Analysis of credit risk assessment models to ensure the economic security of an organization in the context of digitalization

Análisis de modelos de evaluación del riesgo de crédito para garantizar la seguridad económica de una organización en el contexto de la digitalización

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ABSTRACT

The study considers the role of risk assessment of credit activity in the era of the digital economy. The purpose of the study is to identify the main patterns that determine the features of risk assessment in business as the main element contributing to the achievement of economic security of an organization and to perform a comparative analysis of risk assessment and management methods in the context of digitalization. The authors discuss the advantages and disadvantages of various methods of assessing credit risks and analyze credit risk assessment models. Various methods of risk assessment and management are used in modern economic analysis. The most effective ways to reduce risk in the context of instability of the economic and political situation in Russia include the method of scenarios and the method of hierarchy analysis, as well as diversification, i.e. the distribution of risks between several business participants. When a portfolio has a fragmented asset structure, a bottom-up approach is used to assess potential credit risk.

Keywords: Model; Credit Risk; Risk Assessment; Financial Activity.

RESUMEN

El estudio considera el papel de la evaluación de riesgos de la actividad crediticia en la era de la economía digital. El propósito del estudio es identificar los principales patrones que determinan las características de la evaluación de riesgos en los negocios como el principal elemento que contribuye al logro de la seguridad económica de una organización y realizar un análisis comparativo de los métodos de evaluación y gestión de riesgos en el contexto de digitalización. Los autores discuten las ventajas y desventajas de varios métodos de evaluación de riesgos crediticios y analizan modelos de evaluación de riesgos crediticios. En el análisis económico moderno se utilizan varios métodos de evaluación y gestión de riesgos. Las formas más efectivas de reducir el riesgo en el contexto de inestabilidad de la situación económica y política en Rusia incluyen el método de escenarios y el método de análisis jerárquico, así como la diversificación, es decir, la distribución de riesgos entre varios participantes comerciales. Cuando una cartera tiene una estructura de activos fragmentada, se utiliza un enfoque ascendente para evaluar el riesgo crediticio potencial.

Palabras claves: Modelo; Riesgo crediticio; Evaluación de riesgos; Actividad Financiera.

1. INTRODUCCIÓN

The existing need to ensure a continuous increase in the efficiency of the functioning of companies during the active digitalization of financial activities creates the need for timely detection, identification, minimization, and reduction of credit risks to ensure their manageability at all levels of an organization (Voskovskaya et al., 2022; Slepov et al., 2022).

Credit risk is the possibility that the debt will not be repaid on time or fulfilled following the terms of the contract (Abdulaev, 2016; Bolgov et al., 2020; Kabushkin and Nikonorova, 2017). The following situations are associated with credit risk: Buyer's insolvency, Military actions, Confiscation, Introduction of restrictions, etc.

The time of acceptance and issuance of a loan is the stage at which maximum caution is required. A bank must make the following clarifications at this hidden stage of assessing possible losses:

1. How confident is the financial institution in the reputation of the borrower (in terms of their financial position, marketing capabilities, and production potential)?

2. Is the bank satisfied with the intended use of the loan? How much the loan portfolio will change as a result of the issuance of new loans?

Credit risk refers to the largest loss that the bank expects to suffer over time at this hidden stage of assessing possible losses (Muradyan et al., 2023; Levin et al., 2023). The value of the loan portfolio may decrease if the borrower partially or completely fails to fulfill their loan obligations, which may lead to losses (Adzinova, 2013; Lobanov, Chugunova, 2014; Kukota, 2017; 2018).

2. METHODOLOGY

We used a mixed approach to the study of credit risk assessment models in the context of the digital economy. The design of the study included qualitative and quantitative methods to collect comprehensive data and provide a comprehensive understanding of credit risk assessment practices.

A systematic review of the relevant literature was conducted to identify and analyze existing credit risk assessment models and their characteristics. Academic journals, research papers, industry reports, and regulatory guidelines were accessed through databases such as Scopus and Web of Science. We used the keywords "credit risk assessment", "digital economy", and "credit risk models" to search for relevant sources.

The comparative method was used to assess various credit risk models used in the Russian Federation. The study included an analysis of the advantages and disadvantages of each model, their applicability in the digital economy, and their effectiveness in managing credit risk.

3. RESULTS AND DISCUSSION: CREDIT RISK ASSESSMENT METHODS

There are separate **categories of credit risk**:

1. The risk that the borrower will not be able to pay the contribution on the principal debt and interest on the loan. Similar risks relate to loans, promissory notes, bonds, etc.

2. The risk that some of the assets owned by the lender may lose value or that their real return will be much less than expected. In this situation, the source of credit risk is the loan portfolio and not individual loans.

The choice of the best credit risk assessment methodology has a great impact on the lending sector.

Two different approaches are used in combination to assess credit risks arising in relation to a borrower. Expert assessments and scoring models based on mathematical statistics are subjective.

The advantages and disadvantages of each of these techniques are different. For example, all statistical methods consider previous results. Despite this, they cannot assume the behavior of the borrower who was refused if they were given a loan. The unstable situation in the Russian economic sector also has a certain impact. Thus, forecasting based on historical data does not always turn out to be completely correct (Pomorina, 2014; Khokhlov, 2003; Dosugova, 2011).

Determining the overall credit risk of a portfolio is the most difficult problem. In this case, two strategies are possible.

The qualitative type of assessment is based on the characteristics of the borrower's financial condition. In addition to considering the performance indicators, liquidity, and profitability of a business, financial stability and liquidity of collateral are also considered (Kiseleva et al., 2023). The greatest loss potential is determined using the second technique, which involves a quantitative study evaluating qualitative characteristics. The result is a risk management mechanism for enterprise activity planning (Kiseleva, 2002; Rostova, 2013; Avdiiskii, 2012).

The Basel Committee has developed proposals for credit institutions on the issues of risk assessment (Implementation of Basel II: Practical Considerations, 2001). It is assumed that banks should use independent external ratings provided by impartial organizations, as well as their internal ratings, which they set independently.

It is important to consider unforeseen and expected losses in their estimates of the results. Calculations should be made separately for the degree of probability of default, the value of assets at risk, and the ratio of potential losses and total credit losses.

There are many ways to reduce credit risks. For example, credit insurance, limiting transactions, creating a reserve to cover losses, and portfolio diversification (Chernova, Kudryavtsev, 2003; Shapkin, 2013; Kosov et al., 2016).

It is necessary to be guided by the following features to classify all currently existing models of portfolio credit risk management:

1. Using top-down and bottom-up strategies as modeling methods;

2. Market-to-market risk assessment and default risk as two different types of credit risk;

3. Structural and reduced models are two methods to measure the correlation coefficient of the risk of non-payment;

4. Conditional and unconditional models for assessing the probability of default.

Depending on the characteristics of the counterparty, downward or upward modeling can be used to calculate the credit risk assessment. Large homogeneous groups of borrowers, such as credit card holders or small businesses, are the target group of the first class of models. The amount of credit risk is determined by constructing a probabilistic distribution of losses across the portfolio for the corresponding group of homogeneous borrowers based on preliminary information. Without a further assessment of the risk characteristics associated with the borrower, the obtained estimates are then used to assess the risk attributed to one of the comparable loans. The simplicity of this method and its vulnerability to subtle changes in the composition of a homogeneous group are serious drawbacks.

Banks apply a bottom-up approach to assessing potential credit risk when a portfolio has a fragmented asset structure. This method is often used to assess credit risk when assessing large and medium-sized borrowers. It is also used to calculate the risk of various financial sector instruments. For each of the levels of the portfolio structure, the bottom-up assessment model allows determining the risk by considering individual characteristics, financial position in the market, and development prospects for any borrower and instrument. The total risk of the portfolio is determined by adding the risk of several borrowers and the correlation effect. The bottom-up model can be compared with the method of calculating the VaR of a portfolio (viewed from a market perspective) because these methods allow controlling the portfolio risk at the levels of various counterparties and assessing the contribution of portfolio parts to the overall aggregate risk (Bochkareva et al., 2023).

Default mode models do not consider various changes in the market value of assets caused by credit events, such as credit rating changes, although they do consider events such as counterparty default. The models analyze both market and credit risk indicators, such as default or credit rating changes to determine the market value of an asset. Given that the calculation horizon is the period of liquidation of the asset, this approach helps to create a more objective view of the potential risk.

Conditional models consider macro- and microeconomic factors affecting the frequency of bankruptcy of companies in the market and allow calculating the probability of default of the counterparty. Unconditional models, on the contrary, calculate the probability of default based only on the internal characteristics of a potential borrower or product and do not consider external factors. Correlations between defaults can be predicted by structural models, as they are based on changes in the value of assets (stocks and bonds) and are more sensitive to the slightest dynamics in the probability of bankruptcy of the borrower. The reduced models, in turn, estimate correlations indirectly by considering the probability of a potential default based on specific risk factors (stock and industry indices).

Leading international financial corporations have developed new models for assessing the credit risk of a portfolio using differential methods at different levels of complexity (Redhead, Hughes, 2005; Morrow et al., 2007; Foss, 2007). Such models have received worldwide recognition and have become industry standards: CreditMetrics (J.P. Morgan), CreditRisk+ (Credit Suisse), Portfolio Manager (KMV), and Credit Portfolio View (McKinsey & Co., Inc.) are the most well-known models. Table 1 shows a comparison of different models based on the aforementioned factors.

Table 1. Comparative characteristics of portfolio credit risk assessment models

Characteristics	Credit Metrics	CreditRisk+	KMV Portfolio Manager	Credit Portfolio View
Developer Company	J.P. Morgan	Credit Suisse Financial Products	KMV Corporation	McKinsey&Co., Inc.
Modeling approach	Bottom-up	Bottom-up	Bottom-up	Top-down
Type of credit risk	Change in market value	Losses in default	Change in market value	Losses in default
Credit risk factors	Asset value	Probability of default	Asset value	Macroeconomic factors

Credit event	Credit rating change/default	Default	Continuous Probability of Default (EDF)	Credit rating change/default
Probability of default	Unconditional	Unconditional	Unconditional	Conditional
Volatility	Constant value	Random value	Constant value	Random value
Correlation between defaults	Structural (stock-based)	Simplified (default process)	Structural (stock-based)	Factor model
Debt recovery level	Random value	Constant value within each range	Random value	Random value
Calculation methodology	Simulation modeling/analytical solution	Analytical solution	Analytical solution	Simulation modeling

The macro method used by the regulator to assess credit risk is constantly being developed and improved. Instruction 62-A "On the procedure for forming a reserve for possible loan losses" has served as the basis for the practice of assessing credit risk since the first days.

This process is based on two factors:

1. Securing a loan;

2. The quality of debt service.

All loans are divided into four groups according to the degree of credit risk:

The first group includes standard loans (risk-free loans), the second – non-standard loans, the third – doubtful loans, and the fourth – bad loans (there is practically no possibility of repayment; the loan represents actual losses for the bank). This method of assessing credit risks does not consider the financial situation, which is a very important factor. Regulation No. 590-P (June 28, 2017) "On the procedure for the formation of reserves by credit institutions for possible losses on loans, on loan and debt equivalent to it" provides for a component of the financial condition as part of the credit risk assessment. Three factors are used to assess credit risk:

1. Financial condition;

2. Quality of debt service;

3. Provision.

All loans are allocated to one of five groups according to credit risk:

1. Standard loans belong to Group 1;

2. Non-standard loans belong to Group 2;

3. Doubtful loans belong to Group 3;

4. Problem loans belong to Group 4;

5. Bad loans belong to Group 5.

When assessing credit risk, the international rating agency Standard & Poor's considers various credit models. Based on the characteristics of a company's production and economic risk, as well as its capital, income, internal risk assessment, and liquidity, a rating from the worst ("cc") to the best ("aaa") is assigned.

The rating of a financial institution can be determined in several stages.

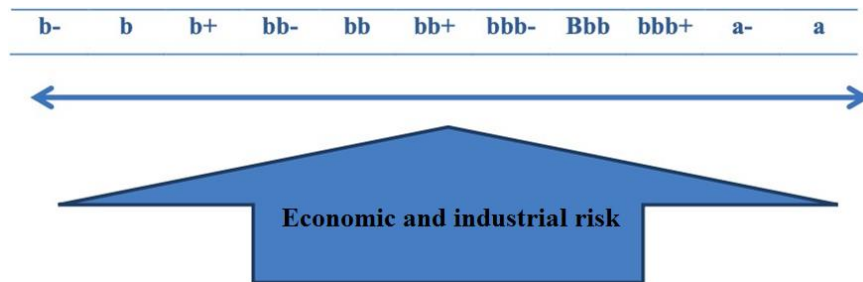At the first stage, the minimum score "-b" and the maximum score "a" are set (Fig. 1).

Figure 1. Methodology of rating establishment

On a scale from 1 to 10, economic and industrial risk in each country is assessed individually, considering such factors as economic stability, the impact of the economy on credit risk, and potential imbalances.

The assessment of industry risks considers the structure of the industry, the competitive environment, and financial investments.

A final decision is made based on the cumulative analysis of the collected data (Table 2).

The assigned rating may change from "cc" to "aaa" at the second stage when more factors are considered (such as a company's position, capital, income, various risks, and liquidity).

Table 2. Establishment of the rating of a financial institution

Industrial risk	Economic risk									
	1	2	3	4	5	6	7	8	9	10
1	a	a	a-	bbb+	bbb+	bbb				
2	a	a-	a-	bbb+	bbb	bbb	bbb-			
3	a-	a-	bbb+	bbb+	bbb	bbb-	bbb-	bb+		
4	bbb+	bbb+	bbb+	bbb	bbb	bbb-	bb	bb		
5	bbb+	bbb	bbb	bbb	bbb-	bbb-	bb+	bb	bb-	b+
6	bbb	bbb	bbb-	bbb-	bbb-	bb+	bb	bb	bb-	b+
7		bbb-	bbb-	bb+	bb+	bb	bb	bb-	b+	b+
8			bb+	bb	bb	bb	bb-	bb-	b+	b
9				bb	bb-	bb-	b+	b+	b+	b
10					b+	b+	b+	b	b	b-

In addition, Standard & Poor's ratings range from very strong to very weak, which leads to an increase or decrease in a company's ratings (Table 3).

Table 3. Standard & Poor's rating formation

Positions	Business position	Capital and income	Risks	Liquidity
Very strong	+2 rating points	+2 rating points	+2 rating points	+2 rating points
Strong	+1 rating point	+1 rating point	+1 rating point	+1 rating point
Normal	Without changes	Without changes	Without changes	Without changes

Fluctuating	-1 rating point	-1 rating point	-1 rating point	-1 rating point
Weak	-2-3 rating points	-2-3 rating points	-2-3 rating points	-2-3 rating points
Very weak	-5 rating points	-5 rating points	-5 rating points	-5 rating points

Thus, in assessing the creditworthiness of the borrower, Standard & Poor's agency considers the assessment of credit risk, as well as several other factors including:

• Industry and economic risk;

• A company's position in the market;

• Profitability and available capital;

• Risk and liquidity.

Another method of determining credit risk is the Basel II approach. This approach is based on a differentiated assessment using three components: market discipline, rules and principles of risk management, and credit risk assessment (Table 4).

Table 4. Basel II components for credit risk assessment

Components	Comments
First component: A standardized approach	It involves weighing the number of credit requirements to the coefficient that is assigned to the borrower depending on their rating established by an international rating agency (Standard& Poor's, Moody's, etc.)
First component: an approach based on internal credit ratings	It is a mathematical model that considers four factors: Probability of Default (PD) Loss Given Default (LGD) Exposure at Default (EAD) Effective Maturity (M)
Second component: principles and recommendations for the organization of a risk management system	It addresses the following issues: Transparency and accountability to the supervision of banks Stress testing of credit risks Definition of default Residual risk Credit concentration risk
Third component: market discipline	A set of information disclosure requirements has been formulated: Amount of capital and its sufficiency for credit risk Exposure to credit risk Risk assessment processes

The concept of 5Cs, considering the reputation of the borrower, as well as the terms of lending, is a characteristic aspect of American practice in assessing creditworthiness and associated risk. Components of the methodology are the borrower's reputation, financial capabilities, capital, collateral, and conditions (Table 5).

Let us consider the pros and cons of **techniques used in Russia for credit risk assessment.**

Table 5. Components of the 5C methodology

Components	Comments
Character (the borrower's reputation)	The borrower's credit history, i.e. their ability to repay past obligations is of no small importance
Capacity	The analysis of financial opportunities involves an assessment of the company's financial statements in terms of the possibility of repayment based on current

	financial and projected activities
Capital	Capital assessment is the main indicator of financial stability, the possibility of debt repayment from equity
Collateral	In most cases, the company will not be granted a loan if it does not have collateral
Conditions	Include the following parameters: Macroeconomic and market conjuncture Prospects of the client's work

1. Method of expert assessments

A complex of various logical, mathematical, and statistical methods and procedures for processing the results of group surveys of experts regarding the probability of risk is usually used to implement this method. For example, Aminov (2019) uses the idea of fuzzy sets applied to enterprises or legal entities applying for a loan to assess credit risk. These calculations consider all statistically obtained data and other risk variables. The disadvantage of this method is that it can be difficult to implement when considering a wide range of characteristics. The expert approach also makes the risk assessment subjective if the expert offers characteristics based on their experience.

2. Decision tree method

Based on information from the borrower's credit history, a financial decision tree is used to graphically represent the available options. For it, it is important to place the probabilities of outcomes on the branches of the tree and then calculate the probability of default by the borrower in each of the scenarios (Fig. 2).
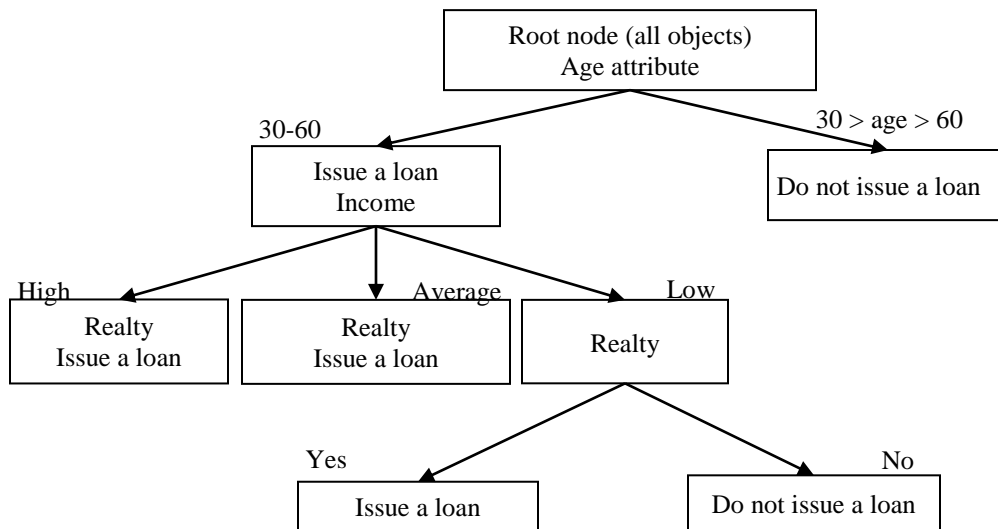
Figure 2. An example of making a credit decision using the decision tree approach on a graph

The decision tree method does not allow for accurately assessing the risk in quantitative terms or determining the success of a loan.

3. Rating method

The point approach, or rating assessment, establishes the rating of each of several borrowers in the studied array, based on a certain algorithm from which it is possible to deduce the probable creditworthiness of

the borrower. In the course of the analysis based on the rating assessment, attention is focused on one borrower, and the initial indicators are its financial indicators.

Credit organizations determine the probability of offering credit resources based on the number of points scored by the borrower and the class assigned to them. In this case, three classes are usually considered:

1) For first-tier borrowers, creditworthiness is beyond doubt;

2) For second-tier borrowers, lending is conservative;

3) For third-tier borrowers, lending is riskier.

The inability to consider data on the macroeconomic situation in the country is the biggest disadvantage of using the rating/point methodology. Although qualitative indicators are still poorly understood and the weighting of indicators is not fully supported by statistical data, assessing the creditworthiness of borrowers based on quantitative indicators alone is insufficient to obtain an accurate assessment. As a result, credit scores are too arbitrary and inaccurate to be used as a tool for controlling credit risk.

4. Coefficient analysis method

The method of coefficient analysis helps to determine coefficients and their comparison. This method is best used concerning various companies and not individuals.

The coefficients characterizing solvency include:

• net cash flow adequacy ratio;

• cash flow efficiency ratio;

• reinvestment coefficient;

• cash flow liquidity ratio, etc.

The assessment of creditworthiness is too biased and lacks reliability without a single classification of ratio indicators.

5. Monte Carlo method

The Monte Carlo method is a mathematical method used to predict the possible outcomes of a planned event. It is based on a set of specified parameters, and the values of exogenous parameters are selected following the specified parameters, which are set based on the failure probability distribution model. Using a random but structured process, it is possible to determine the values for the perturbing actions that create observations, while meeting the requirements of the potential distribution. As a result of several repetitions of the Monte Carlo method, it is possible to determine the final volumes of a certain number of samples. In combination with several risk assessment methods, it is possible to investigate the distribution of estimates in samples and their relationship with true estimates. Then the properties of the distributions are compared with the properties of their theoretical equivalents. The main drawback of this approach is that statistical data are inaccurate in case of sudden changes in the economic environment, although they can be used to determine the overall risk of the portfolio.

4. CONCLUSION

Thus, we analyzed the main current methods of determining credit risk and its assessment for legal entities and individuals. Risk assessment is understood as a set of analytical measures that allow predicting the possibility of obtaining additional business income or damage from a risk situation and the untimely adoption of measures to prevent risk. The division of all methods into qualitative and quantitative is accepted in the literature. The following methods of qualitative risk analysis are distinguished: the method of expert assessments; the method of rating assessments; checklists of risk sources. The basis of qualitative analysis is the expert assessment method, which is a qualitative risk assessment based on the processed expert data. The following methods of quantitative risk analysis are distinguished: statistical method; analytical methods. Analytical methods are represented by the following types: the method of adjusting the discount rate; the method of reliability of equivalents; the break-even point; the method of scenarios; the decision tree; the Monte Carlo method.

REFERENCIAS

Abdulaev, Z.I. (2016). Klassifikatsiya bankovskikh riskov i meropriyatiya po ikh snizheniyu s tselyu optimizatsii bankovskoi deyatelnosti [Classification of banking risks and measures to reduce them in order to optimize banking]. Vestnik nauki i obrazovaniya, 5(17), 37-40.

Adzinova, S.V. (2013). Skoring kak metod otsenki kreditnogo riska. Upravlenie ekonomicheskimi sistemami: elektronnyi nauchnyi zhurnal [Scoring as a method of assessing credit risk]. Management of economic systems: electronic scientific journal, 2, 23-26.

Aminov, Kh.I. (2019). Kompyuternye tekhnologii bankovskoi deyatelnosti [Computer technologies of banking]. St. Petersburg: Publishing House of St. Petersburg State Economic University.

Avdiiskii, V.I. (2012). Risk-menedzhment kak sostavnaya chast korporativnoi sistemy upravleniya [Risk management as an integral part of the corporate management system]. Bukhgalterskii uchet, 8, 98–101.

Bochkareva, E., Kurdyuk, P., Voronenko, E., & Farikova, E. (2023). Impact of Digital Tools and Technologies on The Effectiveness of Financial Control. Nexo Revista Científica, 36(02), 199–207. https://doi.org/10.5377/nexo.v36i02.16063

Bolgov, S.A., Pavlovich, V.E., Toropova, L.V. (2020). Bankovskie riski i ikh klassifikatsiya [Banking risks and their classification]. Ekonomika i biznes: teoriya i praktika [Economics and business: theory and practice], 8(66), 27-32.

Chernova, G.V., Kudryavtsev, A.A. (2003). Upravlenie riskami [Management of risks]. Moscow: Prospect, 2003.

Dosugova, A.V. (2011). Kontrolling riskov v sisteme risk-menedzhmenta organizatsii [Risk Controlling in the Organization's Risk Management System]. Kontrolling, 3, 60–63.

Foss, N.J. (2007). Scientific Progress in Strategic Management: The Case of the Resource-Based View. International Journal of Learning and Intellectual Capital (IJLIC), 4(1/2).

Implementation of Basel II: Practical Considerations. (2001). Basel Committee on Banking Supervision. Retrieved from: https://www.bis.org/publ/bcbs109.pdf

Kabushkin, S.N., Nikonorova, M.E. (2017). Izmerenie kreditnogo riska banka: otechestvennyi i zarubezhnyi opyt [Measuring a bank's credit risk: native and foreign experience]. Vestnik Belorusskogo gosudarstvennogo universiteta, 3, 5-14.

Khokhlov, N.V. (2003). Upravlenie riskom: Uchebn. posobie dlya vuzov [Risk Management: A Study Guide for Universities]. Moscow: UNITY-DANA.

Kiseleva, I., Gasparian, M., Karmanov, M., Kuznetsov, V. (2023). Methods of risk assessment and decision-making in investment projects amid economic instability. Revista Gestão & Tecnologia, 23(1), 57-68. https://doi.org/10.20397/2177-6652/2023.v23i1.2536

Kiseleva, I.A. (2002). Modelirovanie otsenki riskov v protsesse prinyatiya bankovskikh reshenii. [Modeling risk assessment in the process of making banking decisions]. Audit i finansovyi analiz, 1, 118-124.

Kosov, M.E., Akhmadeev, R.G., Bykanova, O.A., Osipov, V.S., Ekimova, K.V., Frumina, S.V. (2016). Economic practicability substantiation of financial instrument choice. Journal of Applied Economic Sciences, 8, 1613-1623.

Kukota, V.A. (2017). Sravnitelnaya kharakteristika metodik otsenki kreditosposobnosti zaemshchikov v kommercheskom banke [Comparative characteristics of methods for assessing the creditworthiness of borrowers in a commercial bank]. Voprosy nauki i obrazovaniya, 6(7), 78-81.

Kukota, V.A. (2018). Sovershenstvovanie metodiki analiza protsedur otsenki kreditosposobnosti zaemshchika kommercheskogo banka [Improving the methodology for analyzing the procedures for assessing the creditworthiness of a commercial bank borrower]. Voprosy nauki i obrazovaniya, 19(31), 23-25.

Levin, M., Novikova, M., Filatova, I. (2023). Impact of Global Threats on Economic Security. REICE: Revista Electrónica De Investigación En Ciencias Económicas, 10(20), 43–52. https://doi.org/10.5377/reice.v10i20.16025

Lobanov, A.A., Chugunova, A.V. (2014). Entsiklopediya finansovogo risk-menedzhmenta [Encyclopedia of financial risk management]: 2nd ed., updated. Moscow: Alrina Business Books.

Morrow, J.L., Sirmon, D.G., Hitt, M.A., Holcomb, T.R. (2007). Creating Value in the Face of Declining Performance: Firm Strategies and Organizational Recovery. Strategic Management Journal, 8(3), 271-283.

Muradyan, S., Mikhaylenko, N., Skachko, A., Ivanova, Y., Rogachev, E., Alimamedov, E. (2023). Mining of Cryptocurrencies: Analysis of Law Enforcement Practice and Problem Solving in Legal Regulation. Jurnal Cita Hukum (Indonesian Law Journal), 11(1), 21-32. https://doi.org/10.15408/jch.v11i1.31161

Pomorina, M.A. (2014). Osnovnye elementy bankovskogo planirovaniya: strategiya, biznes-planirovanie, finansovoe planirovanie [Basic elements of banking planning: strategy, business planning, financial planning]. Bankovskoe delo, 2014, 7-8.

Redhead, K., Hughes, S. (2005). Upravlenie finansovymi riskami [Financial risk management]. Moscow: INFRA-M.

Regulation of the Bank of Russia N 590-P. (June 28, 2017). On the procedure for the formation by credit institutions of reserves for possible losses on loans, loan, and equivalent debt. Retrieved from: http://www.garant.ru/products/ipo/prime/doc/71621612/

Rostova, E.P. (2013). Pokazateli otsenki effektivnosti vlozhenii v bezopasnost predpriyatiya [Indicators for evaluating the effectiveness of investments in enterprise security]. Organizator proizvodstva, 3(58), 68–72.

Shapkin, A.S. (2013). Ekonomicheskie i finansovye riski. Otsenka, upravlenie, portfel investitsii [Economic and financial risks. Valuation, management, investment portfolio]. Moscow: Publishing and trading company "Dashkov and K".

Slepov, V.A., Grishina, O.A., Kosov, M.E., Khoranyan, M.E., Balandin, S.A. (2022). Two-parameter model of optimization of the progressive taxation system and its applicability. Nexo Revista Científica, 35(01), 412–424. https://doi.org/10.5377/nexo.v35i01.14011

Voskovskaya, A. S., Karpova, T. A., Tantsura, T. A., Shirokih, A. Y., Lebedeva, O. Y., & Lebedev, K. A. (2022). The Risk Management System as an Enhancement Factor for Investment Attractiveness of Russian Enterprises. Risks, 10(9), 179. MDPI AG. Retrieved from http://dx.doi.org/10.3390/risks10090179

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