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DEVELOPING OF A BANKRUPTCY PREDICTION MODEL FOR THE UK CONSTRUCTION COMPANIES

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The paper provides a comparative analysis and classification of existing methods of diagnosing and forecasting the financial condition of companies. Furthermore, the features of carrying out multiple discriminant analysis (MDA) were discussed in details. Besides, the relevance of Altman's and Taffler's models was proved by testing these models using the financial data of current construction companies. Finally, a new model of diagnostic the financial condition of British construction companies based on MDA has been developed.

Keywords: applied mathematics, bankruptcy prediction models, construction, classifier design, features selection, financial ratios, multiple discriminant analysis, Z-score model

INTRODUCTION

At the moment, the accuracy of research results in various areas of economic science is becoming increasingly important. Many scientists aim to create unique tools and approaches that allow to maximize the accuracy of analysis results and forecasts regarding the development trends of examined companies.

The issue of analysing the financial condition of an enterprise can be solved in many ways, depending on the required accuracy of the results. Sometimes the economists need to carry out brief evaluation which allows to obtained a balanced result that is accurate enough but finished in a very short time. It is extremely usable in monitoring of a group of enterprises with similar characteristics, such as geographical position or industry sector. Using of mathematical statistics methods may will help to simplify the realisation of complex analytical operations.

The purpose of this research is to test the hypothesis of feasibility of implementing an express financial diagnostic method developed by the means of multiple discriminant analysis.

LITERATURE REVIEW

Discriminant models are the most common when it comes to predicting the bankruptcy risk of a company. Multiple discriminant analysis (MDA) is used as a mechanism of classifying and distributing the objects under observation into several groups depending on their characteristics [1]. Therefore, according to Afifi & May [2], one of the main tasks of the research is to identify economically determined and clearly-defined characteristics by which classification groups will be created. In most cases, two or more groups can be formed. Once the groups are established, necessary information on objects of research is collected with MDA providing a useful technique for determining how to distribute the objects to the final groups. In this case, the two categorizations are bankrupt and non-bankrupt firms [1]. If the specific object (a company) has the primary characteristics (financial indicators) that can be quantified, it is possible to identify a set of weighting coefficients that will be assigned to each indicator. As such, when the weighting coefficients are applied to the primary characteristics, a basis for classifying objects into two (or more) mutually exclusive groups develops. Härdle & Simar [3] state that the future of MDA lies in the analysis of holistic sets of company characteristics, and their interrelationships.

McLachlan [4] believes that one of the chief advantages of MDA in relation to the problems of object classification for certain groups involves the prerequisites of analysing a set of company characteristics, whereby it facilitates evaluation of several individual indicators simultaneously. Brown [1] confirms that similar to the way linear programming has fundamentally defined traditional methods of solving budgeting problems, the MDA approach involving traditional coefficient analysis succeeds in setting research tasks more clearly, reformulate, and address them efficiently. In particular, combinations of indicators can be analysed together to eliminate possible inaccuracies and classification errors to which traditional research in the field of coefficient analysis is exposed.

Conversely, the quality of discriminant models and the effectiveness of their application depend on the sampling of the data on which they are based in no small extent [5]. In this regard, models based on data from companies in different sectors of the economy, as well as various countries, cannot be considered as

universal, since they do not consider the peculiarities of economic activity. Simultaneously, if a significant number of financial indicators in the process of assessing the threat of bankruptcy at a particular company exist, some of the indicators will have slightly stronger links with each other than with the other indicators [2]. Furthermore, to obtain reliable results, the values of the weight coefficients must be updated regularly [4].

American economist Altman [6] contributed to the development of the most famous and widely-used model for predicting bankruptcy by applying MDA to overcome the limitations of the Beaver model. In essence, the main drawback connected to Beaver's method was the fact that he used only one indicator at a time to analyse the stability of a company. The shortcoming of this approach is that it may lead to conflicting results, especially if the indicators are computed wrongly.

Therefore, Altman's method can be presented as a five-factor model, which is based on the data of successfully operating and bankrupt industrial companies in the USA. Altman studied 66 firms, 50% of which went bankrupt between 1946 and 1965, while 50% performed successfully. He investigated 22 analytical coefficients that could be useful for predicting possible bankruptcy. After this analysis, he selected five of the most significant information for forecasting and the formulation of a multifactor equation. Therefore, the Altman Z-score, Formula 1 in Methodology, is a function consisting of some indicators that characterize the economic potential of a company as well as the results of its work over the past period.

The results of testing the model were as follows: 95% of companies were correctly classified a year before bankruptcy, 72% of the enterprises were correctly classified in two years before bankruptcy, while a sharp decrease in the forecast accuracy of the model to 48% was observed in three years before bankruptcy. Lastly, the accuracy for a four-year and five-year period was 29% and 36% correspondingly.

In 1982-1983, a British economist known as Taffler tested Altman's approach on 80 UK companies and developed a four-factor forecast model, formula 2 in methodology, with a different set of factors. Tests revealed that this technique identifies the bankrupt company with a probability of 97% a year before bankruptcy, 70% two years before bankruptcy, 61% in three years, and 35% in four years [7].

At the moment, Altman’s model, as well as its variations such as Taffler’s Z-score, has repeatedly been criticised by the supporters of the regression analysis. However, some studies prove that the model can still be used successfully today. For example, Chiaramonte’s research [8] that focused on testing banks in twelve European countries confirmed that the "Z-score shows a good predictive power". In 2017, Altman himself, with the help of his colleagues, conducted a renewed empirical analysis of the model and stated that it is still a "well-tested general model that works reliably and consistently across different countries" [9]. At the same time, the developer of Taffler’s model contends that after thirty years it has not lost its productivity [10]. In this case, it should be noted that Agarwal & Taffler [10] believe that the main reason for the disapproval of MDA models is the misunderstanding "of the purpose that elevates the z-score from its simple role

as a measurement device of financial risk to the lofty heights of a full-blown theory of corporate financial distress". For now, authors emphasize that "specific nature of the Z-score models means that they can only be appropriately applied to the population of firms from which they were developed."

RESULTS AND ANALYSIS

The study sampling includes 45 British construction companies. Financial data on the companies was taken from Fame database (accesses is provided by Westminster Business School), as well as from annual reports of companies available on official websites, and Avention one-stop reports, available in the British Library.

At the initial stage of the research, the companies were divided into three subgroups: 15 companies which are currently bankrupts, 15 companies: those with relatively stable financial state and 15 companies with excellent financial state. Besides there was a testing group comprised 25 companies, which were not the part of the model computations.

Conclusions about the company's financial condition were made on the basis of expert reports of Morningstar Agency for 2016, which are also presented on Fame database.

It should be noted that all complex matrix calculations were made in MS Office Excel application (the file with calculations is attached to the paper).

Before starting the development of the actual model, it is important to test the previous versions of the Z-score. In the testing 12 construction companies are involved. According to Fame database experts all of them are currently bankrupts. The assessment stated that both of the models revealed problems of all fifteen companies with 100% accuracy. This once again confirms the relevance of this methodology.

Methods of bankruptcy forecasting provide a clear and simple assessment of the state of a company and allow to trace the dynamics of its development. Approbation of two widely known models of bankruptcy forecasting has shown, that they can be used for construction organizations in their initial form. Meanwhile, a literature study reviled that the most accurate results are shown by those models that were developed specifically for a particular type of company. Also, an important indicator of the effectiveness of the model is the use of the most up-to-date financial indicators.

An algorithm of developing a new unique model of bankruptcy prediction for the UK construction companies using MDA method is described can be described as follows:

(1) selection of the maximum possible number of necessary companies, depending on the purpose of use and the general aim of the model (classified by size, type of economic activity, and other parameters), to form a representative sample;

(2) conducting a detailed financial and economic analysis in order to divide the selected organizations into groups according to their condition (for example, a state close to bankruptcy, an average condition, a stable state, a good condition);

(3) defining of indicators, which most accurately illustrate each of the groups;

(4) calculation of the weighted values of the selected coefficients depending on the degree of their significance for assessing a particular situation;

(5) construction of a function and a description of its criterial values that determine the separation parameters;

(6) approbation of the received model, revealing of percent of an error, correction of lacks.

According to Härdle & Simar [3] discriminant analysis is a method that solves problems of identifying objects according to a given set of characteristic features. The whole process of conducting discriminant analysis is divided into two stages, each of them can be considered as a completely independent research.

The first stage is the identification and formal description of the differences between the existing sets (groups) of observable objects. The second stage is the direct classification of new objects, i.e. assigning each object to one of the existing sets.

One of the most important stage of development of a model is the selection of a number of indicators that accurately and fully characterise the specific activities of the companies (feature selection).

Initially, most studies used variables that were selected on the basis of prevalence and popularity in the literature. Meanwhile, Altman [6] started with a rather large set of analytical coefficients (22), and then reduced them to a minimum with the help of the MDA (5). However, the variables chosen by Altman characterize the bankrupt company inadequately, since they did not affect all areas of the organization's activities, which was noticed by Taffler [7]. Thus, a new model should contain components that are responsible not only for liquidity, but for other aspects of company's activities: business activity, financial risk, productivity, operational activities, etc.

In the course of a comprehensive assessment of the activities of the UK companies, we selected five performance indicators, each of which is responsible for a certain direction of economic analysis: X_1 – revenue / total assets, X_2 – current ratio (liquidity ratio), X_3 – equity / debt (Financial risk, Gearing), X_4 – PBIT / Capital Employed (Return on Capital Employed, Profitability), X_5 – PBIT / Interest (Interest cover, Investor's Ratio). In the event that the financial position of the company is good these indicators should strive for maximum.

Further, the assignment of organizations to a certain group in accordance with their financial condition is arranged (classifier design), based on information obtained as a result of a comprehensive analysis of these firms.

After applying of MDA technique, the original model, designed for the rapid assessment of the status of the UK construction companies, has the following form:

$$\begin{cases} Z_1 = -1.04X_1 - 1.27X_2 + 0.4X_3 - 0.01X_4 + 0.01X_5 + 2.74, \\ Z_2 = -3.41X_1 - 3.04X_2 - 1.13X_3 + 0.05X_4 + 0{,}002X_5 + 7.54, \\ Z_3 = -2.37X_1 - 1.77X_2 - 1.53X_3 + 0.03X_4 - 0.01 + 4{,}79 \end{cases} \quad (1)$$

In case, if:

$Z1>0$ and $Z2>0$, then a company is a bankrupt;

$Z1<0$ and $Z3>0$, then a company has a stable financial position;

$Z2<0$ and $Z3<0$, then a company has an excellent financial position.

Testing of the created model, using random construction firms, revealed that the accuracy of the model is 98%.

It should be noted, that for good discrimination of the coefficients between two groups of companies, it is necessary that the densities of their distributions do not overlap, or such overlaps should be minimal. Since this research is based on the data of real enterprises, the spread of values could not be avoided. That is why some of the indicators has very small weighted coefficients.

In the future, this model can be modified and turned into a single function

CONCLUSIONS

The advantage of predictive models is the simplicity in the interpretation of results, as well as fairly accurate estimate of the probability of bankruptcy. Financial models can be used by entrepreneurs (to test the practical feasibility and cost-effectiveness of their ideas); managers of companies (to assess the impact of strategic and operational decisions on the financial performance of the firm); third-party investors (to assess the effectiveness and risks of the project and decide on participation in it); creditors (to decide on the provision of borrowed funds).

The novelty of the developed model is determined by its specific industry and its relevance. According to the latest quarterly reports of The Insolvency Service, construction companies are in a second place by the annual number of new bankrupts in this industry. Therefore, at the moment there is a real need to create a methodology that allows to regularly monitor construction companies in a short time. To achieve this goal, the following tasks were set and solved:

1) to analyse the main approaches of quick assessing of enterprises' financial state, and make sure that this MDA is the most preferable for evaluation of construction companies;

2) develop a new actual bankruptcy prediction model for quick diagnosis of the financial situation of the UK medium-sized construction companies.

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МЕТОДИЧЕСКИЕ ПОДХОДЫ К ФОРМИРОВАНИЮ НОРМАТИВОВ РАСХОДЫ РЕСУРСОВ И РАСЦЕНОК НА ОСНОВЕ ТЕХНОЛОГИЧЕСКИХ КАРТ

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Общереспубликанская база. нормативов расхода ресурсов 2017 года содержит около 47000 нормативов, из них 6500 (14%) разработаны на основе технологических карт [4]. Данное направление пополнения и обновления сметно-нормативной базы строительного комплекса Республики Беларусь осуществляется на основе Перечня и графиков, утвержденных Министерство строительства и архитектуры Республики Беларусь. Современная нормативная база является основой организации