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## EMPIRICAL APPROACH TO ASSESSING THE RELIABILITY RATING OF UZBEKISTAN COMMERCIAL BANKS

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### **ABSTRACT**

In recent years, with the development of the economy of New Uzbekistan, it has been actively promoting structural economic reforms and the transformation of the functioning of the bank to improve the standard of living and well-being of people. It is necessary to study methods to improve the structure of the reliability assessment rating based on increasing the level of financial stability of the bank. The purpose of the paper is to develop theoretical aspects and practical recommendations for the development of methods to ensure the reliability of the bank. When developing a solution to this problem, methods and techniques of probability theory and mathematical statistics, as well as econometric modeling, are used. The article examines the probability of an event, which is that the bank for a certain period of time will be reliable in order to function, taking into account the influence of random factors, i.e. regularly and timely perform all functions, as well as by simulating the parameters of the equations, it becomes possible to control and predict the stability of the bank in the future. This study attempts to create a scorecard for evaluating a bank's safety assurance rating. Based on an empirical study, proposals are put forward from the point of view of the existing form of banking services and the application of information technologies in order to determine the rating of ensuring the reliability of the bank of Uzbekistan and optimize the structure of banking services.

**Keywords:** Reliability rating assessment, The *Article history:* problem of stability, Methods and techniques Received: of probability theory and mathematical statistics.

### **INTRODUCTION**

The tasks of increasing the efficiency of the ongoing transformations of the economy of Uzbekistan, providing them with a stable financial sector make the problem of the stability of banking structures and the reliability of their functioning particularly relevant. An important role is played by the features of transformation, the main of which is the dynamism and instability of the banking system as a whole (Gantseva L.A., 2001). Constant crises in the country's financial markets indicate that Uzbekistan has not yet formed an acceptable mechanism for the sustainable functioning of the banking system, which is capable of achieving the goals of the country's economic development. In addition, the decline in domestic production, the chronic deficit of the state budget, the crisis of the payment system, the sharp devaluation of money, the instability of the political situation weakened the liquidity of many banks, and the less stable ones went bankrupt. This determines the dependence of the economic, and often the political situation, on the state of stability of the banking system.

The state should not have a reason to question the stability of the banking system, and partners,

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depositors and investors should have complete confidence in the reliability of any commercial bank. In order not to lose confidence, commercial banks should be as open as possible, strictly controlled by banking supervisors and constantly aimed at strengthening their reliability and stability (Novikov I.N., 1999). The latter is achieved by banks by maintaining a sufficient level of equity, pursuing an effective credit and investment policy, prudent liquidity management, focusing on the optimal level of profitability and good management. Banking regulators strengthen the stability of the banking system through effective systems of supervision, control, audit, through the function of "lender of last resort".

A holistic image of a bank in the public mind is formed through the perception of a wide variety of aspects of banking activity: from its financial condition to the technical means, technologies, and appearance of the bank used by it. The most significant of all components of the reputation of a commercial bank is, of course, the financial position of the bank.

The formation of a banking system resistant to various shocks is one of the most relevant areas for the development of the economy of Uzbekistan. In recent years, the economy of Uzbekistan has a certain financial stabilization. At the same time, there are problems that have not been properly resolved. They concern, first of all, the banking system (Abdullaev A., 2021). Some of them are so acute that they pose a threat to the security of the entire economy, and not just the banking system. The low rate of structural transformations in the economy, the raw material orientation of export industries, their close relationship with the external economic environment, the unstable development of the international trade market, the influence of political forces, negatively affect the structure of the domestic banking market focused on export industries.

The weakness of the resource base, the economic insolvency of clients, the lack of the required volume of long-term deposits, undercapitalization, were a serious obstacle to the safe development of the banking system (Ezangina I. & Popova S., 2016). Destructive, crisis-forming processes that continue in the banking sector are exacerbated by the low level of development of banking competition, the underdevelopment of the financial market, lagging behind international standards, and the insufficient development of modern banking technologies.

The pace of financial stabilization differs in different segments of territorial reproduction processes, which leads to disproportions in the regional development of commercial banks. Non-transparent ownership structure; poor asset quality; insufficient level of qualification of banking specialists; poor governance, including weak risk management systems; do not smooth out emerging internal contradictions (Melnik D., 2018).

The domestic system of banking supervision does not give a sufficiently objective assessment of the real financial condition of commercial banks, the quality of internal control is not up to the mark, there is no corporate governance quality rating, there is no financial stability rating (Vedernikova T., 2016). These negative processes lead to a weakening of the regulation of financial relations in the banking system.

In recent years, an important direction in the successful development of the banking system has been the introduction of international banking standards, which include the recommendations of the Basel Committee on Banking Supervision and the Financial Action Task Force on Money Laundering

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(FATF). The main purpose of applying these standards for the banking system of New Uzbekistan is to maintain their financial stability both in the domestic and foreign markets.

The global pandemic has revealed the need to modernize the methods of ensuring the resilience of the banking system. Due to the lack of efficiency of existing methods, as well as their fragmentation during the global pandemic, the financial stability of the banking system has significantly worsened, and the overly aggressive lending policy pursued by commercial banks has contributed to the formation of an additional group of factors of financial instability of banks in Uzbekistan. Obviously, for effective functioning in the market, as well as for maintaining stability, new methods are needed to ensure the stability of banks (Andreeva E., 2013). In modern realities, a system of methods for ensuring the stability of the banking system is needed, capable of identifying signs of threats at the initial stage and making timely decisions to minimize their manifestation and reduce the likelihood of negative consequences.

In recent years, various threats from the external and internal environment have affected the banking system of Uzbekistan. The banking system is the most vulnerable and subject to external negative impacts, so the state needs to be ready to develop mechanisms to prevent threats of various scale and duration at the macro, meso- and micro levels (Abdullaev A. Ya., 2021). The deepening of market relations and the process of globalization led to a change in the status of the banking system of Uzbekistan: firstly, banks gained access to world financial markets; secondly, new conditions for their participation in international competition have been formed, which contributes to improving the image of banks; thirdly, the banking system received a favorable opportunity to adopt the best world experience in the development of its own banking products, services and technologies. All these aspects create a favorable environment for ensuring the stability of the banking system as a whole.

However, ensuring the stability of the banking system, as one of the important components of national security, requires solving such serious problems as instability in the foreign exchange market and low public confidence in banks, a small share of bank long-term lending and insufficient financing of the real sector of the economy, poor quality of the loan portfolio and growth risks and imbalances in banking activities.

On the other hand, the practice of functioning of commercial banks in Uzbekistan has shown the dependence of socio-economic processes on their stable operation; banks experience not only various internal risks (interest, credit, currency risks, unbalanced liquidity risks), but also external risks (regional, social, political, etc.). The aggravated problems and ongoing crises necessitate streamlining the tools for studying various aspects of the stability of commercial banks. Economic science has such tools, formed by scientists from countries with market economies. Currently, scientists from Uzbekistan are engaged in theoretical and educational developments of this aspect of the activities of banks.

However, many theoretical and methodological issues of analyzing the economic activities of banks, making financial decisions in planning their sustainable functioning need to be worked out and further developed. A particularly urgent problem for each commercial bank is the ability to make variant calculations of optimal planned forecasts for various situations and thus develop the most optimal financial planning models for attracting and allocating financial resources. At the same time, an

important point is the availability of appropriate schemes and methods.

The modern practice of analyzing the functioning of banks indicates that, within the framework of existing management methods, there is no one that would cover all types of activities of a commercial bank. In addition, none of the methods gives an answer to the question of the quality of management decisions; nor do they provide clear proposals for regulatory action in a short and visible manner. But the sustainable functioning of a commercial bank largely depends on its ability to make the right decisions. Based on this, the bank needs to have forecasts and estimates of cash flows that cannot be developed without data on the results of the analysis of the current financial condition. The purpose of the bank is to determine what analytical methods can be used in the analysis of financial statements to identify the most important internal problems of the bank and find ways to solve them.

Assessment of the bank's financial condition and at the same time the formation of its image as a sustainable and stable commercial bank is carried out on the basis of ratings.

In economically developed countries, much attention is paid to the problem of assessing the reliability of commercial banks, as well as building reliable rating systems. Therefore, in most countries, along with the existing independent rating systems, a system of state supervision over the activities of banks is being created and is effectively functioning.

New Uzbekistan is developing in modern conditions, it just has to create its own banking infrastructure, including organizations that evaluate and rank commercial banks. This need becomes especially evident in the context of the growing decline in the reliability of domestic commercial banks and the stability of the banking system of Uzbekistan as a whole.

All business entities, both the banks themselves and their clients, need a reliable assessment of the reliability of commercial banks. In this regard, the need for a deep and high-quality analysis of the financial position of banks becomes an extremely important task.

The urgency of this problem, its great importance for the successful restructuring and recovery of the economy of New Uzbekistan, the lack of theoretical and methodological elaboration, the underdevelopment of the tools used in the construction of ratings, determined the author's choice of the topic of this scientific work.

## **LITERATURE REVIEW**

In the scientific works of many foreign and domestic scientists, special attention is given to assessing the reliability of the bank. A. Novikov (1999) conducted a study on assessing the reliability of a commercial bank based on a system-process approach and developing practical recommendations for its application. The study summarizes and systematizes the advantages and disadvantages of Uzbek and foreign methods for assessing the reliability of a bank, and sets out the directions for their development; on the basis of the study, the requirements for the system of indicators characterizing the reliability of the bank and the requirements for the methods of grouping banks in the space of indicators were developed; substantiated the use of automatic classification algorithms without a training sample in the bank reliability assessment system; within the framework of the proposed classification mechanism, a procedure for smoothing indicators has been developed to bring the description space to a form suitable for grouping; the classification algorithm is modified in order to

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adapt to the task by changing the exit conditions for the implementation of the process of selecting internal parameters; Based on the developed system of indicators and the proposed classification mechanism, an economic and mathematical model for assessing the reliability of a commercial bank has been formed.

I. Yakshilov (2004) built a system of indicators of the reliability of banking activity, including the size, age and stages of the life cycle of the bank, consistency in the formation and placement of banking resources, the profitability of banks, as well as the quality of management; using the calculation of subindices, assessed the reliability of the resource base of commercial banks; in contrast to the traditional approach to the classification of banking risks in accordance with the principle of hierarchy, he proposed a variant of the interaction of the banking risk system with systems of other types of risks; proved the need to improve the existing ratings of banks using new methods of analysis based on international accounting and reporting standards; on the basis of mathematical and statistical methods of analysis, he built multifactor models of the reliability of banking activities for the period 2001-2003, which make it possible to reveal the mechanism of the influence of the analyzed factors on the final results of banks' work.

A. Buzdalin (2005) developed a method for express assessment of the current reliability of a commercial bank based on the Bayesian classification model of binomial distributions, in which the result of assessing the bank's reliability is presented as a function of the compliance of the bank's key performance indicators with the proposed system of standards, which allows, in contrast to the methods of Altman, Taffler, Cao, in addition to the final assessment of the bank's reliability, point out specific advantages and disadvantages in the bank's activities that determined the significance of the final result; using methods of non-parametric statistics from the financial statements of commercial banks for the period 1999-2001, he identified a set of 17 key indicators of the bank's performance that have the most significant impact on the level of their reliability. Based on the original mathematical implementation of the Neumann-Pearson homogeneity criterion, the areas of acceptable values for 17 main indicators of bank reliability are found. By using the methods of discriminant analysis, the weight coefficients of the main indicators of the current reliability of banks are estimated. This result can be used to improve the regulatory framework for banking supervision; developed a model of the bank's current reliability using multivariate factor analysis methods that take into account the structural features of the banking system.

Clustering of the banking system is based on indicators of the aggregate value, profitability and volume of key high-risk assets of commercial banks; for the period of 1998-1999, he calculated the weight coefficients and acceptable limits of the main indicators of the current reliability of banks using non-parametric statistics methods, which made it possible to quantify the nature of the impact of the crisis change in the economic environment of the functioning of banks on the features of assessing their reliability; statistically established the importance of the size of the bank in determining its reliability, based on the results of which, based on an empirical analysis of the banking system, a classification of commercial banks was carried out according to the volume of their total assets, which corresponds to the qualitative composition of the client base of banks; he proposed a model for evaluating the reliability of banks in the long term using multicriteria

optimization methods. This approach made it possible to obtain more informative conclusions than the only existing alternative concept for assessing credit risks in the long term, implemented in the Credit Risk + model.

In addition, A. Buzdalin (2005) revealed the ratio of long-term reliability of banks, which is an ordinal ratio on the totality of banking risk indicators, given by a logical polynomial that determines the typology of the banking system according to the forms of ensuring financial stability. In his scientific work, it is substantiated that the long-term reliability of some banks may not be comparable, and also that such an analysis cannot be carried out in isolation from the general structural analysis of the banking system; developed a methodology for determining the importance of the bank in the overall structure of the banking community, which is a key concept in determining the overall stability of the banking system. The methods of multicriteria optimization and factor analysis were used in constructing indicators of the bank's significance.

V. Shakhnazarova revealed a complex of macro- and microeconomic factors affecting the reliability of commercial banks, which consists in taking into account the combined factors of the dualism of the components of the foreign exchange market, compulsory insurance of bank deposits and approaches to reserving funds and measures to combat the legalization and laundering of proceeds from crime; substantiated the main directions for optimizing the procedure for diagnosing commercial banks from the point of view of the state, owners and clients in order to enhance their positive impact on the development of the economy; presented the author's classification of existing areas for diagnosing the activities of a commercial bank, from the point of view of the internal and external environment, which makes it possible to visually and reliably conduct a study of its reliability; carried out an analysis of credit risks of commercial banks in the conditions of existing competition, as well as in interaction with the economic and financial priorities of the region; based on the study of the relationship and interdependence of all components of diagnosing a commercial bank, she developed a methodology for self-diagnosing a commercial bank based on the creation of "compliance control" services, aimed at increasing its reliability.

V. Maksimov revealed new features in the underdevelopment of the banking infrastructure, consisting in their multiplicity, decentralization of the management system and dispersal of executive functions among various types of banks (commercial, investment, innovative, savings), which prevents them from performing macroeconomic functions; introduced into circulation a new concept of "reliability of a commercial bank", interpreted as the implementation of a trend towards the transformation of the functional indicators of its activities in a time continuum, suggesting a permanent positive trend, which contributes to the definition of categorical criteria for assessing the aggregate state of a credit institution; revealed the asynchrony of the functioning of large enterprises in the manufacturing sector, enhanced by the absence of similar entities in the system of commercial banks, which is a constraint on effective lending to the real sector of the economy; proved the need to strengthen control over the activities of commercial banks by the state in order to increase the degree of their stability, which requires the deformatization of approaches to the implementation of supervisory functions by the Central Bank of Russia; proposed a mechanism for increasing the reliability of commercial banks, including the procedure for reorganizing the banking system with

the liquidation of bad banks, the merger of troubled banks with financially stable ones, the geographical deconcentration of banking capital, and increasing the level of capitalization of regional banks.

The advantage of the proposed method for determining the reliability rating of commercial banks, according to the criterion of forecasting internal economic threats, is the simplicity of calculations, visibility, which allows assessing the level of financial stability, increases the efficiency and effectiveness of management decisions. This gives the following advantages:

- firstly, to gain time to recognize the growing threat, to take specific measures to prevent a decrease in the level of financial stability;
- secondly, ensuring a high level of financial stability, maintaining the image of a reliable bank, attracting new investors, depositors, thereby increasing the capital of a commercial bank.

However, despite the existence of a significant number of fundamental and applied works on certain aspects of ensuring the stability of the banking sector, the problem of integrated management of this central element of banking activity has not been studied in sufficient detail from the point of view of its implementation both at the level of the banking system as a whole and at the level of each specific commercial bank of Uzbekistan.

## **METHOD**

For the purposes of determining the reliability of a bank, the probability that the bank will continue to function reliably in the future is much more important.

Therefore, in this paper, the reliability of a bank is determined by the probability of an event, which is that the bank will operate safely for a certain period of time, taking into account the impact of random (economic) factors, i.e. to perform all its functions properly and in a timely manner.

In our case, the random variable  $R$  depends on time, i.e.  $R = R(t)$ . For example, if the rating value  $R$  is calculated based on the bank's monthly balances, then the value  $R$  will take on random values at fixed times ( $t_k$ ) corresponding to the last days of each month.

The probability of reliable functioning of a commercial bank will be defined as the probability that the value of the rating value  $R$  at time  $t$  will be greater than some critical value  $R_{kp}$ .

The  $P_k$  value is the lower limit value of the rating and characterizes the state of a bank that has completely lost its solvency and liquidity, i.e. exhausted equity capital as a result of losses incurred in the amount of equity capital. The values of the bank's balance sheet parameters corresponding to such a state are calculated using the bank's model for twelve months, and then, using the numerical values of these balance sheet parameters, the ratings for each month are calculated. The  $R_{kp}$  value is calculated as the arithmetic mean of the calculated rating values and equals  $R_{kp} = 0.35$ .

For further reasoning, it is necessary to accept the hypothesis about the law of distribution of the random variable  $R_t$ . The following laws of distribution of random variables are most widely known:

- uniform distribution law;
- binomial distribution law;
- Poisson distribution;
- normal distribution law or Gaussian law.

Consider a random variable  $\theta^{(n)}$  which is equal to:

$$\theta^{(n)} = \theta_1 + \theta_1 + \theta_3 + \dots + \theta_n$$

For this random variable, the mathematical expectation is  $a_n$ , and the Root-Mean-Square Deviation (RMSD) is  $\sigma_n$ . Then the formula for the normalization of this random variable will be written as:

$$\mu^{(n)} = 1/\sigma_n(\theta^n - a_n)$$

The Moivre-Laplace theorem states that the law of distribution of a normalized random variable tends to the Gaussian law as  $n \rightarrow \infty$  (Lloyd, E. & Lederman W.).

A. Lyapunov proved that the law of distribution of the normalized sum  $\theta_1 + \theta_1 + \theta_3 + \dots + \theta_n$  of independent random terms is close to the Gauss law (normal distribution law) if  $n$  is large and the ratio can be represented by the following formula

$$\sum_{k=1}^n (\theta_k - a_n)^3 : \left( \sum_{k=1}^n D\theta_k \right)^{3/2} \quad (a_n = M\theta_n) \text{ little.}$$

This condition is violated if the variance of a small number of terms significantly exceeds the variance of the remaining terms, which, for this reason, after normalization, as it were, disappear. The Lyapunov condition is also violated in some special cases, for example, in the case leading to Poisson's law.

If a Gaussian law is obtained after normalization, then this means that before the normalization there was a Gaussian law, but with an arbitrary mean value and variance. So, the sum of many independent random terms is distributed according to the Gaussian law, regardless of how the terms were distributed.

Since the value of  $R$  is the sum of the values of  $R_i$ , and those, in turn, are also the sum of a sufficiently large number of terms (the sum of the balances in various balance accounts), then with sufficient reason we can talk about the normal distribution of the random variable  $R$ .

Normal distribution, as is known, is determined by two parameters. These parameters are the first and second order moments, or the mathematical expectation  $mR$  and the variance  $DR$  of the random variable  $R$ .

The formula for the probability density of a random normally distributed quantity "x" is written as:

$$f(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{-(x-a)^2/2\sigma^2} \quad (1)$$

Graphically, this function has a bell-shaped form. The peak of the bell falls on the mathematical expectation of the random variable, and the larger the dispersion of the random variable, the flatter the curve of the distribution density function has.

There is also a practical way to check whether a random variable belongs to one or another distribution law. The so-called  $\chi^2$  criterion serves this purpose. Using this criterion, it is checked whether the considered random variable "x" satisfies the given distribution law  $F_0(x)$ . This criterion is called the goodness-of-fit criterion.

The hypothesis  $H_0(F_x(x)=F_0(x))$  is rejected if  $\chi^2 \geq \chi^2_a$ .

$$\chi^2 = \sum_{k=1}^k (M_i - np_i)^2 / np_i$$

$\chi^2$  - is a measure of the deviation of the true distribution from the given one.

The value  $\chi^2$  is determined according to special tables depending on the number of degrees of freedom of the specified accuracy (value  $a$ ).

In our case, the random variable  $R$  depends on time, i.e.  $R = R(t)$ . The time function  $R(t)$ , which takes random values for each fixed  $t$ , is called a random process. For example, if the rating value  $R$  is calculated based on the bank's monthly balance sheets, then the value  $R$  will take on random values at fixed times  $t_k$  corresponding to the last days of each month.

To solve the problem of determining the probability of safe operation of the bank for some time (from the current moment to the time  $T_{np}$ ), it is necessary to predict the value of the random variable  $R$  at the time  $T_{np}$  (to obtain the value  $R(T_{np})$ ).

The function  $R(t)$  is determined from the available information about the values of  $R$  over the past period of time as a set of points  $(R_1, t_1), (R_2, t_2), \dots, (R_n, t_n)$ . The resulting function can be extended for a certain time ahead, i.e. predict the mathematical expectation of a random variable in the future with a certain error.

Using the least squares method, you can solve the problem of drawing the best straight line through the set of points  $(R_1, t_1), (R_2, t_2), \dots, (R_n, t_n)$ . If the sampling distribution is normal, then the least squares estimate is the same as the maximum likelihood estimate.

Indeed, for the sample  $(R_1, t_1), (R_2, t_2), \dots, (R_n, t_n)$   $R_i$  has a normal distribution with mathematical expectation and variance  $DR$ :

$$mR = a + b * t. \quad (2)$$

The Gauss-Markov theorem states that the least squares estimate has the minimum variance in the class of all linear unbiased estimates of the parameters  $a$  and  $b$ .

The prolongation error of the  $mR(t)$  function will be equal to the square root of the variance of the random variable. In this case, the prediction error will be the greater, the longer the prediction period. The RMSD of the  $R$  value prolonged by the time interval  $\Delta t$  is determined by the formula:

$$RMSD = \sqrt{DR + DR * (\Delta t * b)^2} \quad (3)$$

To find the coefficients  $a$  and  $b$  from equation (2), the following matrix expression is used:

$$\begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} n & \sum t_i \\ \sum t_i & \sum t_i^2 \end{pmatrix}^{-1} \times \begin{pmatrix} \sum R_i \\ \sum R_i t_i \end{pmatrix} \quad (4)$$

where  $n$  is the number of values  $R_i$ ;  $t_i$  - time points corresponding to the values of  $R_i$ , ( $i = 1, 2, \dots, n$ ).

Solving equation (4), we determine the values of the coefficients  $a$  and  $b$ :

$$a = \frac{\sum R_i * \sum t_i^2 - \sum R_i * t_i * \sum t_i}{n * \sum t_i^2 - (\sum t_i)^2} \quad (5)$$

$$b = \frac{n * \sum R_i * t_i - \sum R_i * \sum t_i}{n * \sum t_i^2 - (\sum t_i)^2} \quad (6)$$

The variance of a random variable  $R$  is determined by the formula:

$$D_k = \frac{1}{n-1} * \sum (mR_i - R_i)^2 \quad (7)$$

And the value of the RMSD of the random variable  $R$  from its mathematical expectation  $mR$  is defined as:

$$\sigma = \sqrt{D_R} \quad (8)$$

To determine the multiple correlation coefficient, it is necessary to use the following dependencies:

$$R = \frac{\sum (a + bt_i)^2}{\sum R_i^2} \quad (9)$$

Now, knowing the mathematical expectation of  $R$  and its variance at time  $T_{np}$  (forecast date), i.e. values that completely determine the normal distribution  $N(R, mR, DR)$ , it is possible to determine the probability ( $p$ ) that the random variable  $R$ , distributed according to the normal law, will be at the calculated time in a certain range of values:

$$p(c \leq R \leq d) = \frac{1}{\sqrt{2\pi}} \int_c^d e^{-(R-mR)^2/2\sigma^2} dR_i \quad (10)$$

The forecasting interval is selected from the conditions of the bank's complete loss of liquidity and solvency, i.e. complete depletion of his own capital.

As it was shown above, if the value of the rating  $R$  decreases below 0.36, the bank has exhausted its own capital and, according to the rules of efficient functioning, should be closed. Thus, the lower integration limit is  $c = R_{kp}$ , and the upper  $d$  - is infinity.

The probability ( $p$ ) can be expressed in terms of the probability integral:

$$\Phi(t) = \frac{\sqrt{2}}{\sqrt{\pi}} \int_0^t e^{-s^2/2} ds \quad (11)$$

To determine the values of this probability integral, there are detailed Laplace tables on the integral function of the normal distribution, from which the probability values are determined. If the following substitution is made into the expression for determining the probability (10):  $s = \frac{R-mR}{\sigma}$ , then the probability of finding a random variable  $R$  in the interval from (c) to infinity can be expressed through the table function  $\Phi(t)$  as follows:

$$p(c \leq R \leq \infty) = \Phi\left(\frac{\infty - mR}{\sigma}\right) - \Phi\left(\frac{c - mR}{\sigma}\right); \quad \Phi\left(\frac{\infty - mR}{\sigma}\right) = 0.5$$

$$p(c \leq R \leq \infty) = 0.5 - \Phi\left(\frac{c - mR}{\sigma}\right) \quad (12)$$

Thus, the probability value we need is determined by relation (12) using a table to determine the values of the function  $\Phi\left(\frac{c-mR}{\sigma}\right)$ .

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The resulting probability value will be the same value that determines the probability that a commercial bank will maintain its solvency and liquidity, i.e. the likelihood of reliable operation.

## **FINDINGS AND DISCUSSIONS**

The problem of ensuring the stable and safe functioning of banks is solved with the help of banking regulation and control. The regulation of banking activity is reduced to supervision over the operations of banks, control over the reflection of these operations in the financial statements, regulation of activities in the financial market.

In the last year, we have often witnessed the bankruptcy of banking institutions. The damage caused by the failure of one bank due to the presence of feedback, which in technology is called positive feedback due to the nature of its impact, affects the entire banking community and the economic system of the country as a whole. Therefore, in the current situation, the problem of a deep and qualitative analysis of the financial position of banks is extremely relevant. And this analysis should become an attribute of the emerging financial infrastructure. Domestic banks are not yet able to satisfy customers in quality banking services.

Ensuring the reliability of banks provides for the presence of subjects to influence objects in order to solve strategic and operational problems of reliability, conduct organizational measures, compensate for losses, ratings. The reliability rating of commercial banks consists in deriving a free assessment of the level of economic security. The main criterion for such an assessment of banks is the qualitative indicators of their reliable operation. The formation of the rating is focused on the dynamics of indicators and involves the development of categories for the reliable state of banks. The end result of the assessment is the assignment of banks to one or another category of reliability.

For a qualitative assessment of the influence of factors, reliability is differentiated into five stages: stable, unstable, threatening, critical and extraordinary according to the degree of increase in the impact of destructive factors. Each stage is characterized by a change in the values of the indicators and is a deterministic model of the relationship between the effective indicator of the level of reliability at a particular stage and the factor indicator. Under the level of reliability, the author understands the totality of stages of reliability at a specific point in time for a single bank. Since a scientifically based mechanism for differentiating the permissible level of impact of destructive factors on the danger to which the activities of commercial banks are exposed has not yet been developed.

The reliability strategy is implemented on the basis of a system of criteria and reliability indicators. The criteria for the reliability of banks can be: classification of banks according to the degree of problem; establishment of a system of limits; assessment of the financial condition of banks in crisis conditions.

Within the framework of banking supervision and control, the classification of banks according to the degree of problematicness divides them into four groups according to the degree of increasing problems and threats, which mainly concern four aspects: the presence of unpaid customer documents, the amount of the bank's own funds (equity); deficiencies in accounting and reporting and failure to provide the required reporting forms as of the current date. However, not all of the listed

signs of problematicness can be indicators of reliability. The indicators include the lack of funds on the correspondent account of the bank and the lack of own funds (equity) of the bank.

In the system of bank reliability, indicators must meet the requirements of the system: firstly, reflect the main areas of activity of banks; secondly, to be interconnected with the process of their development. Methodologically, the indicators must meet the following requirements: be sufficiently simple and specific, definite and illustrative, compatible with the current accounting system and provide for the possibility of tracking and control (monitoring).

When developing the threshold values of indicators, the key role belongs to the dynamics of changes in indicators, which reveals positive and negative trends, and is determined either by the growth rate or the rate of decline of individual indicators. An analysis of trends in indicators changes makes it possible to judge the increase or decrease in threats and the reaction of banks to their approach or removal. A logical conclusion follows from this, which is as follows: firstly, the growth or decline rates of indicators give an idea of the approach or removal of threats and characterize the stage of reliability of banks at which they are at a certain point in time; secondly, according to the dynamics of changes in indicators, one can judge the financial condition of banks and their “feedback”, i.e. measures taken to approach or remove threats.

When developing the parameters of reliability indicators, the basis is the statement about an acceptable level of reliability, at which banks will be able to develop reliably.

The internal control service is focused on protecting the interests of investors, banks and their clients, by monitoring compliance with the legislation by bank employees, ensuring an appropriate level of reliability, minimizing: banking risks. The Internal Control Service controls internal threats. The protection of banks from external threats is partly carried out by collection units, financial management, analytical support service, legal department. There is no consistency between them, there is a duplication of functions of departments and services, they do not work for a single goal - ensuring the reliability of all bank activities.

An analysis of the existing organization of the reliability of commercial banks showed that the range of economic threats is not fully covered by the services of the bank, indicators are not monitored, and the level of reliability is not determined. The management link of commercial banks does not include the task of ensuring reliability among the top priorities. The absence of a system of interaction, coordination of efforts, and an integrated approach to solving the problems of ensuring reliability does not create conditions for predicting economic threats.

There is a need to improve the reliability strategy of commercial banks. It is due to the essence of the process of reliability and forecasting of economic threats, which implies the prospect of further activities and development of banks. The content of the reliability strategy is determined by the internal policy of the bank and the dynamics of changes in indicators, taking into account the specifics of the bank's activities. The strategy should be anchored in the bank's strategic plan based on their long-term sustainable development goals. In the long term, the reliability rating is based on the use of a probabilistic model. Knowing the joint distributions of probabilistic output indicators for various internal states of the bank, as well as a priori distributions of possible internal states, which together determine the probabilistic model of the object, using the apparatus of mathematical statistics, one



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n	$a_n$	$b_n$	$\sigma_n$	$r_n$	$R_{np_n}$	$\sigma_{np_n}$	$S_n$	$\omega_n$
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The value of the integral of probabilities  $\Phi(s)$  is determined according to the Laplace tables. Here the value is  $s = \frac{c-R_{pv}}{\sigma}$ ;  $c=R_{pv}$ .

Probability ( $p$ ) that until the time  $T_{np}$  the bank will be solvent, i.e. will not tolerate bankruptcy, is determined by substituting the tabular value of the probability integral into formula (12). These calculations are carried out for each bank, and then the banks are listed in order of decreasing probability ( $p$ ).

The method described above for determining the probability of safe functioning of sixteen banks according to the algorithm.

For calculations, the monthly balance sheets of these banks for the period from January 1, 2021 to January 31, 2021 are used. Banks were selected for the purposes of the study.

Table 2 presents the results of calculations of the following quantities:  $a$  and  $b$  are the values of the coefficients in equation (2) for approximating the value of  $R$ ;  $\sigma$  is the value of the standard deviation of  $R$ ;  $KR$  is the coefficient of multiple correlation;  $R(t+3)$  - predictive value of  $R$  for three months ahead;  $\sigma(t+3)$  - predictive value of RMSD;  $s$  is the value of the argument of the probability integral function;  $p$  - the probability of reliable functioning of the bank for three months.

Table 2

The results of the probability of the reliability of the functioning of commercial banks (Source: author's calculations)

Bank number	Equation parameter, (a)	Equation parameter, (b)	RMSD ( $\sigma$ )	Correlation coefficient ( $r_m$ )	Predictive rating value, ( $R_{np}$ )	Predictive value of RMSD, ( $\sigma$ )	Function argument (s)	Probability value, (p)
1	0.6487	-0.0061	0.1386	0.030	0.7768	0.1389	1.3887	0.899715
3	0.6821	0.0040	0.1137	0.8723	0.7849	0.0040	3.3776	0.996802
1 2	0.6496	-0.0067	0.1386	0.031	0.5488	0.1389	1.3890	0.898941
2	0.6481	-0.0060	0.1378	0.027	0.7693	0.1381	1.3880	0.901108
4	0.6828	0.0043	0.1143	0.8429	0.7856	0.1143	3.3783	0.998578
5	1.0639	-0.0331	0.1651	0.4047	0.7149	0.1659	0.9398	0.821768
6	0.6448	-0.0096	0.0891	0.1613	0.4930	0.0891	1.3815	0.916459
7	0.6832	0.0046	0.1145	0.8425	0.7568	0.1146	3.3787	0.999997
9	1.0644	-0.0336	0.1659	0.4050	0.7068	0.1667	0.9404	0.819997
8	0.6447	-0.0095	0.0888	0.159	0.4927	0.0888	1.3812	0.916432
1 1	0.6826	0.0042	0.1141	0.8688	0.7852	0.1141	3.3781	0.998163
1 0	0.6482	-0.0061	0.1379	0.028	0.7799	0.1385	1.3883	0.901129
1 3	0.6499	-0.0063	0.1389	0.033	0.5491	0.1389	1.3892	0.898998
1 4	0.6824	0.0041	0.1139	0.8691	0.7849	0.1139	3.3779	0.997164
1 5	0.6829	0.0045	0.1143	0.8432	0.7567	0.1143	3.3785	0.999893
1 6	0.6483	-0.0060	0.1382	0.029	0.7801	0.1387	1.3884	0.900901

Table 2 provides a list of commercial banks in descending order of the probability of their reliable operation during the three months following December 31, 2021.

Table 3

Reliability rating of commercial banks in accordance with the probability of their reliable operation

Place in the ranking	Bank number	Security Probability	
		$p(a \leq P \leq \infty)$	%
1	7	0.999997	99.99
2	15	0.999893	99.99
3	4	0.998578	99.99
4	11	0.998163	99.99
5	14	0.997164	99.99
6	3	0.996802	99.99
7	6	0.916459	91.65
8	8	0.916432	91.64
9	10	0.901129	90.11
10	2	0.901108	90.11
11	16	0.900901	90.09
12	1	0.899715	89.97
13	13	0.898998	89.90
14	12	0.898941	89.89
15	5	0.821768	82.18
16	9	0.819997	82.00

Table 3 shows that the reliability of the functioning of banks that took places in the reliability rating from 1 to 6 is beyond doubt; the reliability of the functioning of banks ranked from 7 to 13 may cause concern. The bank, ranked from 15 to 16 in the reliability rating, is in a critical position from the point of view of security.

After achieving a balance in all indicators, the decision maker makes a comparative assessment of the consequences of the decisions made on alternative options. If none of the alternatives satisfies the decision maker in terms of economic values, then it re-applies to the database and implements models with a qualitatively new array of information. He will repeat this procedure until a satisfactory calculation option is reached. The structure of the database provides for the possibility of reflecting all the necessary data, taking into account the economic conditions and content systems of each commercial bank.

The following designations are adopted in the Fig. 1: 1 - decision maker (DM); 2 - database; 3 - algorithms for the tasks of analyzing retrospective data on the development of bank reliability; 4 - algorithm of the bank's reliability, taking into account the equity factor; 6 - algorithms for calculating the parameters of the equations, the standard deviation and the multiple correlation coefficient; 7 - algorithm of the predicted value of the bank's reliability rating; 8 - forecasting algorithm standard deviation of the rating value for banks; 9 - checking the balance and acceptability of the results; 10 -

model results for the analysis and evaluation of the consequences of decisions; 11 - algorithm for predicting the reliable functioning of the banking sector

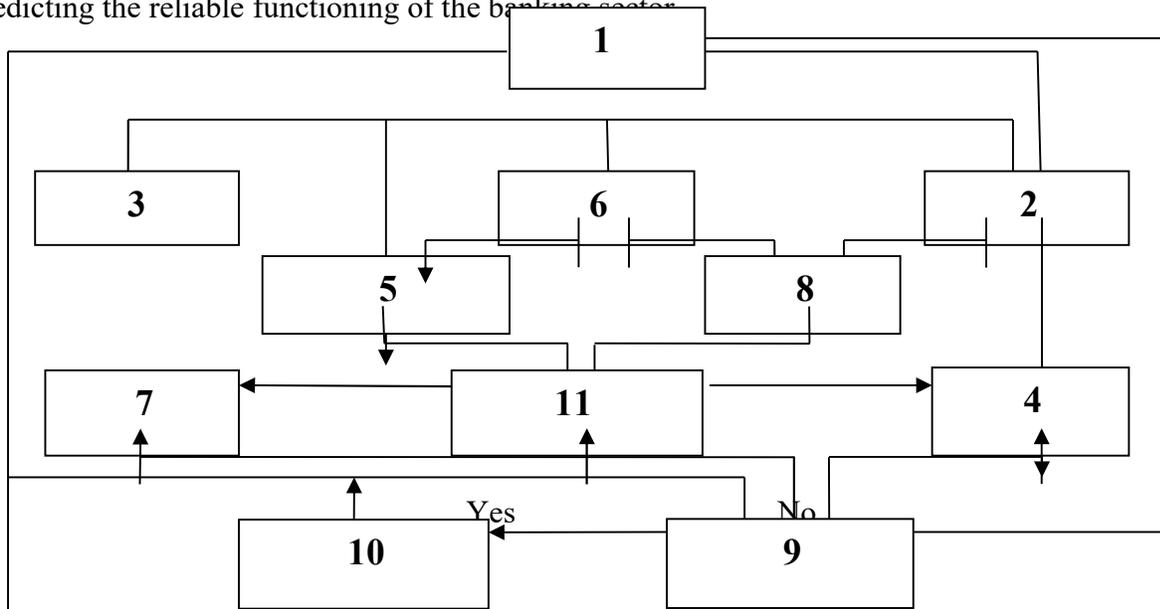


Fig. 1. Mechanism for rating the safe functioning of the banking sector (Source: author's calculations)

In general, the results of the analysis of the retrospective of the reliability of banks by various types show that the development and implementation of algorithms in them are of fundamental importance. In this regard, there is great interest in the algorithm for the long-term functioning of the banking sector, taking into account reliability in the two-level system "branch - head office". To implement these tasks, it is necessary to develop a system of algorithms for the safe development of the banking sector on a PC.

## CONCLUSION AND FUTURE RECOMMENDATION

In this paper, a method for predicting the financial condition of a commercial bank is substantiated, according to which the reliability of a bank is determined by the probability of an event consisting in the fact that it will function reliably for a certain period of time in the future, taking into account the impact of random parameters.

The advantage of the proposed method for determining the reliability rating of commercial banks, according to the criterion for predicting internal economic threats, is the simplicity of calculations, clarity, which allows you to assess the level of reliability, increases the efficiency and effectiveness of management decisions. This gives the following advantages:

- firstly, to gain time to recognize the growing threat, to take specific measures to prevent a decrease in the level of reliability;
- secondly, ensuring a high level of reliability, maintaining the image of a reliable bank, attracting new investors, depositors, thereby increasing the equity of the bank.

An integrated approach to considering a bank as a complex dynamic system operating in a

changing market environment made it possible to give a detailed definition of a bank's reliability rating, reveal the content of its reliability rating and apply research methods that are widely used in the theory of complex systems management. This approach also determined the basic principles of constructing a bank's reliability rating, which gives its users not only a comparative assessment of the current state of banks, but also allows one to judge the reliability of the bank's financial position in the future.

The proposed methodology for determining the reliability rating of commercial banks can be used by counterparty banks, bank supervisors, rating agencies both to compare the reliability of banks relative to each other at different points in time, and to determine the likelihood of reliable functioning of individual banks in the future.

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