

# The Use of Econometric Models in Analyze the Solvency of a Business Entity

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**Abstract.** In article the characteristics of the methodology used to analyze the solvency of a business entity and its shortcomings is described. The analysis of modern approaches to assessing the financial stability and probability of bankruptcy of an organization (Altman Z-models, discriminant models of Tuffler, Beaver, Argenti A-account) and their limitations are provided. The approaches to the successful application of foreign methods in the Republic of Belarus are proposed.

**Keywords.** solvency, financial stability, bankruptcy, solvency ratios, solvency and insolvency criteria.

## 1. Introduction

Solvency is one of the most important indicators characterizing the financial condition of an enterprise, since it is an external manifestation of its economic stability. In fact, solvency characterizes, to a certain extent, the survival of the organization, because if there is a long-term and stable insolvency, it is subject to economic insolvency (bankruptcy) procedures. One of the problems that arise when considering bankruptcy cases is the determination of the financial condition of the debtor, which is determined on the basis of information on the degree of its solvency and property status, obtained from the results of financial analysis according to the methodology approved by the Decree of the Council of Ministers of the Republic of Belarus dated 12.12.2011 № 1672 [1] and the Instruction on the procedure for calculating solvency ratios and analyzing the financial condition and solvency of business entities, approved by the Decree of Ministry of finance of the Republic of Belarus and the Ministry of Economy of Belarus from 27.12.2011 № 140/206 [2]. The source of information for the analysis of the solvency of the organization is the balance sheet with its annexes, completed in accordance with the requirements of the law. Based on this information, economic courts make decisions on initiating bankruptcy proceedings, and subsequently one of two areas of action is chosen - reorganization of the organization or its liquidation. Remediation is a system of measures for the financial recovery of the enterprise, implemented with the help of third-party legal entities or individuals and aimed at preventing the debtor company from declaring bankrupt and liquidating it.

Considering the fact that the reorganization procedure is applied by the courts extremely infrequently and the domestic methodology for analyzing solvency and forecasting bankruptcy does not allow an accurate assessment with respect to specific business entities, analysis of the state and prospects of using modern approaches to analyzing solvency and assessing the probability of bankruptcy in the Republic of Belarus is relevant and allows you to determine ways to solve problems in this area.

## **2. The characteristics of the applied methodology for analyzing the solvency of a business entity and its shortcomings**

The modern Belarusian methodology for assessing the solvency and probability of bankruptcy of an organization is based on the calculation of the following ratios (according to clause 1 of the Decree of the Council of Ministers of the Republic of Belarus No. 1672) [1, 3]:

- current liquidity ratio (K1), which characterizes the overall security of a business entity with short-term assets to repay short-term liabilities and calculated as the ratio of short-term assets to short-term liabilities;
- the ratio of own working capital (K2), characterizing the existence of a business entity own working capital necessary for its financial stability, and calculated as the ratio of the amount of equity and long-term liabilities minus long-term assets to the amount of short-term assets;
- the coefficient of security of liabilities with assets (K3), characterizing the ability of a business entity to calculate its liabilities and calculated as the ratio of total liabilities to total assets.

Further, in the Decree of the Council of Ministers of the Republic of Belarus No. 1672, the normative values for the coefficients K1 and K2 are presented, differentiated by types of activity. The value of the coefficient K3 is not more than 0.85 for all sectors of the national economy. Also, in paragraphs 6-8 of Instruction No. 140/206, the procedure for calculating the above solvency ratios is given and, for the purposes of Article 43 of the Law of the Republic of Belarus “On Economic Insolvency (Bankruptcy)”, a further financial analysis is carried out, consisting of calculating the absolute liquidity ratio, composition, structure and dynamics of all groups of the balance sheet (clause 13-15 of the Instruction No. 140/206). This analysis is supplemented by the calculation of profitability indicators (parts 3-4 of clause 15), turnover (clause 16) and financial stability (clause 17).

At the same time, Resolution of the Council of Ministers of the Republic of Belarus dated January 22, 2016 No. 48 “On Amendments and Additions to the Resolution of the Council of Ministers of the Republic of Belarus dated December 12, 2011 No. 1672” (hereinafter referred to as the Decree of the SMRB No. 48) established the following criteria for recognizing a business entity as solvent or insolvent:

- in the presence of K1 and (or) K2 at the end of the reporting period, depending on the main type of economic activity, having values more than normative or equal to them, as well as K3, the value of which is less than or equal to 1, for leasing organizations - less than or equal to 1.2 ;
- if there are simultaneously K1 and K2 coefficients at the end of the reporting period, depending on the main type of economic activity, having values less than normative, as well as K3 coefficient, the value of which is less than or equal to 1, for leasing organizations - less than or equal to 1.2;
- the entity has insolvency, which becomes sustainable in the presence of both K1 and K2 ratios at the end of the reporting period, depending on the main type of economic activity, having values less than normative during the four quarters preceding the preparation of the latest financial statements, and K3 coefficient having a value less than normative or equal to it;
- the subject is in a state of insolvency, which has a stable nature, in the presence of at least one of the following conditions:

1) the presence of both the current liquidity ratio and the ratio of own working capital at the end of the reporting period, depending on the main type of economic activity, having values less than normative during the four quarters preceding the preparation of the latest

financial statements, and the availability of the security ratio at the date of the last financial reporting asset liabilities of more than normative significance;

2) the availability at the date of preparation of the latest financial statements of the asset security ratio, the value of which is more than 1, for leasing organizations - more than 1.2.

According to domestic economists, in this official methodology for analyzing the solvency of a business entity and conclusions on economic insolvency (bankruptcy), formulated on its basis, there are many shortcomings, for example:

- the inaccuracy of the wording of the definition of solvency ratios laid down by the Decree of the Council of Ministers of the Republic of Belarus No. 1672. It states that the current liquidity ratio (K1) characterizes “the general security of the business entity with short-term assets to pay off short-term liabilities” [1]. In many theoretical sources on financial analysis, the current liquidity ratio shows the theoretical ability to pay off your short-term liabilities by selling short-term assets based on their book value at a certain date. At a different date, this ratio may have a completely different meaning, since the performed business operations lead to a change in assets and liabilities;

- mismatch of the name of the coefficient of security with own working capital (K2) to its definition in the Decree of the Council of Ministers of the Republic of Belarus No. 1672. It states that K2 characterizes "the presence of the business entity own working capital necessary for its financial stability" [1]. However, the formula for calculating this indicator characterizes only the availability of working capital and their share in the formation of short-term assets, and not their security. In order to really assess the security of the organization with its own working capital, it is necessary to compare their actual value with the planned need for them, or their minimum value, ensuring the financial stability of the organization. Indeed, the main purpose of using own working capital is “to ensure the possibility of uninterrupted continuation of economic activity when it becomes necessary to simultaneously repay all short-term obligations”. Moreover, there is a direct functional relationship between the coefficients K1 and K2, which can be expressed by the formula by mathematical transformation of the coefficients K1 and K2:

$$K2 = 1 - (1 / K1). \quad (1)$$

Based on the formula (1) it can be seen that the coefficient K2 has no additional information compared with the coefficient K1. The presence or absence of working capital can be determined from the value of the coefficient K1. If the value of the coefficient K1 is greater than one, then there are own working capital; if less, then there are none [4]. Similar opinions on the coefficient K2 are expressed by other domestic scientists-economists, in particular N.P. Mytsky and V.A. Mytsky [5];

- the asset security ratio (K3) is calculated by the ratio of borrowed capital to total assets. Based on the name of the coefficient, it should show how many assets are per unit of liability. In this case, this ratio should be calculated as the ratio of assets to liabilities, and not vice versa. In addition, it is necessary to clarify, regarding the characteristics of this coefficient as “the ability of a business entity to calculate its liabilities after the sale of assets”, it is necessary to clarify: “based on their book value” [4, 6].

Considering the above disadvantages and the indisputable advantages of the Belarusian methodology, among which are the simplicity of calculating the coefficients and conclusions based on them, the presence of the developed standard values of the coefficients K1 and K2 by types of economic activity, etc., from the point of view of diagnosing the probability of bankruptcy of the organization, this technique has a number of limitations. Assessing the probability of bankruptcy of an organization for three indicators (K1, K2 and K3) does not

provide an objective assessment for a number of reasons. For example, the static nature of these indicators, as they are calculated according to the balance sheet data for a specific date. Such an analysis does not take into account such important factors as the volume of sales of products (goods, works, services), costs, profits. The real picture can only be presented in the relationship of liquidity, turnover and profitability. Therefore, the methodology should organically link the current liquidity ratio, capital turnover ratios and return on assets.

### 3. Analysis of modern approaches to assessing the financial stability and probability of bankruptcy of an organization and their limitations

In world practice, to assess the financial stability and probability of bankruptcy of an organization, a wider range of financial and economic indicators has long been used, on the basis of which a number of universal and more effective methods have been developed and successfully applied. The most common among them are Altman Z-models, discriminant models of Tuffler, Beaver, Argenti A-score.

The model of the American economist Edward Altman, called the Z-account, was developed by him in 1968 based on statistics from 66 American companies [7]. It was developed to analyze joint stock companies that list their shares on world stock exchanges, and is a five-factor model in which bankruptcy diagnostic indicators act as factors. The Altman Z-score model is calculated by the formula (2):

$$Z = 1,2X1 + 1,4X2 + 3,3X3 + 0,6X4 + X5, \quad (2)$$

where:

- Z – an integral indicator of the level of threat of bankruptcy;
- X1 – the ratio of working capital to the total assets of the enterprise;
- X2 – ratio of net profit to the total assets of the enterprise;
- X3 – coefficient of the ratio of profit before tax to the total cost of assets;
- X4 – ratio of equity to borrowed capital;
- X5 – the ratio of sales (net sales) to the total value of the assets of the enterprise.

The level of threat of bankruptcy of an enterprise in the Altman model is evaluated on the scale given in table 1.

Table 1. Evaluation scale for the Altman model

The value Z exponent	Probability of bankruptcy	Bankruptcy probability,%
$Z < 1.81$	Very high	80 - 100%
$1.81 \leq Z < 2.77$	High	35 - 50%
$2.77 < Z < 2.99$	Possible	15 - 20%
$2.99 \leq Z$	Very low	Close to 0

The scientist also developed a simplified two-factor model based on current liquidity ratios and the ratio of borrowed capital to total liabilities, a seven-factor model (1976) that allows predicting bankruptcy with an accuracy of 70% on the horizon in 5 years, and a five-factor model (1983) for companies whose shares are not quoted on the exchange market [7].

British scientists R. Tuffler and G. Tishou in 1977 [8] proposed a four-factor model. When developing it, the following approach was used: at the first stage, statistics was collected on eighty companies, both bankrupt and solvent. Using the statistical method, known as the “multidimensional discriminant analysis,” a solvency model was built.

Selective calculation of ratios is typical in determining key company performance indicators such as profitability, working capital adequacy and liquidity. The solvency model, combining these indicators and bringing them together appropriately, reproduces the exact picture of the financial condition of the enterprise. The Tuffler model for analyzing companies whose shares are listed on exchanges has the formula:

$$Z = 0,53X1 + 0,13X2 + 0,18X3 + 0,16X4, \quad (3)$$

where:

X1 – the ratio of profit before tax to the amount of current liabilities (shows the degree of feasibility of the obligations of the company due to internal sources of financing);

X2 – the ratio of the sum of current assets to the total amount of assets (characterizes the state of working capital);

X3 – the ratio of the current liabilities to the total assets (an indicator of financial risks);

X4 – the ratio of revenue to total assets (determines the ability of the company to settle obligations).

A Z-score of more than 0.3 indicates a low probability of bankruptcy, if less than 0.2, then the likelihood of bankruptcy is high. The advantage of the Tuffler model is the high accuracy of the forecast of the probability of bankruptcy of the company, which is associated with a large number of companies analyzed.

The famous financial analyst William Beaver in 1966 proposed his own system for determining the probability of bankruptcy [9]. His five-factor model contains the following indicators:

- return on assets;
- current ratio;
- the share of net working capital in assets;
- the proportion of borrowed funds in liabilities;
- Beaver's ratio (the ratio of the amount of net profit and depreciation to borrowed funds).

The design features of this model are the absence of weighting factors, as well as the ability to determine the threat of bankruptcy over five years. The W. Beaver model does not provide weighting factors for indicators and does not calculate the final probability coefficient of bankruptcy. The obtained values of the indicators are compared with the normative values characteristic of the three states of the company formulated by W. Beaver:

- for successful companies;
- for companies that went bankrupt during the year;
- and for companies that have gone bankrupt within five years.

The Argenti model (named after the English economist John Argenti) characterizes, first of all, the managerial crisis that could lead to bankruptcy of the company [10]. Determining the probability of bankruptcy of a company using this model suggests that:

- the process leading to bankruptcy is already underway;
- this process will continue for several years;
- the process can be divided into three components: symptoms, deficiencies, errors.

J. Argenti identified three components of the process leading to the bankruptcy of the company - flaws, mistakes and symptoms. Almost all companies that are threatened with bankruptcy have flaws for several years (table 2), obvious long before actual insolvency. Due to their accumulation, an enterprise can make a fatal mistake (table 3), leading to bankruptcy (the author of the model assumes that organizations that do not have shortcomings do not make mistakes). Symptoms (table 3) - they show the mistakes made by the company. The approaching insolvency is indicated by the deterioration of financial indicators, cash shortages.

Table 2. A-account method for predicting bankruptcy (deficiencies)

<b>Index</b>	<b>Assignable score</b>
Disadvantages	
1. Autocracy in the top management of the company	8
2. The chairman of the board and the executive director are one and the same person	4
3. Passive Board of Directors	2
4. Unbalanced Board of Directors	2
5. Incompetent CFO	2
6. Unskilled management	one
7. Weak budget control	3
8. Lack of cost reduction system	5
9. Slow and not always adequate response to the change in market conditions	fifteen
10. Lack of cash flow reporting	3
Total points	45
Critical score for the group	10

When testing, the indicators in tables 2, 3 must be assigned one of two values - either “yes” or “no”. Each stage factor is evaluated in points, after which the aggregated indicator - A – score, is calculated by summing all the points. Intermediate values are unacceptable, that is, it is necessary to evaluate each position in terms of whether the researcher agrees with the given judgment or not. Maximum possible A – score: 100 points. If an enterprise scores up to 25 points in all groups (“passing score”), then the company is stable, if more - in the near future the company faces bankruptcy. The more points scored, the worse.

Table 3. A-account method for predicting bankruptcy (errors and symptoms)

<b>Index</b>	<b>Assignable score</b>
Mistakes	
1. High debt	fifteen
2. Overtrading (loss of current liquidity)	thirteen
3. Large unsecured projects	fifteen
Total points	43
Critical score for the group	fifteen
Symptoms	
1. Financial signs of decline	4
2. Incorrect content of accounting and reporting ("creative approach")	4
3. Non-financial signs of decline	3
4. Final signs of decline	one
Total points	12
Critical score for the group	0
Maximum points	one hundred
Critical score for all groups of indicators	25

The main advantage of the J. Argenti model can be considered taking into account non-financial indicators and risks of the company, such as: problems in management, lack of budget control, slow reaction to changing market conditions and others. The disadvantages of the model include the subjectivity of grading, the absence of a final coefficient, and the lack of a statistical base and the dependence of the accuracy of calculations on the source information.

Quantitative models of R. Lis, G. Springate and others are also successfully applied. However, the application of the above models of discriminant and qualitative analysis for enterprises of the Belarusian economy is extremely difficult due to the following circumstances:

- the difference in the statistical sample of enterprises in the formation of the model; the difference in accounting for individual indicators (in the United States, a GAAP accounting system is used);

- the model does not take into account the effect of inflation on indicators, which is extremely important for the national economy of Belarus;

- the difference in the carrying amount and market value of assets, etc.

The most important problems of their use are the obsolescence of the data used for these models, the absence among them of any of the most effective (universal) and the practical impossibility of their application to reflect the real state of Belarusian enterprises. For example, according to the Altman model, insolvent organizations with a high level of X4 (the ratio of equity to borrowed) receive a very high rating, which is not true in our country. Due to the imperfection of the current methodology for revaluation of fixed assets, when old worn-out fixed assets are given the same value as new ones, the share of equity capital unreasonably increases due to surplus capital [4]. Therefore, the models in which this indicator is present can distort the real picture of the financial condition of the organization.

#### **4. Conclusions**

Thus, despite the presence of a large number of methods that allow predicting the financial viability of an organization with varying degrees of probability, none of them can be used as universal. Therefore, when diagnosing bankruptcy of an organization, it is advisable to use several techniques at the same time, taking into account the specifics of the situation. The methodology for calculating the weighting coefficients and threshold values of the applied models taking into account Belarusian economic conditions does not allow the absence of statistical materials on bankrupt organizations in the Republic of Belarus, and the determination of weighting factors by experts does not ensure their sufficient accuracy. Nevertheless, economists from many countries, testing the Altman model in practice, agree with its universality and reliability. Adapting weights with coefficients in the model for their states and industries, many economists appreciate its high working ability and statistical reliability. The same can be said of the other models used in the global practice of diagnosing bankruptcy. For the successful application of foreign methods in the Republic of Belarus, weights must be adjusted for ratios and other model indicators taking into account the specifics of the national market economy.

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