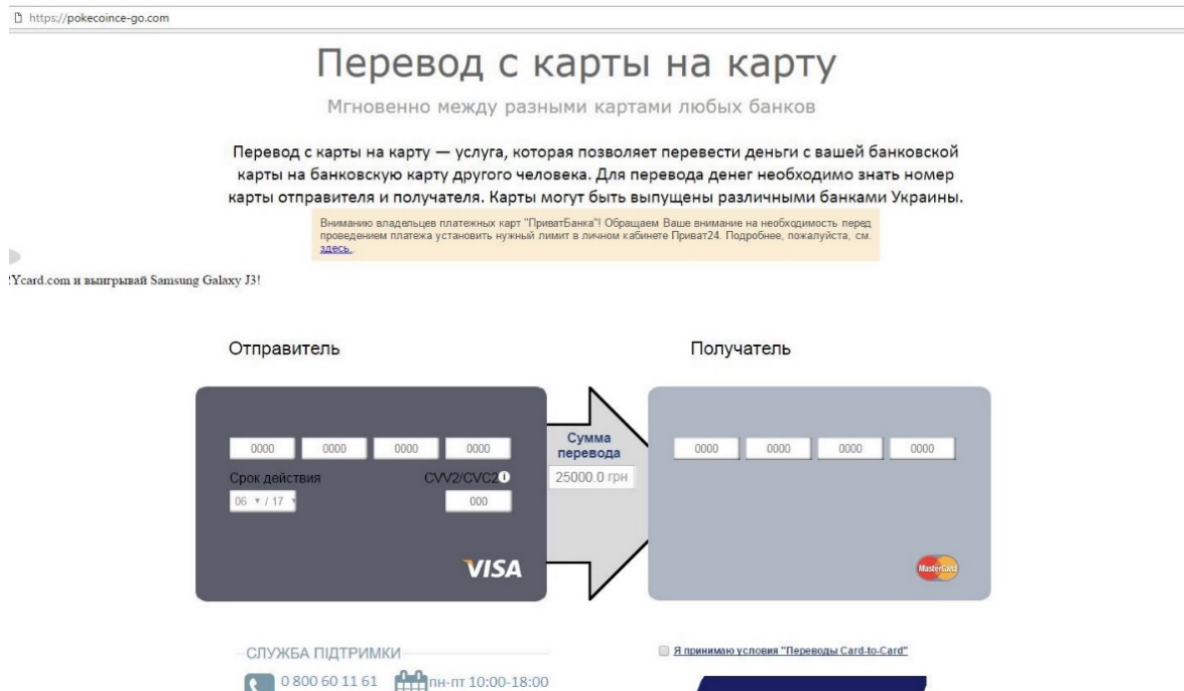*Fig. 2.* **Example of a phishing website of a fictitious bank**

Source: [3] and lecture by Eugene V. Kaspersky, CEO of Kaspersky Lab at the Financial University — full version. URL: https://youtu.be/s2YLFXQVkPc (accessed on 27.05.2021).

of domain names, design, or content of information.[6] Based on this approach to phishing, we will consider the most common online scams.

FAKE BANKS

One of the most common categories of phishing resources is websites of fictitious (non-existent, fake) banks. An unscrupulous person creates a "bank" resource and begins to attract funds from citizens and legal entities for deposits. The user of the resource does not think about the legality of the activity of this person, since the interface of a non-existent "credit organization" is very similar to the interface of an operating bank [15]. Unfortunately, freedom of speech sometimes develops into the freedom of disinformation.

Fake documents presented on the resource (such as copies of licenses and powers of attorney) give the consumer the impression that this bank is legal (*Fig. 2*).

On behalf of the bank, the attackers are ready to provide all kinds of loans. When a consumer contacts such a bank (with a request

to provide him, for example, a mortgage loan), his application is approved and he is asked to pay for the courier delivery of the contract and the sum insured. After the payment, the bank stops any communication with the client.

According to the official statistics of the Bank of Russia,[7] in Q3 2020, 375 sites of fake banks were identified, of which 95% of websites were blocked. It should be noted that the number of fake banks has tripled compared to the same period in 2019. Presumably, this is due to the expansion of people' need for money, as well as the expansion of the range of remote provision of financial services during the COVID-19 pandemic, which caused a reorientation of fraudsters in this area.

Also, cybercriminals actively use the names of operating banks and create clone sites or twin sites, which allows them to deceive the user [16].

Here is a list of the signs of phishing resources in this category:

1. Lack of information about the organization in the reference books (registers) of the Bank of Russia.

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[6] Domain names registration rules in.RU and.РФ domain zones. URL: https://cctld.ru/ru/docs/project/algoritm/rules_draft.pdf (accessed on 17.01.2021).

[7] Review of the reporting of information security incidents during the transfer of funds. URL: https://www.cbr.ru/analytics/ib/review_3q_2020/ (accessed on 01.02.2021).

The official website of the Central Bank of the Russian Federation (URL: http://www.cbr.ru) contains:

• Book of state registration of credit institutions.

• Reference book on credit institutions.

2. Lack of information about the organization in the relevant registers of the Federal Tax Service of the Russian Federation and Roskomnadzor.

Information about the organization presented on the site can also be checked in the following registries:

• The Unified State Register of Legal Entities is posted on the official website of the Federal Tax Service (FTS) of the Russian Federation.

• The register of operators processing personal data is posted on the official website of Roskomnadzor of Russia.

Fake banks have become one of the most common methods of fraud in Russia, since attackers do not need to accurately copy the resources of real credit institutions, it is enough to place tabs with the name "Loan", "Deposits", etc. on the site. These names can mislead the user and give him a real idea that he is on the site of an operating bank.

Consumers need to pay attention to the design of the resource: fraudsters, as a rule, do not bother to post the relevant documentation on the "official website" (in some cases, they do not even indicate the license number for operations).

FAKE INSURANCE COMPANIES

The emergence of the possibility of issuing electronic compulsory motor third party liability insurance (OSAGO) using the Internet not only made life easier for drivers but also provoked an increase in fraud in this area.

Within this category, the attacker acts in various ways:

• creates a copy of the resource of an operating insurance company with proposals for issuing electronic OSAGO;

• offers for sale fake or unsecured insurance company forms.

The consumer either pays for a falsified OSAGO or pays for delivery and buys fake forms.[8]

According to the statistics of FinCERT of the Bank of Russia, in the period from 01.09.2018 to 31.08.2019, 22 resources were removed from the delegation, on which the activities of fake insurance organizations were carried out.[9]

The phishing site of an insurance company allows the consumer to create a false impression that the purchase of a form does not entail negative consequences for the consumer. However, when acquiring knowingly false, empty and invalid forms, the consumer loses the opportunity to claim insurance compensation in the event of an insured event.

Fake insurance companies are becoming quite common in Russia due to the fact that the consumer is trying to save time and money when drawing up an insurance certificate in the hope that an insured event will not occur [2].

Also, in practice, there are cases when an insurance company creates a resource and pretends to be an organization that provides insurance services. The consumer orders this or that insurance service, pays for it by transferring the money to the insurer's card or to his account. The insurer undertakes to deliver the insurance certificate or provide another service at a certain time but never provides the offered certificate or service to the consumer (*Fig. 3*).

In this regard, the consumer should not only pay attention to the design and content of the resource of the insurance company but also check this organization in the relevant directories and registers (in the Directory of financial market participants of the Bank of

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[8] According to Art. 327 "Forgery, manufacture or circulation of forged documents, state awards, stamps, seals or letterheads" of the Criminal Code of the Russian Federation both sellers and buyers answer in law.

[9] For more details see "Report of the Center for Monitoring and Responding to Computer Attacks in the Credit and Financial Sphere of the Information Security Department of the Bank of Russia" posted on the official website of the Bank of Russia. URL: https://cbr.ru/Content/Document/File/84354/FINCERT_report_20191010.PDF (accessed on 02.02.2021).
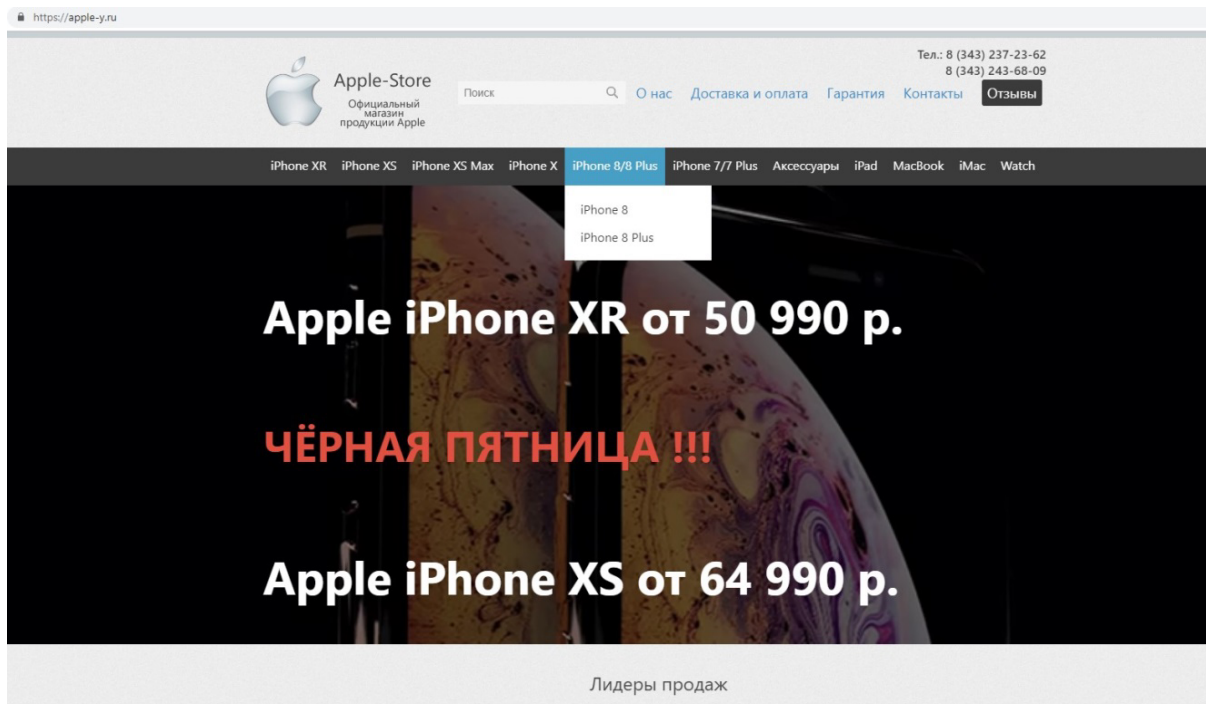
Fig. 3. **Example of a phishing website of a fictitious insurance company**

Source: [3] and lecture by Eugene V. Kaspersky, CEO of Kaspersky Lab at the Financial University — full version. URL: https://youtu.be/s2YLFXQVkPc (accessed on 28.05.2021).

Russia,[10] in the list of the Russian Union of Auto Insurers[11]).

FAKE P2P (PEER-TO-PEER)

This category is one of the most attractive for cybercrime, due to the simplicity of the design of an information resource for theft of funds. Attackers using this method get access to confidential information of both the payment card and the consumer himself. According to the statistics of FinCERT of the Bank of Russia, in the period from 01.09.2018 to 31.08.2019, 132 sites were removed from the delegation, which pretended to be resources that provide services for P2P transfers.[12]

The simplicity of the design of information resources that provide services for P2P

transfers allows fraudsters to fake them easily: an image of plastic cards is drawn up, and the emblems and names of payment systems or a credit institution are indicated. These attributes allow the consumer to form a false idea that he is on the site of an operating organization (*Fig. 4*).

It should be noted that the user transfers to the attackers not only his personal data but also the number of the third party's payment card to which he makes a remote transfer.

Such resources are very attractive for consumers since they offer services for an interest-free transfer or a transfer with a low percentage of funds between payment cards of different banks or payment systems [17].

Avoiding the use of unscrupulous resources will help to check the presence of the organization in the Register of payment system operators of the Bank of Russia, as well as the use of a secure connection when making a transfer.

At the same time, if the resource indicates that the services are provided by any credit institution, then it is necessary to check the presence of this organization in the corresponding list of the Bank of Russia.

[10] Directory of participants in the financial market of the Bank of Russia. URL: http://www.cbr.ru (accessed on 02.02.2021).

[11] Is the organization's web address included in the list of the Russian Union of Auto Insurers? URL: https://www.autoins.ru/e-osago/chleny-rsa-osushchestvlyayushchie-oformlenie-elektronnykh-polisov/ (accessed on 02.02.2021).

[12] For more details see «Report of the Center for Monitoring and Responding to Computer Attacks in the Credit and Financial Sphere of the Information Security Department of the Bank of Russia». Official website of the Bank of Russia. URL: https://cbr.ru/Content/Document/File/84354/FINCERT_report_20191010.PDF (accessed on 02.02.2021).

Fig. 4. **Example of a phishing website of a fictitious P2P system**

Source: [3] and lecture by Eugene V. Kaspersky, CEO of Kaspersky Lab at the Financial University — full version. URL: https://youtu.be/s2YLFXQVkPc (accessed on 29.05.2021).

FAKE ONLINE STORES

Online stores attract customers with their prices (due to savings on the rental of premises), as well as the possibility of convenient delivery.[13] Online stores attract customers with their prices (due to savings on the rental of premises), as well as the possibility of convenient delivery. The scheme of fraud, in this case, is the same: as soon as the buyer transfers his money to the seller's account, communication with him is ceased (the store's website stops working, there is no response by e-mail).

The design and content of the resources are also similar to the sites of the operating organizations (*Fig. 5*) [18].

To protect themselves and purchase the appropriate product, the consumers need to check the information about the organization that provides the goods or services indicated on the site,[14] as well as reviews and the domain name in the search engine.

FRAUD

This category is generalized. It contains fraud schemes that are carried out by organizations using the Internet. These schemes of fraudulent activities of fictitious organizations can be divided into the following subtypes:

• an organization conducting fake surveys under the pretext of paying a reward;
• an organization promising employment;
• an organization offering to formalize the payment of non-existent compensation (*Fig. 6*) [19];
• the organization issuing the "COVID-19 Vaccination Certificate".[15]

Attackers attract users by providing an opportunity to get money quickly. Users,

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[13] In a number of cases, the seller justifies these prices, sometimes not at all hiding such facts as "stolen goods", "confiscated", etc. Therefore, if the victim decides to buy such a product, then it is unlikely that he will later go to complain, since, in fact, he is an accomplice in the crime (buying stolen goods).

[14] This information can be checked on the official website of the Unified State Register of Legal Entities of the Federal Tax Service of the Russian Federation. URL: https://egrul.nalog.ru (accessed on 26.10.2021).

[15] "The same as the original": How scammers sell COVID passports in Russia. URL: https://ria.ru/20210303/covid-1599609177.html (accessed on 14.03.2021).

Fig. 5. **Example of a phishing website of a fictitious online store**

Source: [3] and lecture by Eugene V. Kaspersky, CEO of Kaspersky Lab at the Financial University — full version. URL: https://youtu.be/s2YLFXQVkPc (accessed on 01.06.2021).

counting on this, transfer personal data to cybercriminals, including bank card data, to transfer the promised salary.[16]

The interface of resources in this category is identical to the interfaces of official resources, which allows misleading the client about generating income.

A user on this resource takes a survey (test), which consists of 7–10 simple questions. Once the survey is complete, the resource generates a fictitious prize and invites the user to transfer funds to his payment card. To save money and arrange their withdrawal to the resource, it is proposed to post a deposit.[17] The user provides the attackers with the card details and personal data, which allows the scammers to write off funds from his payment card [20].

In addition to surveys, fraudsters offer various compensation (for example, for medical services). As a rule, the resource contains non-existent documentation of the Government of the Russian Federation, which makes it possible to return and pay compensation to the population.

Users (most often pensioners) are actively involved in this category of resources through calls and SMS-mailings, in which people are convinced that compensation is provided within the framework of one of the federal programs and does not lend itself to publicity, since there is a payment limit.

Attention should be paid to the fact that surveys and compensation can be carried out both by real organizations and by government services. In order not to become a victim of fraudsters, you need to pay attention to the following signs, which most often indicate the fraudulent nature of the resource in this category:

• transfer of funds to third parties as payment;

• the lack of an organization in the Unified State Register of Legal Entities of the Federal Tax Service of Russia;

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[16] It is not uncommon for people to pay an insurance premium for the provision of orders or to fix payments to find a non-existent job, or it is proposed to pay for the delivery of an employment contract.

[17] The payment amount is insignificant and ranges from 250 to 1000 rubles.
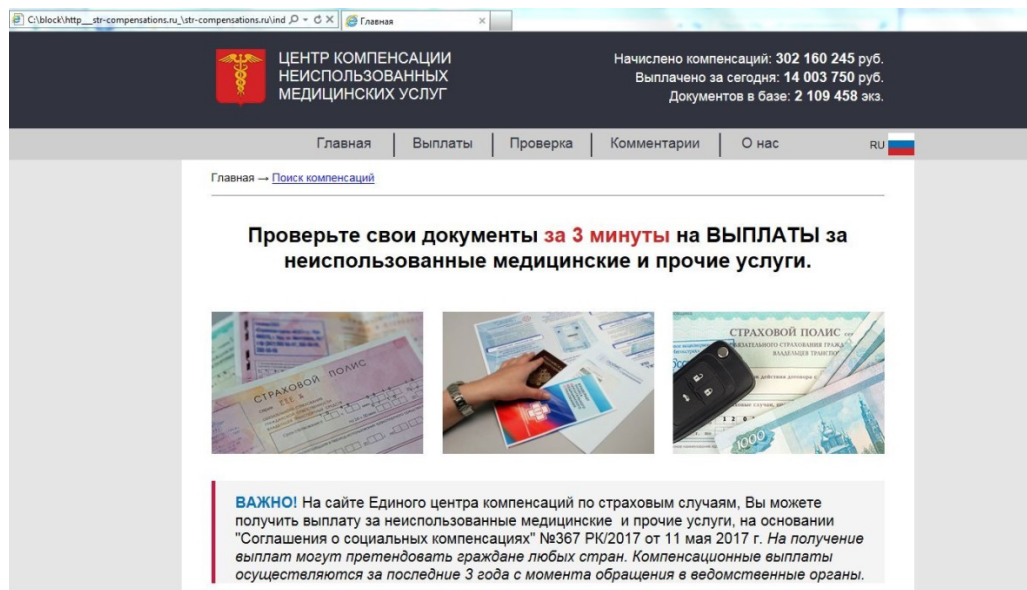
Fig. 6. **Example of a phishing website with information about payments of non-existent compensation**
Source: [3] and lecture by Eugene V. Kaspersky, CEO of Kaspersky Lab at the Financial University — full version. URL: https://youtu.be/s2YLFXQVkPc (accessed on 02.06.2021).

• carrying out activities not provided for by the license (permit);

• reviews of real people about the organization, found online (Yandex, Google).

Counteraction to this type of fraud is carried out not only by law enforcement but also by regulatory authorities. In accordance with the regulations of the Bank of Russia, credit and non-credit financial institutions inform the Bank of Russia when information and financial security incidents are detected,[18] and also notify about identified phishing resources [21].

Supervisory measures by the Bank of Russia and Roskomnadzor are aimed primarily

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[18] For more details see the regulation of the Bank of Russia dated 09.06.2012 No. 382-P "On the requirements for ensuring the protection of information when making money transfers and on the procedure for the Bank of Russia to monitor compliance with the requirements for ensuring the protection of information when making money transfers", Regulation of the Bank of Russia dated 17.04.2019 No. 683-P "On the establishment of mandatory requirements for credit institutions to ensure the protection of information in the implementation of banking activities in order to counteract the transfer of funds without the consent of the client", Regulation of the Bank of Russia dated 17.04.2019 No. 684-P "On the establishment of mandatory requirements for non-bank financial organizations to ensure the protection of information when carrying out activities in the field of financial markets in order to counter the implementation of illegal financial transactions".

at ensuring the stability of the financial system and the protection of creditors and depositors. Such activities are based on an integrated approach: compliance with regulations, timely notification of the Bank of Russia and comprehensive analysis within the framework of supervisory measures allow credit and non-credit financial institutions to minimize the risks of adverse consequences both for themselves and their clients, as well as increase the level of information safety and security.

IMPROVING CYBERSPACE CONTROL
Given the active use of cyberspace in the provision of various types of banking services, it is necessary to understand that the regulatory authorities are faced with a rather difficult task — to build effective supervision over the reliability of information posted on Web-representations of financial institutions. Obviously, such work should be carried out with active interaction with law enforcement agencies to take timely measures to prevent fraudulent actions (close fraudulent resources as soon as possible and take measures to bring the perpetrators to justice) [3, 22].

An important role in reducing cybercrime is also assigned to increasing the overall level

SUPERVISION and MONITORING by regulatory bodies

It is necessary to ensure control over the "purity" of cyberspace — to improve the quality of interaction between regulatory and law enforcement agencies to reduce the time it takes to identify fraudulent resources on the Internet

INTERNET USERS

CYBER LITERACY and CYBER HYGIENE activities for INTERNET users

Fake bank

Fake online store

Fake insurance company

Fake P2P

Cybercriminals and their counterfeiters create fraudulent (phishing) sites for non-existent organizations and, using social engineering techniques, lure Internet users to these fraudulent resources

Fig. 7. **Measures to control cyberspace**
Source: complied by the authors.

of cyber literacy among all groups of the population (*Fig. 7*). One of the most effective ways is to include specialized disciplines (courses) in educational programs for students of secondary and higher educational institutions, according to which students will gain knowledge in the field of functioning of new financial technologies, as well as in basic methods ensuring cybersecurity (including specific topics on countering cyber fraud).

In addition, the literature discussed in the first part of the article "Introduction" will contribute to an increase in the level of cyber literacy and general literacy of the population. Since the beginning of June 2021, the Bank of Russia has published a list of companies with identified signs of illegal activity in the financial market (the so-called "black" list): https://cbr.ru/inside/warning-list/, which includes, among other things, and phishing companies. If the organization is on this list,

then it is better to ignore its services and leave. If a client has encountered a fraudulent company, but it is not on the list, he can report it.[19]

Phishing prevention also includes watching TV programs such as "Eduard Petrov's Investigation. Internet pandemic, or COVID-19 Cult — Russia 24" (URL: https://youtu.be/0hklRanOSxI) and "Finiko Finale. Special Report — Russia 24" (URL: https://youtu.be/5OtEZtLw9bE), which illustrate the results of human belief in magic pills and financial pyramids.[20] Thus, a control system in cyberspace will be developed

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[19] More details: "The Central Bank has published a blacklist of 1.8 thousand illegal companies". URL: https://www.rbc.ru/finances/01/06/2021/60b5fbdc9a79471a267396e1 (accessed on 25.07.2021).

[20] Only fakes about the miraculous effect of eating…fly agarics, which are gaining popularity, can surpass the existing phishing methods. (see URL: https://smotrim.ru/article/2639202).

and the cultural behavior of all cyberspace participants will be enhanced.

CONCLUSIONS

The contribution to the development of theoretical and applied science consists in adapting solutions for the development of scientific and technological progress in Russia based on the positive experience of China, as well as in expanding the methodological apparatus of information security and cyber literacy.

The new reality and cybersecurity challenges that both financial institutions and their clients are forced to face when using remote banking technologies require modernization, and in some cases, a significant revision of risk management procedures, including new procedures for controlling information posted on the web-representations (sites) of organizations [15]. It is also necessary to increase the level of cyber literacy of various groups of the population.

The lag in cyber literacy is becoming the main reason for stealing money from clients of organizations in the credit and financial sector. In this regard, it is necessary to use various communication channels and media to alert customers to potential threats from cyber fraudsters, the most common types of cyberattacks and methods of social engineering.[21] Such activity will significantly reduce the level of cyber fraud and minimize it. Regulators should improve the way they oversee and control the information posted on the Internet. The result of such activities will not only increase the confidence of customers and Internet users in remote banking technologies but also increase confidence in the credit and financial sector as a whole.

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[21] On this topic, the Bank of Russia issued recommendations for credit institutions dated February 19, 2021, No. 3-MP "Methodological Recommendations for Strengthening Information Work with Clients by Credit Institutions in order to counteract unauthorized transactions". URL: https://cbr.ru/StaticHtml/File/117596/20210219_3-mr.pdf (accessed on 02.02.2021).

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Revenkov P. V. — the setting of the research task, development of the concept of the article, verification of the results and conclusions.
Oshmankevich K. R. — the results of the research, graphical representation of the material, formation of recommendations and conclusions.
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