Methodical Approach to Bankruptcy Prediction Model Development

Natalia S. Samarina, Ph.D. in Economics, Associate Professor, the Department of Economics and Management, Vladivostok State University of Economics and Service
(690019, Russia, Vladivostok, Gogolya street 41, e-mail: Natalya.Samarina@vvsu.ru)
Marina V. Oslopova, Ph.D. in Economics, Associate Professor, the Department of Economics and Management, Vladivostok State University of Economics and Service
(690019, Russia, Vladivostok, Gogolya street 41, e-mail: marina.oslopova@vvsu.ru)
Victoria P. Gadzhibek, Ph.D. in Economics, Associate Professor of the Department of Economics and Management, Vladivostok State University of Economics and Service
(690019, Russia, Vladivostok, Gogolya street 41, e-mail: viktoriya.gadzhibek@vvsu.ru*)*
Vladimir V. Kryukov, Doctor of Economics, Professor**,** Vladivostok State University of Economics and Service**,** vladimir.kryukov@vvsu.ru

Article Info
Page Number: 39 - 47
Publication Issue:
Vol 71 No. 3s (2022)

Article History
Article Received*: 22 April 2022*
Revised*: 10 May 2022*
Accepted*: 15 June 2022*
Publication*: 19 July 2022*

Abstract
There is a likelihood of a crisis in any organization, which is determined by objective factors such as the fluctuations in market conditions, periodic modernization of technology, the changes in the organization of production, the change of personnel or external conditions, and often political circumstances. Bankruptcy is a critical variant of crisis phenomena at an enterprise.
Of course, bankruptcy is an important element of the market system structure, and its purpose is to protect social-economic processes from the results of ineffective activities of their members and the failure to fulfill their obligations.

Keywords: - bankruptcy, bankruptcy analysis, bankruptcy analysis methods, bankruptcy prediction.

Introduction. The issue of declaring an organization bankrupt also applies to other interested subjects, for example, the liquidation of an enterprise created by the founders means the loss of property contributed as a contribution to the authorized capital. The shareholders who bought the shares of the enterprise in order to make a profit will not receive income, and also lose invested funds. The suppliers lose one of the consumers of their products, and the customers lose the supplier of goods and services, which leads to the disruption of the normal functioning of these counterparties.

Problem statement. Not only the enterprise itself is interested, but also its counterparties, as well as the state to obtain an objective picture of the financial and economic condition of an enterprise and the degree of its stability. This is especially important for maintaining a favorable state of individual industries and the country economy as a whole and for an objective assessment of an enterprise, the analysis and forecasting of its bankruptcy probability is used. After analyzing the financial and economic activities of an enterprise, it becomes possible to predict the likelihood of bankruptcy, to clarify the economic "illness" of the debtor, which, in turn, provides the management with the opportunity to develop and implement timely a number of anti-crisis measures to prevent the liquidation of the enterprise.

Research methodology and methods. During the writing of the work, a number of scientific methods were used, including non-formalized ones. The main ones include analysis, synthesis, comparison, assessment, generalization method, and system analysis.

Result. Of course, bankruptcy is an important element of the market system structure, and its purpose is to protect social-economic processes from the results of ineffective activities of their members and the failure to fulfill their obligations. As a result of bankruptcy, insolvent enterprises are removed from the market economy, that is, resources are redistributed from inefficient owners to those who work most efficiently, which means that bankruptcy is one of the ways to improve the country economy [1]. Also, bankruptcy ensures the safety and growth of the asset use efficiency by an enterprise experiencing financial difficulties, protecting the interests of creditors, and meeting their claims against the debtor. By implementing the latter function, bankruptcy contributes to lower prices and thus increases the availability of credit, which provides a favorable climate for the development of entrepreneurship [2].

The terms "insolvency" and "bankruptcy" are synonymous in the legislative framework. However, it should be noted that the main sign of an enterprise bankruptcy is its insolvency, which is expressed in the inability of an enterprise to pay off its obligations timely and fully [8, 9].

We believe that the concepts of "insolvency" and "bankruptcy" must be distinguished. Insolvency should be determined through certain results of an enterprise financial activity, that is, according to its financial indicators, while bankruptcy - through the presence of certain legal facts, namely through the decision of the arbitration court, thereby:

- insolvency should be understood as a certain stage of an enterprise crisis, associated with a complete loss of solvency, liquidity and financial stability;
- bankruptcy should be understood as the inability of a debtor to satisfy the creditors' claims fully recognized by the arbitration court [10].

In modern economic conditions, the threat of bankruptcy for organizations is quite common. Historically formed features - the lack of an effective strategy for the development of the economy within the framework of a market economy, inflated prices for energy resources, transport and rent, low rates of innovation, loss of economic ties with the former Soviet republics, strong competition from foreign counterparts - directly or indirectly affect the institution bankruptcy in Russia.

Scientists around the world identify the most likely causes of bankruptcy from their point of view. For example, G. Burleigh names low sales and competition [3]. E. Torkanovsky [4] identified four main areas that can serve as the sources of the economic situation deterioration in an organization: the organization strategy, resources, principles of activity, quality and level of marketing. Also, the most common is the classification by M.D. Ames, which is presented below [5]:

- insufficient capital;
- disadvantageous location of business;
- lack of experience;
- ineffective working capital management;
- non-optimal credit policy;
- overinvestment of fixed assets;
- unjustified use of company funds for personal needs;

The dynamics of the number of bankruptcies among legal entities in Russia for the period from 2008 to 2019 is shown by Figure 1.

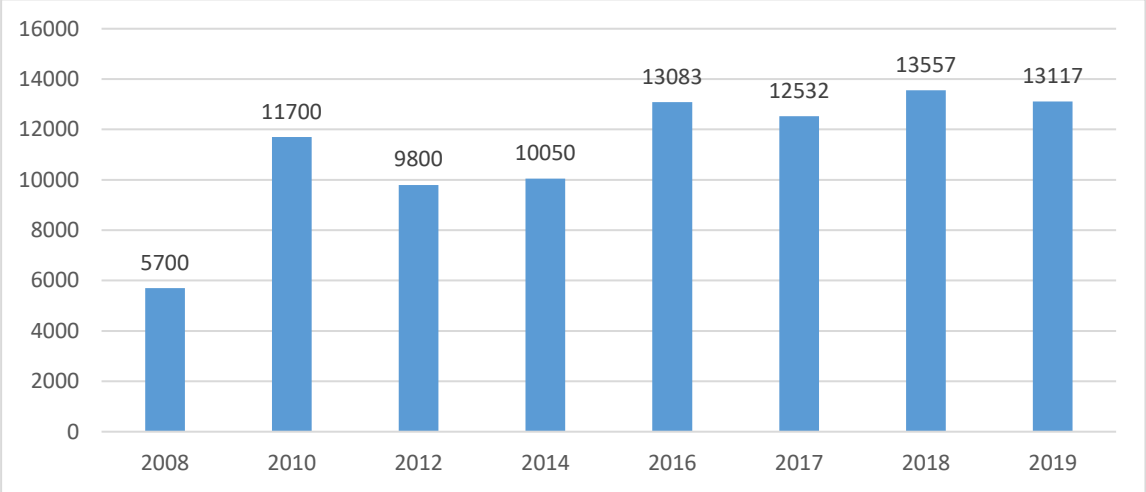

Figure 1 - The actual number of bankruptcies in the Russian economy

Such industries as construction, trade and real estate are the most affected by bankruptcy. The number of bankruptcies decreased in all three industries during 2019: by 3.4% in trade, up to 3,701 companies, by 3.5% in construction, up to 2,670, by 4.1% in real estate transactions, up to 1 405. The recognition of enterprises as bankrupt occurred as the result of these enterprises unprofitability and inefficiency. This situation has developed due to the belated response (decision-making) of enterprise managers to changes in the external business environment. Therefore, keeping production “afloat”, maintaining fixed assets and key technologies, labor resources, that is, stabilizing the situation in business at least at the pre-crisis level [13], has become a global task.

Bankruptcy forecasting is a complex tool for predetermining the bankruptcy of an enterprise; in Russian and world economics, bankruptcy assessment models are often used, which combine the assessment of various factors and methods. The feasibility and effectiveness of bankruptcy forecasting models depend not only on the actual performance of an enterprise, but also on the specifics of the country economic development, on the pace and volume of legislation development, on the political situation in the country and the world. The classical models developed in the 90-ies of the 20-th century and much earlier have become widespread, which casts doubt on their effectiveness in the modern conditions of the economy [12].

The financial condition of an enterprise is characterized by a whole system of indicators reflecting the ability of a business entity to finance its activities and timely pay off obligations at a certain point in time. Assessing and analyzing the financial condition of an enterprise, the financial and economic services of the enterprise are able to predict the development of the enterprise in the future and improve its position [6].

In general, the methods for analyzing the financial activities of the enterprise are presented in Table 1.

Table 1 - Methods for analyzing the financial activities of an organization

Indicator	Analysis trend
1. Preliminary overview of the economic and financial situation of an organization	1.1. Description of the general focus of financial activities; 1.2. Identification of "sick" reporting items.
2. Assessment and analysis of the organization economic potential	2.1. Property assessment. 2.1.1. Analytical net balance development 2.1.2. Horizontal balance analysis 2.1.3. Vertical balance analysis 2.1.4. The analysis of qualitative shifts in property status 2.2. Financial assessment 2.2.1. Estimation of liquidity 2.2.2. Financial stability assessment 2.2.3. Business activity assessment
3. Assessment and analysis of the organization financial performance	3.1. Assessment of production activities 3.2. Profitability analysis
4. Assessment of bankruptcy likelihood	4.1 Diagnosis and prediction of bankruptcy
5. Development of trends for the financial recovery of the organization	Development of an anti-crisis strategy

Anti-crisis management is not sufficiently developed in Russia: there are few of those who own fine financial and economic technologies for business recovery. Market mechanisms for obtaining additional financing are not always available for medium and small businesses, and the high rate of debt depreciation does not allow long waiting for their return, the procedure becomes unprofitable for creditors [14.16].

Despite the emergence of new methods and models for bankruptcy prediction, at present, multiple discriminant analysis is most popular in the domestic theory and practice of anti-crisis management, which necessitated a more detailed study of its well-known representatives in order to identify the weights (factors) to which the greatest value (weight) is given by the authors of a particular methodology.

Comparative characteristics of the most priority weight coefficients in bankruptcy forecasting models by foreign and Russian authors are presented in Table 2.

Table 2 - Comparative characteristics of the most priority weight coefficients in bankruptcy forecasting models by foreign and Russian authors

Factor	Beaver	Tafller	Lis	ISEA	Zaitseva
Profitability of core business			0,092		
The ratio of the salle profit to short-term liabilities	0,40	0,53			
Coefficient of security by own funds					

Net loss to equity ratio					0,25
Share of current assets in property				8,38	
Net loss to sales ratio					0,25

Source: author's development

Table 2 shows that according to the Lis model, preference is given to such an indicator as the profitability of the main activity. According to the models by Beaver and Taffler, the most significant indicator is the ratio of sales profit to short-term liabilities (profitability of short-term liabilities). According to the ISEA model, the greatest weight is assigned to the share of circulating assets in property. Zaitseva's model considers the ratio of net loss to equity and the ratio of net loss to sales to be equally significant.

The least significant indicators in the models of the abovementioned scholars are summarized in Table 3.

Table 3 - Comparative characteristics of the least priority weighting factors for bankruptcy forecasting models by foreign and Russian scholars

Factor	Beaver	Tafller	Lis	ISEA	Zaitseva
Liabilities to Assets Ratio	0,37				
Equity to Liabilities Ratio			0,0014		
Revenue to balance sheet ratio				0,054	
The ratio of current assets to the amount of liabilities		0,13			
The ratio of accounts payable and receivable					0,1
Debt to equity ratio					0,1
Balance sheet currency to revenue ratio					0,1

Source: author's development

Table 3 shows that the least weight in the Beaver model belongs to the share of liabilities to assets, and in the Fox model - to the share of equity in liabilities. Taffler assigned the lowest rating to the ratio of current assets to the amount of liabilities. In the ISEA model, the ratio of revenue to balance sheet total is estimated as the lowest one. In Zaitseva's model, three indicators have the least weight: the ratio of accounts payable and receivable; the ratio of borrowed capital to equity and the ratio of the balance sheet currency to revenue.

Having analyzed the possibilities of foreign discriminant function application to assess the financial insolvency of Russian enterprises, we note that, despite a number of advantages of these models, confirmed experimentally, when using them in national analytical practice, it is necessary to take into account the differences in the factors of the external economic environment that generate the threat of bankruptcy of business entities in Russia [15,17]: instability and ignorance of the sectoral features of domestic enterprises and organization activities, bias in accounting information on the value of assets and liabilities and the differences in accounting and calculation of individual indicators. Thus, it is safe to say that the use of Western models for diagnosing bankruptcy at Russian enterprises does not provide sufficiently objective forecasts.

To eliminate the listed disadvantages, it is necessary to adjust the weighting parameters of the indicators used in the above discriminant functions. Speaking about the need to adapt foreign models to the specifics of the domestic practice of forecasting insolvency, it is also worth mentioning the main problems that arise in this case:

- lack of comprehensive information about the empirical data base used to calculate the weighting parameters of the model coefficients;
- lack of information about the database used to calculate the criteria evaluating the obtained values of the integral indicator;
- the lack of extensive statistics on the bankruptcies of national enterprises, which denied or confirmed the reliability of a particular discriminant function;
- low reliability of information reflected in the reporting of enterprises, also due to the use of various methodological approaches to accounting and reporting.

An assumption was made about the creation of an author's model on the basis of these indicators. To do this, a corresponding weight is assigned to each of the indicators, based on the considerations about the importance of its values in order to analyze the threat of bankruptcy. The overall score of the proposed four-factor model was defined as -1. The results of the gradation of indicators are presented in Table 4.

Table 4 - Gradation of indicators according to the degree of importance of their values for prediction the bankruptcy of an enterprise

Symbol	Indicator	Specific weight
K1	General ratio of financial independence	0,40
K2	General solvency (liquidity) ratio	0,30
K3	Financial stability ratio	0,20
K4	Return on assets	0,10

The model proposed in accordance with this gradation is the following:

$$Z = 0{,}4K1 + 0{,}3K2 + 0{,}2K3 + 0{,}1K4 \quad (1)$$

Thus, a conclusion is drawn based on the Z indicator:

- if the value $Z \leq 0.8$, then the probability of bankruptcy is maximum;
- if the value $Z \geq 0.8$, then the probability of bankruptcy is minimal.

It should be noted that it is impossible to be guided by these four indicators for a more objective assessment of an enterprise financial condition, however, a comprehensive analysis of the financial condition of an enterprise is often not required in order to identify the signs of a threat of bankruptcy.

In most cases, a preliminary diagnosis of the financial condition of an enterprise can be given based on the calculations results of financial independence general coefficient, the coefficient of total solvency (liquidity), the coefficient of financial stability and return on assets.

Let us analyze what value Z we will obtain when calculating the indicators for an energy enterprise, while this enterprise is not officially declared bankrupt. At the same time, the analysis of

the threat of bankruptcy according to Russian and foreign methods indicates the approaching insolvency of an enterprise (Table 5).

Table 5 - Testing the mathematical forecasting model of an enterprise bankruptcy based on significant factors of the energy company financial condition

Indicator	2018	2019
General ratio of financial independence	0,67	0,67
General solvency (liquidity) ratio	0,45	0,71
Financial stability ratio	0,70	0,84
Return on assets	-7,44	2,26
Z1	0,54	0,87
Z2	-0,20	0,87

Table 5 shows that the overall ratio of financial independence is 0.67 in 2017-2018, which is higher than the standard value of 0.5. Consequently, the energy company is financially independent from external sources of financing, that is, during the analyzed period, 67% of assets are covered by its own funds. The remaining 33% of assets are secured from external sources of financing. The total solvency (liquidity) ratio amounted to 0.45 in 2018 and increased to 0.71 by the end of 2019. However, it is below the standard 1 and means that the company is insolvent, since it is able to cover only 45% of its existing liabilities in 2018 with its own assets and 71% in 2019. The financial stability ratio in 2018 was 0.70 and increased to 0.84 at the end of 2019, which is higher than the standard value of 0.6 and indicates that 84% of the company financing sources can be used for a long time, and 16% of the company assets are financed from sustainable sources.

The question arises with the return on assets. In table 5, it is presented as the indicator with a negative sign. This is due to the fact that profit before tax is presented as a loss in the statement of financial results of the energy company for 2018. There is no consensus in the economic literature on this situation - whether to take into account the zero value for this indicator or to calculate the profitability with a minus sign, but most often it offers the possibility of analyzing the negative profitability. However, there is another point of view: the indicator of negative profitability is almost meaningless. The authors believe that profitability, which is close to zero, is already a bad indicator, indicating the weak efficiency of the enterprise, and if this indicator is less than zero, then it does not matter which figure it is - 2, 4 or 5. Therefore, calculation was performed taking into account these two points of view. If we use “negative profitability” in the calculation, then Z takes a negative value, if we do not take into account the “negative profitability”, Z takes the values less than 1.

According to the proposed model, the probability of bankruptcy of the energy company in 2018 is high, and it is low in 2019.

Comparing the developed model with other techniques, a number of advantages can be noted:

- based on up-to-date data;
- ease of the value interpretation;
- simplicity of calculations.
- the industry specificity of enterprise activities is taken into account;

At the same time, the model has a number of disadvantages:

- small amount of statistical data;
- the possibility of the final coefficient to be beyond the standard;
- the organizational form of the company is not taken into account.

Thus, it can be concluded that further research is needed to improve the resulting model.

Since the obtained value of Z is in the interval from 0.8 and indicates a low probability of bankruptcy of the company in 2019, it follows that it is necessary to adopt an anti-crisis strategy for sustainable development, the purpose of which is not to fall into the zone of high probability of bankruptcy on the one hand and to strengthen their financial condition on the other, continuing to develop their activities.

Summary. Based on the analysis results of the most and least priority indicators of bankruptcy models by foreign and Russian authors, it was found that foreign authors include the indicators calculated using the data on financial results (the report on financial results) as the most significant indicators, while Russian authors are more focused on the use of the enterprise property status (balance sheet). Most publications on the analysis of the threat of bankruptcy using Russian and foreign methods contain the opinions about the inadequacy of these models to modern Russian conditions, due to the fact that the development of weight coefficients took place in other economic conditions. It should be noted that currently there is no universal model that allows any stakeholder to predict the likelihood of an unfavorable financial situation with a high degree of reliability. Nevertheless, the variety of models allows each subject to choose a method that suits his capabilities and interests.

REFERENCES

[1]. Gerasimenko Yu.A. Bankruptcy of enterprises // Scientific electronic journal Meridian. - 2020. - No. 9 (43). - pp. 394-396.
[2]. Ushanova A.M. Bankruptcy concept. Diagnostics of bankruptcy // Competitiveness in the global world: economics, science, technology. - 2017. – No. 12 (59). - pp. 109-111.
[3]. Berle G. The Do-It-Yourself Business Book. New York: John Wiley & Sons, 1989
[4]. Torkanovsky E. Anti-crisis management // Economy and law. 2000. No. 1. pp. 14–30.
[5]. Ames M.D., Wellsfry N.L. Small Business Management. St. Paul: West Publishing, 1983.
[6]. Savinkova T.S. On the issue of organization bankruptcy prevention: legal and economic aspects // Financial Bulletin. - 2017. - No. 4 (39). - pp. 52-60.
[7]. Luneev E.D. Bankruptcy of companies: causes and consequences // Marketing and Sales Director. 2013. No. 5.
[8]. Silchenko E.S. Legal aspects of legal entity bankruptcy // Science. Society. State. - 2017. - V. 5. No. 4 (20). - pp. 140-145.
[9]. Ustinovich E.S. Legal aspects of a legal entity bankruptcy. // Marketing and Sales Director. - 2019. - No. 2. - pp. 69-75.
[10]. Kamenkov V.S. Bankruptcy begins with terms // Bulletin of regulatory information. Legal world. - 2018. - No. 2. - pp. 59-66.
[11]. Lazareva O.S., Nelyubov N.G. Bankruptcy of legal entities. Fictitious and deliberate bankruptcy // Alley of Science. - 2018. - V. 1. No. 6 (22). - pp. 376-382.
[12]. Potomova I.A. Crisis of organizations and bankruptcy of companies // From the collection:

Accounting, control and analytical processes in the economy digitalization. Part 3. N.A. Prodanova, L.A. Tchaikovskaya, I.F. Karpova, E.A. Malinina, Yu.L. Bachurina, E.V. Zubareva, B.Ya. Ovsiychuk. Moscow. - 2019. - pp. 152-156.

[13]. Konvisarova E.V., Levchenko T. A., Pustovarov A. A. (2020) Problems Of Statistical Accounting In Russian Price Index Determination// Reice-Revista Electronica De Investigacion En Ciencias Economicas №8 (15) P. 272-285. doi: 10.5377/reice.v8i15.9958.

[14]. Miroshnikova T., Taskaeva N. (2018) Model for assessing the financial potential of the region. International Scientific Conference on Business Technologies for Sustainable Urban Development (SPbWOSCE). 170. 1042. doi: 10.1051/matecconf/201817001042.

[15]. Terentyeva T. V., Konvisarova E. Vi., Levchenko T. A., Borovitskaya M. V. (2018) Theoretical and methodical approaches for control introduction in the management system of industrial organization. Amazonia Investiga. 7 (14). pp. 50-60.

[16]. Terentyeva T. V., Vasilenko M. V., Titova N. Y. (2019) Organizational and economic mechanism for sustainable development of Fishing Industry of the Primorsky territory: Cluster Approach. Dilemas Contemporaneos-Educacion Politica Y Valores. 6. 132.

[17]. Vasilenko, M., & Titova, N. (2019). Accounting policy the system of enterprise economic security. Amazonia Investiga, 8(22), 254-260. Retrieved from https://amazoniainvestiga.info/index.php/amazonia/article/view/424.