

Application Of Classical And Fuzzy Methods For Bankruptcy Risk Assessment Of Ukrainian Enterprises

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Abstract—Bankruptcy forecasting models for Ukrainian enterprises should be based on a set of indicators specific to transition economies. Methods like fuzzy sets and neural networks, which take into account analysis under uncertainty conditions and make it possible to take into account hidden dependencies, look promising. The study is devoted to the comparative analysis of methods for predicting bankruptcy using artificial neural networks, fuzzy-multiple approach and classical discriminant analysis.

Keywords—discriminant analysis, neural networks, fuzzy sets, bankruptcy forecasting models.

INTRODUCTION

The function of methods and models for early prevention of bankruptcy of companies and enterprises is their classification according to the levels of potential threat to the financial condition based on the values of several independent variables. At present, there is complete uncertainty in the world about the duration of the economic crisis caused by the COVID-19 pandemic and its consequences for the world economy. Given the high level of unforeseen bankruptcies of Ukrainian enterprises, even in relatively stable times, it can be argued about the relevance of forecasting and reliable determination of the probability of bankruptcy.

For many years, statistical models and one-dimensional classification methods have been used to predict the risk of bankruptcy, the most famous of which is the method of the American economist E. Altman [1, 2]. But the conditions of activity of Ukrainian enterprises are more consistent with the universal discriminant function of the Ukrainian researcher O. Tereshchenko [3] and the discriminant model of economist A. Matviychuk [4]. Many scientists who have studied the problem of bankruptcy prediction have concluded that neural networks are more accurate than classical statistical approaches, have no restrictions on the stationary processes or the invariance of external conditions [5, 6].

In [7] a comparative analysis of discriminant models of A. Matviychuk and O. Tereshchenko with a model of artificial neural network such as perceptron and, on the example of analysis of financial condition of several well-known Ukrainian enterprises, the advantages and problems of discriminant analysis and artificial neural networks. O. Nedosekin developed an approach

to diagnosing the possibility of bankruptcy based on elements of fuzzy set theory [8]. In [9] a comparative analysis of bankruptcy risk forecasting methods for light industry enterprises of Ukraine, where it is found that the fuzzy-multiple method of O. Nedosekin is more effective and allows you to more accurately predict the future financial condition of enterprises in the Ukrainian economy compared to the classical method of discriminant analysis of E. Altman. The aim of the research is to increase the completeness and adequacy of information support for the process of making commercial and credit decisions, in particular, to optimize the distribution of investment resources in times of crisis.

MODELS AND METHODS ANALYSIS

The paper considers the approaches used in the analysis of bankruptcy risk of Ukrainian enterprises, namely: multidimensional discriminant analysis, fuzzy-multiple approach and neural networks such as perceptron, and comparative analysis.

To check the accuracy and quality of the studied models, 22 companies with different financial status were selected - 7 financially stable (group 1), 6 with financial difficulties (group 2) and 9 bankrupt (group 3). Data from the financial statements for 2017 from the smida.gov.ua database were selected for analysis. The percentage of cases of correct determination of the financial condition of companies on the basis of indicators of their financial and economic activity is chosen as an indicator of the accuracy of the model classification. The accuracy of the Altman model classification for financially stable enterprises was 57%, enterprises with financial difficulties - 67%, and bankruptcies - 100%. Thus, the average accuracy of model classification for all 3 groups is 74.7%, which is a satisfactory result. The accuracy of Tereshchenko's model classification, developed for Ukrainian companies, was only 29% for financially stable enterprises, 50% for enterprises with financial difficulties, and 100% for bankrupt enterprises. Thus, the average accuracy of the model classification for all 3 groups is 59.7%. Recognition of potential bankrupt enterprises as financially stable companies is economically dangerous.

The reliability of the classification of Matviychuk's model for bankrupt enterprises was 87.5%, and non-bankrupt - 92.3%, which indicates the high accuracy of the model. Matviychuk's model recognizes only 2 classes - bankrupt and not bankrupt. The average accuracy of the classification is 89.9%. However, the allocation of only two classes of the state of the enterprise in the construction of a discriminant model is not always sufficient to assess the real financial situation. In Nedosekin's method for a group of bankrupt enterprises, it is considered that the method did not err if the degree of bankruptcy risk for enterprises in this group is defined as "Very high" (extreme degree of risk) or "High" (dangerous degree of risk). For a group of enterprises with financial difficulties, it is considered that the method did not fail if the degree of bankruptcy risk for enterprises in this group is defined as "Average" (marginal degree of risk). For a group of financially stable enterprises, it is considered that the method did not fail if the degree of bankruptcy risk for the enterprises of this group is defined as "Low" (acceptable degree of risk) or "Very low" (insignificant degree of risk). The accuracy of the Nedosekin method classification for financially stable enterprises was 71.4%, enterprises with financial difficulties - 67% and bankruptcies - 78%. Thus, the average accuracy of the model classification for all 3 groups is 72.1%, which indicates a satisfactory accuracy of the model. The accuracy of the neural network model classification for financially stable enterprises was 86%, enterprises with financial difficulties and bankruptcies - 100%. Thus, the average accuracy of model classification for all 3 groups is 95.3%, which indicates the high accuracy of the model.

ACKNOWLEDGMENT

The availability of reliable methods for assessing the financial condition of Ukrainian enterprises is important in terms of future investment programs, as well as the stability and balance of the economy as a whole.

The comparative analysis of the neural network model of the perceptron type, the model of Matviychuk, Tereshchenko, Altman and the matrix method of Nedosekin on the example of Ukrainian enterprises with different financial status was carried out.

Of the five models considered, Tereshchenko's model has the lowest accuracy. In the considered examples it quite precisely recognizes unprofitable indicators, thus entering in a class of bankrupt and rather profitable enterprises. Matviychuk's model is characterized by a fairly high accuracy, but has shortcomings with the classification of the enterprise into only two categories - bankrupt and not bankrupt. The use of the Altman model in the conditions of the Ukrainian economy is also not quite appropriate, although it has satisfactory accuracy in the test sample. Altman used data from US companies, so it does not take into account the characteristics of Ukraine's economy.

Nedosekin's method gives a fairly satisfactory accuracy in classifying enterprises into potential bankrupt-

cies and enterprises with a favorable economic situation. This result is expected, because Nedosekin's matrix method predicts better in conditions of uncertainty, and can also take into account the subjective assessments of experts. In addition, it takes into account the uncertain nature of the input data and allows you to identify economic factors that urgently need to be addressed. But this method does not take into account the industry affiliation of enterprises (the same systems of preference relations are used for all enterprises).

Another factor that negatively affected the results of these methods was the inaccuracy of the input data, because companies that were not declared bankrupt could actually be bankrupt in terms of economic performance.

It should be noted that the neural network model in the test sample gave more accurate results than the other models considered. The neural network model analyzes the situation in the enterprise in more detail and does not consider minor financial difficulties as a significant threat of bankruptcy.

The prediction accuracy using the Altman model was 74.7%, Tereshchenko's model 59.7%, Matviychuk's model - 89.9%, fuzzy-multiple approach - 72.1%, neural network model - 95.3%.

The approach based on the use of an artificial neural network showed higher accuracy in estimating the probability of bankruptcy, the ability to detect latent forms of crisis of the enterprise, to analyze in more detail the financial condition of the enterprise.

As further research, it is necessary to continue to develop models that can learn from more financial indicators, as well as take into account the specifics of industries.

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