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Matrix Assessment Method for Financial Risks

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Abstract— **In the present-day business environment, the impact of financial risks on the efficiency and performance of the organization's financial security system as well as on its financial security level becomes increasingly important. The issues related to the approaches and methods of financial risk assessment, designed to prevent the negative consequences were addressed in the works of Russian and foreign scientists. However, certain schemes, algorithms, methods, models and, approaches to the analysis and assessment of financial risks still remain to be poorly developed. In this view, there is emerging need for the development of a mechanism which would allow assessing the existing financial risks based on the available information sources. The above-mentioned factors render the topic of the current work highly relevant.**

In the present work we define in detail the concept of financial risks and provide the classification of financial risks. The approaches and methods currently used to assess financial risks are analyzed. We report further the development of the integrated matrix assessment method to estimate the risks of financial equilibrium disturbance. We highlight the potential advantages and drawbacks of this method, describe the key steps in the development and implementation of the discussed matrix method, and justify the choice of the indicator system on which the method is based.

The practical relevance of the work is determined by the versatility of the proposed matrix diagnostic analysis method which may be used both in financial risk management to forecast financial insolvency and assess the risk of bankruptcy and in audit to provide support for the continuity assumption when carrying out the analytical review procedures.

The results of the work were applied to 15 vine producers in the Krasnodar Krai. A more close analysis is provided for Lefkadia LLC.

Keywords— risk; financial risks; method for the analysis of financial risks; matrix; system of indicators; matrix method

I. INTRODUCTION

In the course of its financial activity, the economic entity faces a triad of problems: risk identification, assessment, and minimization, which can be addressed by developing tools that allow timely identification, risk assessment, and development of management programs.

The analysis of the works by F.H. Knight, A.P Algin, M.G Lapusta, L.G Sharshukova, A.G. Golubeva, R.M. Kachalov, I.D. Serdyukova, V.V. Shakhov, V.N. Vyatkin, V.A. Gamza showed that in the scientific literature the concept of "risk" is applied to such a wide range of phenomena and processes that it fails to be uniquely defined [1,2,3,4].

There exist two main complementary approaches to defining risk as a scientific category. On the one hand, risk is one of the conditions for achieving success ("the greater the risk, the greater the profit, and the lower the risk, the lower the profit", "the probability of obtaining a planned income under conditions of uncertainty associated with the enterprise"), on the other hand, risk is defined as a certain level of financial losses ("the probability (threat) of the enterprise losing part of its funds, the lack of income or additional costs in the process of entrepreneurship"), [5,6,7,8,9].

Risks arising in the course of financial and economic activities are called entrepreneurial.

Having studied and reviewed the literature on the problems of risk analysis and assessment, we will give here the definition of the term "entrepreneurial risk" [2,6,7,8].

Entrepreneurial risk is the risk of unpredictable and undesirable consequences for the company in the form of the partial loss of its resources, inadequate income, or the emergence of additional costs as a result of adopting certain decision.

There are different kinds of entrepreneurial risks faced by the organization. We believe that the most important risks are financial risks which require close attention in today's business environment characterized by volatility of economic processes and high level of uncertainty as far as they have a significant impact on the results of financial and economic activities and financial stability of the organization.

Theoretically, the relevance of the topic of the current study is determined by insufficient extent of development of the approaches to the analysis and evaluation of financial risks.

In the scientific literature, the problem of financial risks assessment is examined in the studies of Russian and foreign scientists, demonstrating a wide variety of approaches used to address this issue. However, the proposed schemes, algorithms, and recommendations remain insufficiently developed and require further investigation.

Development of methods, concepts, and approaches to identification and assessment of financial risks is particularly important for economic entities, since it will allow timely detection of events or conditions that could adversely affect financial and economic activities of the organization and implement a number of preventive measures aimed at minimizing damage in the case of unfavorable event. Thus, within the framework of this study, it is expedient to specify the following goals:

- To study the nature of financial risks;
- To identify the main types of financial risks in Russian organizations belonging to the manufacturing sector;

- To carry out the analysis of the existing approaches and methods of financial risks assessment;
- To develop a comprehensive matrix method for assessing the risk of financial imbalance;
- To test the results of the study using the wine-growing industry of the Krasnodar Krai as an example.

II. The Concept of Financial Risks and Their Types

The "financial risk" concept has been considered in the economy literature for a long time and is interpreted in different ways. Based on the analyzed approaches and reports on the analysis and assessment of financial risks, we can suggest the following definition [5,6,8].

Financial risk is a type of the entrepreneurial risk, which represents a combination of the probability of adverse financial consequences in the form of expected profit reduction, expected income reduction, financial imbalance, partial or complete loss of the capital or profitability of the organization when adopting one of the alternative decisions in the course of financial and economic activity under uncertainty conditions.

Financial risks are the integral part of the environment in which operates any organization. They accompany almost all lines of financial activities, and are a part of every financial decision. Therefore, in order to ensure the rhythmic functioning and achievement of the set goals in the course of entrepreneurial activity, risks should be estimated.

However, before proceeding to risk assessment, it is essential to determine first the types of risks. This is an important step prior to carrying out further analysis, which will allow deeper understanding of their economic nature. It should be noted that there is no uniform classification of financial risks, different authors following different approaches to risk classification.

For the purposes of this study we adopted the classification of financial risks proposed by the Ministry of Finance of the Russian Federation, according to which they can be subdivided into market risks, credit risks, and liquidity risks [9]:

- Market risks are associated with possible unfavorable consequences in the case of changes in market parameters, including prices, interest rates, and foreign exchange rates.
- Credit risks are associated with possible unfavorable consequences when other persons fail to fulfill their obligations with respect to borrowed funds.
- Liquidity risk is related to the organization's ability to timely and fully repay the financial liabilities as to the balance sheet date [10,11].

This list is in no way exhaustive. We will broaden the diversity range of financial risks presented by the Ministry of Finance of the Russian Federation, by adding the following risks which are most often considered in the scientific literature [11,12,13,15]:

- Structural risk. It is determined by inefficient financing of the company's current costs, which causes high proportion of fixed costs in the total amount of costs.
- Risk of bankruptcy. This is the risk of unforeseen financial hardship that may lead to insolvency.
- Risk of financial imbalance. This is the risk of a disruption in the balance between the capacity of financing sources and the required material assets for the business activity.
- Interest rate risk. This is the risk of financial losses due to changes in interest rates.
- Risk of failure to meet debt obligations. This is the risk that any of the parties to the contract will not be able to meet their obligations.
- Risk of inefficient capital structure. This is the risk of excessive leveraging.

All the above-mentioned risks affect the financial balance of the organization, which is the state of financial activity, in which the need for the main asset volume increase is balanced by the possibility to form financial resources from its own sources. Financial equilibrium implies ensuring permanent solvency, sufficient financial stability, neutralization of possible negative consequences of financial risks, and implementation of necessary financial rehabilitation measures under crisis conditions [15].

Having identified the main types of financial risks, we shall analyze the existing approaches and methods of their assessment.

All methods can be subdivided into two large groups: the quantitative and qualitative methods of financial risks assessment.

The quantitative models are used to diagnose specific financial parameters and their ratios (calculation of coefficients). The most common methods of quantitative analysis include: statistical methods, the method of estimation of the probability of expected damage, the method of loss minimization, mathematical methods, the method based on using decision trees, the method of risk assessment based on the analysis of organization's financial performance, etc.

The advantages of such methods include the objectivity of financial risks assessment and the possibility to analyze and evaluate various case scenarios as well as to consider different risk factors within the framework of a single approach.

Among the disadvantages, we may mention possible problems in obtaining the initial data, which may be unique, the difficulty in correlating the obtained indicator values with the real risks and threats, specific features of the organization's activities being not sufficiently taken into consideration, etc.

The qualitative methods for financial risk assessment allow determining the causes of risks and the circumstances leading to the emergence of risky situations. Methods for qualitative assessment of risks seem to be quite easy to use; however, the

main purpose of such methods is to direct the analyst to the quantitative result.

The most widely used methods for qualitative analysis include the method of analogies, the method of peer reviews, SWOT-, PEST-analyses, etc.

The advantages of such methods include the possibility to assess the quality risks, the simplicity and speed of obtaining the result, and the absence of the need to perform complex mathematical calculations.

The disadvantages include subjectivity of the assessment, highly hypothetical character and high conditionality of the obtained results, and the lack of possibility to obtain numerical risk values.

Having indicated the most common methods of quantitative and qualitative analysis of financial risks, we should identify the main sources of information used to assess them:

- Accounting financial statements (balance sheet, statement of financial results, statement of changes in equity, statement of cash flows, as well as the commentaries to them);
- Statistical information;
- Accounting and management accounting data;
- Audit reports;
- Other external and internal information.

III. Matrix Method for the Financial Risks Assesment

Having considered the existing methods of risk assessment, we will propose here a method for assessing financial risks based on the matrix diagnostic analysis. In our opinion, the use of this method will allow assessing in more detail the financial risks of the economic entity, since it is based on the comprehensive analysis of financial and economic activity, which uses the system of key indicators of the organization's activity, presented in the form of a matrix.

The matrix model has the form of a square; its elements reflect the interrelation of diverse, but interdependent economic indicators. The dimension of the matrix is set by the analyst, based on the number of selected elements. The indicator set should depend on the potential set of financial risks inherent to the organization. Further, the target elements of the matrix are calculated and as the final step, the generalizing indicator is determined, which allows to assess the risk of financial imbalance.

When building the matrix model of financial risk assessment, the algorithm of actions may be presented in the following order.

Step 1. Analysis and systematization of input data.

At this stage, it is necessary to perform a thorough analysis and chose the input parameters that characterize the organization's activities. They represent the indicator indices (growth rates). It should be noted that the data source for parameter selection is the balance sheet and financial results report.

The number of initial parameters of the matrix is chosen by the analyst, depending on the goals of the analysis. The data is taken as at the end of period. The more indicators are used, the more reliable, accurate, and exhaustive the conclusions will be.

Step 2. Calculation of target matrix elements.

Using the data chosen at the previous stage, the target elements of the matrix ($C_{ij} = B_{ij}/A_{ij}$), comprehensively characterizing the activity of the economic entity, are calculated. The calculated values for the indicator indices, obtained in the course of the analysis and indicated in the matrix, allow to draw conclusions about the organization's financial and economic situation and to identify the financial risks to which the corresponding economic entity is exposed.

The example of the index matrix is presented in Table 1, where NP is Net Profit, R is Revenue, C is Cost of Sales, NWC is Net Working Capital, TA is Fixed (Tangible) Assets, AR is Accounts Receivable, AP is Accounts Payable, E is Equity, L is Loan Capital. The choice of indicators is determined by the possibility to calculate the indices of such indicators as profitability of sales (C_{12}), profitability of products (C_{13}), profitability of net circulating assets (C_{14}), return on fixed assets (C_{15}), return on equity (C_{18}), self-sufficiency ratio (C_{23}), current assets turnover ratio (C_{24}), fixed assets turnover ratio (C_{25}), accounts receivable and accounts payable turnover ratio (C_{26} and C_{27}), own and loan capital turnover ratios (C_{28} and C_{29}), maneuverability ratio (C_{48}), financing ratio (C_{89}), etc.

TABLE I. Local Elements of the Index Matrix

A_{ij}	B_{ij}								
	NP	R	C	NWC	TA	AR	AP	E	L
NP	1								
R	C_{12}	1							
C	C_{13}	C_{23}	1						
NWC	C_{14}	C_{24}	C_{34}	1					
TA	C_{15}	C_{25}	C_{35}	C_{45}	1				
AR	C_{16}	C_{26}	C_{36}	C_{46}	C_{56}	1			
AP	C_{17}	C_{27}	C_{37}	C_{47}	C_{57}	C_{67}	1		
E	C_{18}	C_{28}	C_{38}	C_{48}	C_{58}	C_{68}	C_{78}	1	
L	C_{19}	C_{29}	C_{39}	C_{49}	C_{59}	C_{69}	C_{79}	C_{89}	1

When choosing the indicator system, we were guided by the following principles: focus on continuous improvement of financial indicators, consistency of indicators, balance between and comprehensiveness of indicators, information availability for both internal and external users, and sufficiency of indicators to identify the financial risks of the organization.

Step 3. Calculation of the generalizing indicator.

Further, using the obtained values for the index matrix elements the generalizing indicator is calculated to estimate the risk of financial imbalance using the formula of the arithmetic mean of the target matrix elements:

$$I=(2\sum_i\sum_j I_{cij})/(n^2n) \quad (1)$$

where I_{cij} – index matrix elements and n – number of matrix input parameters.

The indicator value higher than 1 is indicative of the low probability of financial imbalance risk.

Step 4. Identification of the key risk groups.

Depending on the results of the analysis performed at the previous stages, it is necessary, by consolidation, to identify the main risk groups. The analysis of each group of indicators will allow making conclusions about profitability, financial stability, business activity, liquidity, and solvency of the organization. Fig. 1 presents the group of indicators and the list of financial risks which may be identified based on the performed analysis [16,17,18,19,20].

Index	Financial risk type
C_{12}-C_{19}	Structural risk; Risk of bankruptcy; Interest rate risk;
C_{23}-C_{29}	Credit risk; Risk of financial imbalance; Liquidity risk; Market risk;
C_{34}-C_{39}	Investment risk; Structural risk; Interest rate risk;
C_{47}	Liquidity risk; Risk of financial stability reduction;
C_{67}-C_{69}	Risk of failure to meet debt obligations; Liquidity risk; Risk of financial imbalance; Interest rate risk; Credit risk;
C_{89}	Risk of financial imbalance; Interest rate risk; Risk of inefficient capital structure, Risk of failure to meet debt obligations.
I_0	Risk of financial imbalance

Fig. 1. Correspondence between the indices and financial risks.

Not only the completeness of the list of financial risks is important, but also the understanding of how they will affect the activities of the organization, and how serious their consequences will be.

Step 5. Development of measures to minimize identified financial risks.

IV. Approbation of the Suggested Model

The proposed method was tested using 15 organizations of the wine-growing industry in the Krasnodar Krai as an example. In our studies, we used the 2015-2016 financial statements.

Implementing the suggested method in practice, we used nine indicators which were chosen in the course of studying the wine-growing industry business processes in the Krasnodar Krai [20].

For each of the 15 enterprises, the matrix model was developed as presented in Table I, and the generalizing indicator was calculated (Table 2).

As it can be seen in Table 2, generalizing indicator for Fanagoria Estate Winery, Gelendzhik Winery, and Lefkadia Valley is lower than 1, which indicates the risk of financial imbalance.

We will go into more detail for Lefkadia Valley, and, based on the obtained data, we will determine what financial risks the organization is exposed to. The calculated values of the matrix elements are presented in Table 3 for clarity.

Local elements of the index matrix allowed us to make the following conclusions. Indices characterizing the profitability of Lefkadia financial and economic activities ($C_{12} – C_{19}$) have zero values, which indicates the lack of profitability, the losses at the end of the year, and inefficiency of the organization's activities.

TABLE II. Final Generalizing Indicator Values

No.	Enterprise Name	I
1	Fanagoria Estate Winery	1.09
2	Fanagoria-Agro	0.99
3	Millstream Wines	1.29
4	Kuban Vino	1.04
5	Château le Grand Vostock	1.39
6	Abrau-Dyurso Russian Wine House	1.40
7	Fanagoria-Yug	1.62
8	Dolina Wine	1.80
9	Soyuz Vino International Wine Production Group	1.06
10	KVZ AGRO	3.17
11	Crymsk Winery	1.02
12	Gelendzhik Winery	0.94
13	Yurovsky Winery	1.77
14	Gai-Kodzor Winery	2.92
15	Lefkadia Valley	0.67

TABLE III. Index Matrix Local Elements Calculated for Lefkadia

Index	Formula	Value	Index	Formula	Value
C_{12}	NP/R	0,00	C_{37}	COGS/AP	0.54
C_{13}	NP/COGS	0,00	C_{38}	COGS/E	1.18
C_{14}	NP/NWC	0,00	C_{39}	COGS/L	0.60
C_{15}	NP/TA	0,00	C_{45}	NWC/TA	1.45
C_{16}	NP/AR	0,00	C_{46}	NWC/AR	0.89
C_{17}	NP/AP	0,00	C_{47}	NWC/AP	1.01
C_{18}	NP/E	0,00	C_{48}	NWC/E	0.98
C_{19}	NP/L	0,00	C_{49}	NWC/L	1.12
C_{23}	R/COGS	1,15	C_{56}	TA/AR	0.62
C_{24}	R/NWC	0,61	C_{57}	TA/AP	0.69
C_{25}	R/TA	0,89	C_{58}	TA/E	0.68
C_{26}	R/AR	0,55	C_{59}	TA/L	0.77
C_{27}	R/AP	0,61	C_{67}	AR/AP	1.12
C_{28}	R/E	0,60	C_{68}	AR/E	1.10
C_{29}	R/L	0,69	C_{69}	AR/L	1.26
C_{34}	COGS/NWC	0,53	C_{78}	AP/E	0.98
C_{35}	COGS/TA	0,77	C_{79}	AP/L	1.12
C_{36}	COGS/AR	0,48	C_{89}	E/L	1.14

The self-sufficiency ratio (C_{23}) has increased by 1.15 times (by 15% compared to 2015). This indicates an increase in the quality of the organization's ability to cover its current costs from sales revenues. The current assets turnover ratio (C_{24}) has dropped by 39%. This indicator's values allow assessing the efficiency of utilization of its own working capital by the organization, in terms of sales volume. In our example, the decrease in turnover indicates less rational utilization of resources. The fixed assets turnover ratio (C_{25}) has dropped by 11%, of accounts receivable (C_{26}), by 45%, of accounts payable (C_{27}), by 39%, and of own capital (C_{28}), by 40%.

The decrease in the turnover ratio of accounts receivable and accounts payable points to an increase in the period of debt repayment by debtors and creditors and to a decrease in the solvency and financial stability of the organization.

The ratio between the accounts receivable and accounts payable (C_{67}) increased by 12%. This indicates a slight excess of accounts receivable over the accounts payable. In this case, the recommended ratio between these indices can be observed.

The financing ratio (C_{89}) increased by 14%, due to the increase in the proportion of own capital in the overall structure of property generation sources, which indicates a

slight improvement in the financial balance of the organization.

As we can see, the indicators' values negatively characterize the financial and economic activities of Lefkadia Valley. The results of the analysis show that there is a risk of losing the financial equilibrium, namely: the risk of permanent solvency loss, the risk of liquidity loss, the risk of financial imbalance, the risk of inefficient capital structure, interest rate risk, and the risk of failure to meet the debt obligations.

In order to reduce the risk of financial imbalance, the following measures must be taken by the organization:

- cost-saving measures and measure for the rational use of resources;
- measures to increase sales volumes, with strict cost planning;
- measures to decrease receivables;
- measures to increase the amount of the own capital.

V. Advantages and Disadvantages of the Matrix Diagnostic Analysis in Financial Risks Assessment

The use of the matrix diagnostic analysis method to assess financial risks will make it possible to assess the financial condition of the organization, to identify threats and weaknesses, and to take measures to minimize financial risks based on the obtained data.

The advantages of using the matrix diagnostic analysis method include:

- the possibility to perform the analysis, which results can serve as a reliable source of information which can be used for the development of activities aimed at minimizing financial risks;
- the ability to monitor the ratio between the receivables and payables, and own and loan capital;
- simplicity of calculations, availability of the required data for both internal and external users;
- the ability to monitor changes in indicators;
- economic and mathematical naturalness of results and clarity of their interpretation;
- minimum probability of subjectivity.

The main disadvantages include:

- extensive calculations;
- difficulty in numerical formalization of the qualitative financial risks.

This method may also be used at audit stages to confirm the hypothesis of the continuity of the entity's activities, when carrying out analytical procedures and performing the analysis of financial and economic activities of the organization.

VI. Conclusions

Financial and economic activities of economic entities are subject to numerous risks. Threats which may lead to a decrease in the expected income, reduction of the expected profit, and partial or complete loss of the capital are combined into the financial risks group.

Under the conditions of environmental instability, and the instability of the country's and global economic situation, variability of the market trends, and a number of other external and internal factors, the influence of financial risks on the financial and economic activities increases. Therefore, in the current context, the issues related to the assessment of financial risks deserve special attention.

Within the framework of this study, the nature of financial risks has been explored, their types have been defined, the existing approaches and methods for assessing financial risks have been analyzed, a comprehensive matrix method for assessing the risk of financial imbalance has been developed and tested using 15 organizations of the wine-growing industry in the Krasnodar Krai as an example.

The theoretical significance of the study is justified by the contribution which the main observations and conclusions can make to the development of the theory of risk management, in terms of justification and implementation of the new approaches to the analysis and assessment of financial risks.

The practical significance of the study is determined by the fact that the scientific results presented in this paper have been brought to the level of the action-oriented proposals which are highly probable to be implemented in real practice when assessing financial risks of the organization, conducting a comprehensive analysis of the organization's economic activities, as well as when performing analytical procedures in the course of audit.

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