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THE IMPORTANCE OF THE DISCRIMINANT ANALYSIS FOR THE EVOLUTION OF EQUITY PRICES

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Abstract: *This paper aims to show the correlation between the results obtained using the discriminant analysis and the evolution of stock prices of listed Romanian companies. For this purpose, we have carried out the research on a sample of 32 issuers from categories I and II of the Bucharest Stock Exchange, pertaining to nine economic sectors, for the period 2010-2012. Our study is based on the Anghel prediction model of bankruptcy, using the stock prices of the 32 listed companies from the first and the last day of trading for each year examined. The results obtained by applying the prediction model allow the classification of issuers into potential bankrupt and non-bankrupt firms and help investors take appropriate decisions on the stock market.*

Key words: *discriminant analysis, the A score function, stock price, correlation index.*

1. Introduction

"To lose some money is an unavoidable part of an investment, and you can't do anything to avoid it. But, to be an intelligent investor, you have to take the responsibility that you will ensure that you will never lose the most of your money". (Graham, 2006)

The prediction bankruptcy risk is a critical factor in the progress of a strong capital market, whether from developed countries or countries whose economies are in transition. The studies performed over the last years focused on the early prediction of potential dangerous situations for the financial health of the companies, as well as on the identification of the corrective measures necessary to diminish the risk of bankruptcy.

Our research aims to assess the extent to which discriminant analysis affects the evolution of the stock price for some companies listed on the Bucharest Stock Exchange. This happens because the price of shares constitutes the most important expression that reflects the general confidence of the market in the management of an entity and the starting point for other analysis accomplished by potential investors.

In order to achieve the purpose of our research, the article is structured as follows: the second section includes a presentation of the most important models developed by foreign and Romanian

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specialists, which highlight the contributions of various researchers to the radiography and prediction risk of bankruptcy. In the third section, we present the research methodology and the empirical results. The fourth section contains discussions regarding the results obtained, while the fifth section presents the conclusions.

2. Literature review

The model of bankruptcy prediction, created by Anghel (2002), presents the means by which the market eliminates uncompetitive businesses and has constituted a point of interest for specialists and researchers. The development of bankruptcy prediction models has made the object of numerous works in the country and abroad. On the basis of the univariate analysis, Beaver (1996) examined the financial situation of a sample of 79 bankrupt and 79 non-bankrupt firms. For the accuracy of the prediction of the bankruptcy process, his research, accomplished five years before bankruptcy took place, took into account 33 variables from which he selected the most relevant five instalments. The result showed that the rate of coverage of the debt with cash-flow is the best predictor, followed by the profitability of the assets.

Altman (1968) studied a sample of 66 companies, 33 of them industrial companies with financial problems and 33 companies without financial problems, from 1946 to 1965. The analysis was started with 22 measures, from which he finally selected five ratios, the most discriminant for the bankruptcy state. The essential factor was considered the assets' profitability, balanced with a value close to the other four indicators together. The results of this initial analysis led to the idea that an enterprise with an overall score lower than 1.81 is considered to be closed to the bankruptcy state. Because the original model could be applied only to firms that were listed on the stock exchange, Altman replaced the measure connected to the market value (1977), with the other ratios unchanged, and he recalculated the influence of all the indicators. To extend the application of the model to other fields of activity, not only for industry, as it was provided in the initial model, the author reconsidered the score function retaining only four variables. The development of the model and of the prediction led to the conclusion that a score lower than 1.10 shows signs of bankruptcy for the analysed companies.

Edmister (1972) tried to apply the previous studies to small companies, confirming that the prediction accuracy increases when the model includes more complex variables. The probabilistic model of Deakin (1977) brought a significant change of the Altman model, materialized by the improvement of the prediction power of the companies analysed, by introducing the initial ratios used by Beaver.

Using 19 financial ratios, which are in fact the most frequently used ones in previous studies, the 1978 Springate model (see Labanauskaite and Noel, 2012) was developed on a sample of 40 companies and chose four ratios as relevant in the bankruptcy prediction. Its result was a score function which classifies a company as bankrupt if it displays a score value below 0.862, with a success rate of 92.5%.

Conan and Holder (1979), two authors belonging to the Continental School of bankruptcy prediction, included 95 small and medium industrial enterprises from the period 1970-1975 in their five ratios model. They reached the conclusion that the risk of bankruptcy depends on limits of the scores. For example, a score between 0.04 and 0.1 reveals a problematic situation of the company, with a risk of

bankruptcy hovering between 30% and 65%. A value smaller than 0.05 leads to failure, with a probability of over 90% that the company will fail. These researchers also developed models in other sectors, such as building or transport.

We can also mention Fulmer, which achieved quite high success rates with the 1984 model (Yang, 2006), which finally employed 9 variables of the 40 originally evaluated, on a sample of 60 small and medium companies, with more than 500 employees. The model showed that there is a 98% success rate for bankruptcy prediction if it is made one year before bankruptcy and an 81% success rate if performed by more than two years before bankruptcy.

Another laborious and very complex model of bankruptcy prediction is the one developed by the Central Bank of France, in 1985, mentioned by Anghel (2002). The model was applied to industrial companies, with about 500 employees, over a period of three years preceding bankruptcy, 1977-1979. If in previous studies the emphasis was put on two categories of companies, bankrupt and non-bankrupt, this time the companies were classified as bankrupt, normal and vulnerable firms. The study imposed the separation of normal companies, with a score over 1.25, from those in difficulty, with a score below -0.25. The companies in difficulty are separated into bankrupt, respectively just vulnerable. In this case, a score below -0.375 indicates that the company could go bankrupt and a score higher than 0.12 suggests signs of vulnerability.

The contribution of the Romanian school to the development of prediction models of bankruptcy started with the study performed by Mânecuță and Nicolae (1996). These two specialists developed a model for metallurgical enterprises. Starting from the empirical coefficient of Pearson for the choice of discriminant financial rates, on a sample of 59 companies, the study was based on a matrix calculation and finally employed 14 ratios, quite above the number of ratios used by other researchers. They reached the conclusion that a company having a score of below 1.56 is a deficient company.

After two years, starting with the traditional international studies and using four ratios, but without specifying the algorithm selection, Băileşteanu (1998), through the function B developed, considered that a level below 0.5 of the score signals an imminent bankruptcy of the company. A value of the function over the level of 2 would indicate a favourable area, while the interval between the two limits suggests an intermediate area.

Having in mind the improvement of the Băileşteanu model, Ivoniciu (1998) used six financial ratios for a total of 50 sample firms, and based on the results obtained, pointed that a score situated under 0, expresses a state of imminent bankruptcy, while a score of over 6 denotes a very low risk of bankruptcy.

The 21st century brought in the foreground the Anghel model (2002) for the diagnosis and prediction of bankruptcy. The construction of this Romanian scoring model was based on a sample of 276 randomly chosen enterprises, and a final number of four financial variables, for the period 1994-1998. Unlike most models mentioned above, in the calculation of the score function Anghel also took into account a constant term. In his model, a company with a negative score is assessed as being bankrupt, whereas a result of over 2.05 ranks the company as non-bankrupt.

The latest Romanian model belongs to Armeanu et al. (2012). The development of the function score was based on a sample of 60 companies listed on the Stock Exchange and took into account seven economic and financial measures. The

results obtained on a matrix calculation showed a successful prediction rate of 98.41% and allowed the identification of three areas: a safe area with a very low probability of failure, for a score of below -2.34, a grey area, for which the probability of bankruptcy occurrence is average, for the scores located between -2.34 and -0.102, and a risky area, with a very high probability of bankruptcy which corresponds to a function score of over -0.102.

The literature review on bankruptcy prediction is very complex and the models presented above represent just some of the many approaches to this subject.

3. Data, methodology and empirical results

3.1. The research methodology

As noticed in the first part of the research, in the literature review section, the models created by foreign researchers can be successfully applied only for the historic moment and the economy where they were originally conceived. For the Romanian economy, which still preserves the imprint of a difficult time, the economic crisis, the Anghel model is considered to be an adequate choice as a reference model for the radiography and the prediction of bankruptcy, and it also serves the achievement of the purpose of this study.

The function score developed by Anghel, (2002, p. 146) the model that also will constitute the basis of this study, it is shown in what follows:

$$A = 5{,}767 + 6{,}3718X_1 + 5{,}3932X_2 - \\ - 5{,}1427X_3 - 0{,}0105X_4$$

In order to minimize errors, the choice of a point or several inflection points, whose role is to predictively classify the companies into two groups, bankrupt and non-bankrupt, led to determining the 0 value, with an uncertainty interval between 0 and 2.05.

The final step is called ex-post analysis of the success rate and consists in the determination of a success rate of the model. Practically, the function developed by Anghel revealed that the success rate increases if an area of uncertainty between 0 and 2.05 is selected. In the same step, the author registered a 3.2% error rate for the type I error (he classified bankrupt firms as non-bankrupt at a rate of 3.2%) and a 3.5% error rate for the type II of error (he classified non-bankrupt firms as bankrupt).

The results obtained are synthesized in Table no. 1 below:

Table 1

The appreciation of risk in the A model

The A interval	The appreciation
A< 0	Bankruptcy/ failure
0 >A >2,05	The area of uncertainty
A > 2,05	Non-Bankruptcy

Source: Anghel I., 2002, p. 146

The certification of the model obtained can be gained only through a-posteriori analysis of the success rate, the last step, from the technical point of view, necessary to determine the score function. This stage involved the application of the model obtained on another sample of businesses, eventually resulting that the *A* score is efficient and can be applied to enterprises in the Romanian economy for those fields of activity for which it was built.

The evaluation of the importance of this discriminant analysis, which will separate the non-bankrupt firms from the non-bankrupt ones or the companies in difficulty in financial terms from the "healthy" ones, will be achieved using an index of correlation. It will be determined as a report between the variation of the

course of the action between two financial exercises and score function variation within the same period of analysis. The formula that allows the determination of the index is the following:

$$Ic = \frac{\Delta Ca}{\Delta A}$$

where:

ΔCa – the variation of the course of the action between two financial exercises

ΔA – the score function variation within the same period of analysis.

A correlation index equal to one reveals that there is a maximum degree of correlation between the variation of share of stock and the economic and financial situation of the company evaluated, appreciated by the score function mentioned above. A higher than one value of the correlation index shows (Dinu and Curea, 2009) that only part of the evolution of the share price is explained by the economic and financial situation of the company. Finally, a negative value indicates the absence of a direct correlation between the two basic components of the analysis.

3.2. The data and the source

The sample companies from our study, which we will use to establish the degree of relevance of the discriminant analysis for the evolution of the share price, are listed in the categories I and II of the Bucharest Stock Exchange, excluding companies from the financial sector. The Anghel model, at the time it was built, did not include this field of activity. The score function will be calculated for 32 enterprises belonging to nine sectors of activity, mostly from the manufacture of chemical substances and products sector, the manufacture of rubber and plastic products, the manufacture of other non-metallic mineral products, machinery and equipment industry, respectively hotels and restaurants sector. The financial exercises for which the analysis will be performed are those comprised in the period 2010-2012. The companies were chosen randomly and 8 of them, as a result of the annual financial information, were estimated to be in difficulty, respectively Dafora S.A, Boromir S.A, Oltchim S.A, MJ Maillis România S.A, Prodplast S.A, Cemacon S.A, Impact Developer & Contractor S.A and Calipso S.A.

The data allowing the determination of the score function for each firm were taken from the consolidated financial statements of the companies during the period 2010-2012 considered, as well as from the specialized site providing financial information, ktd.ro.

The main feature of the Anghel model that will distinguish between the two groups of companies is identified to be an indicator of profitability, respectively the net profitability of revenue. This happens because profitability revenue is very important for assessing the efficiency of activity, as well as the position of the company in relation to other companies from the same industry or sector of activity. The second important element in determining the score function is the coverage rate of total assets with cash-flow, an indicator of indebtedness expressing the financial stability of the company. The rate of indebtedness of the asset, which describes the share of other people's money in total claims related to the activity of the company, is also a relevant indicator of this process. The last significant indicator, the payment of obligations, involves extremely interesting information for the company suppliers and business partners.

For the second part, which finally will help to assess the degree of importance of the discriminant analysis on the evolution of stock prices, we have selected prices

from the first and last trading day of each year for the period of analysis. The prices of the shares of enterprises have been taken from the specialized website *ktd.ro*. Not all companies included in the study were traded on the Bucharest Stock Exchange during this period; the MJ Maillis company has been listed since 2011, Stirom S.A Bucureşti and Calipso Oradea since 2012 and the company Uztel S.A. has not been listed in the last two years, 2011 and 2012.

3.3. The empirical results

A first key objective of the study, the radiography and the prediction of bankruptcy of the 32 firms listed on the Bucharest Stock Exchange using the Anghel model led us to find that the scores of the sample enterprises fitted within the limits -13.816 and 13.917. According to the risk assessment described in the previous table, 6 of the 32 enterprises are considered to be in difficulty or in a bankruptcy situation, with scores hovering between -4.061 and 13.816. This is because the results lie in the lower limit required by the bankruptcy imposed by the Anghel model, respectively below 0. The lowest value, heralding a considerable failure, belongs to the Impact Developer & Contractor S.A, a company that was ranked from the beginning as having financial problems.

At the opposite pole, over 60% of the sample, 20 enterprises respectively, are in a favourable, non-bankruptcy situation, moving significantly over the upper limit of prediction of 2.05. The limits allowing this classification lie between 2.123 and 13.917, with the "healthiest" enterprise being Rompetrol Well Services S.A.

To increase the accuracy of the prediction model of bankruptcy, the Anghel model took into account an area of uncertainty between 0 and 2.05. Six companies are found between these limits, the results of the score obtained being between 0.960 and 1.785.

The results obtained by the companies in the sample during the period of time considered, three years, and their classification within the appreciation of the risk of bankruptcy can be seen in Figure 1 below.

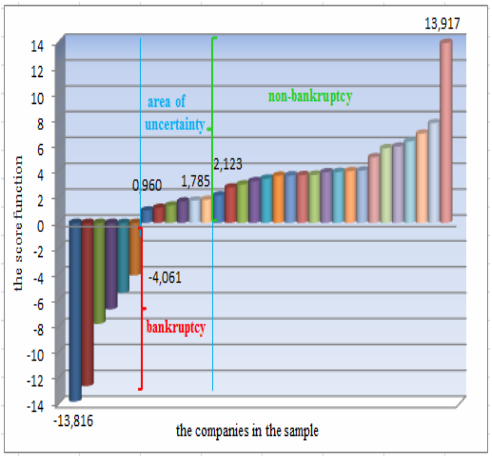

Fig. 1. *The classification of enterprises depending on the score obtained*

Considering the real financial situation of the analysed enterprises, we can say that the Romanian model offered a successful evaluation and prediction of the bankruptcy risks. This appreciation is based on the 87.5% success rate, without the uncertainty area mentioned above, based on the correct classification of 28 out of 32 companies, and upon a rate of 88.46%, respectively 23 correct classifications out of the 26 companies located outside the zone of uncertainty.

This analysis of the capacity of a-priori prediction of the score function also allowed the demonstration of the I and II error types. Thus, type I error, bankrupt enterprises classified as non-bankrupt, recorded a single error quantified through a percentage of error of 3.13%. Type II error, non-bankrupt firms classified as

bankrupt, recorded a failure rate of 9.38%, recording three errors. Practically, 4 out of the 32 companies included in the analysis were classified erroneously, the total percentage applied being 12.5%.

The relevance of the discriminant analysis in the evolution of the shares on the stock market during the period 2010-2012 has led to the following considerations. During 2010-2011, only 2 of the 32 companies in the sample were in the vicinity of the unit value of the correlation index, which allows the estimation of how well the discriminant analysis explains the financial evolution of a stock market listed company. Thus, the correlation is strong only for the case of Romcarbon S.A Buzău and Transilvania Construction S.A., accounting for approximately 6.25% of all the companies included in the research. At the same time, a number of 11 companies presented a negative correlation index, which certifies that the evolution of the stocks prices of these issuers has not reflected the dynamics of the economic-financial situation caught using the Anghel score function. Also, for 15 companies from the sample we can appreciate that the registered economic and financial situation partially explains the progress or the regress of the course of these actions, with other factors having a more significant imprint. For the 4 companies we cannot make an appreciation in terms of the correlation index because during this time they were not listed on the Bucharest Stock Exchange. A simple view of this situation, excluding the extreme values that can distort the overall image of the values obtained, can be observed in Figure 2.

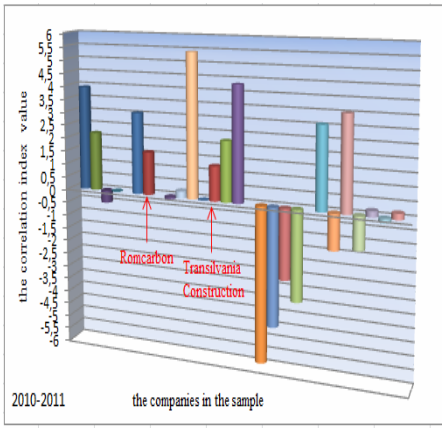

Fig. 2. *The relevance of the discriminant analysis upon the evolution of the stock prices in 2010-2011*

Unlike for the period 2010-2011, during the period 2011-2012, the percentage of companies displaying a maximum correlation between their stock prices and their economic and financial situation was a growing one, reaching 18.75%. However, the number of companies with no direct correlation between the evolution of their stock price and their situation, reflected by the Anghel score function, increased considerably to 16 enterprises. An insight into the presented aspects can be seen in Figure 3 below.

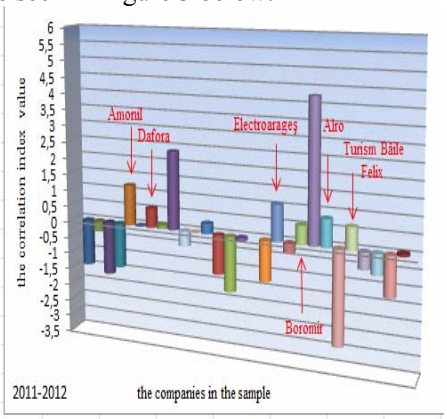

Fig. 3. *The relevance of the discriminant analysis for the evolution of stock prices in 2011-2012*

4. Discussions

Insofar, the importance of the discriminant analysis for the evolution of the stock prices was approached for the entire sample, ignoring the different branches of national economy, whereas in this section we will discuss and compare the results obtained by the nine sectors where the firms analysed in our study originate. As far as possible, we will try to achieve a parallel between the results from this research and other conclusions reached by Romanian and foreign specialists.

The prediction of bankruptcy used insofar has classified companies into three groups, bankrupt companies, companies that are in an uncertain zone and non-bankrupt firms. Watching annex number 3, it can be seen that the most vulnerable situation is displayed by the construction sector, which is not at all surprising considering the period of reporting. This happened because the financial crisis had a major impact on this industry, with long-term consequences. The crisis also affected the sector of chemical products, with the well-known case of Oltchim, subject of extensive media, political and academic discussions. The list of bankrupt companies continues with units from the manufacturing of rubber and plastics, manufacturing of other non-metallic mineral products and the hotels and restaurants.

According to the industrial areas classification made by Altman, 9 of the 25 industrial companies in the sample would have been below the 1.81 bankruptcy threshold. Applying the Altman model to other fields as well, we can see that 7 of the total number of companies would have been classified as bankrupt, registering a score below 1.10. In the same context of industrial companies, if using the results from the Conan and Holder model, the threshold of 0.05, which signals impending failure, would have been passed by only 21 of the 25 companies. Another important model, provided by the Bank of France, would have classified as bankrupt 4 industrial enterprises, displaying values below the -0.375 threshold.

The newest model for failure prediction, developed by the Romanian school, would rank in the risky zone the same number of companies as the Anghel model, with the score function recording values over the -0.102 threshold.

These comparisons of results obtained with a small part of those obtained by the literature is only an overview because each score obtained corresponds to a particular model and cannot be approached in general.

On the other hand, the companies in a favourable situation, with small oscillations of uncertainty, are those from the oil and carbon industry, food and beverages industry, metallurgy, machinery and equipment industry, and even the majority of companies from the hotels and restaurants sector.

The importance of the discriminant analysis for the evolution of stock prices, measured with the index of correlation, did more than merely consolidate the financial situation of the companies in the light of applying the bankruptcy prediction model. An example is Amonil, which activates in the chemical substances and products sector. The value of the index for the period 2011-2012 reveals a significant correlation between its bankruptcy situation, determined using financial measures, and its evolution on the Bucharest Stock Exchange.

However, the companies closest to the maximum correlation point were particularly those from the favourable area, respectively the non-bankruptcy and the uncertainty area.

For more than 35% of the companies in 2011 and almost 50% in 2012, the

evolution of the stock prices of these issuers was not reflected by the dynamics of the economic-financial situation reflected with the Anghel score function.

5. Conclusions

The research studies regarding the construction and development of the bankruptcy risk prediction models, as well as determining their relevance for the evolution of the stock prices presented, for several decades, a particular interest for a large number of specialists and researchers. Since this article is based on a sample of Romanian companies, we considered it appropriate to apply a model suited for the current time and location. Thus, using the Romanian model of Ion Anghel, the results obtained for the 32 companies listed on the Bucharest Stock Exchange allowed us to have the following conclusions.

The scores of the companies from our sample fit between the limits of -13.816 and 13.917. According to the risk assessment interval of the model applied, 6 companies are in a situation of failure, which predicts bankruptcy, 20 companies are in a favourable area, the non-bankrupt ones, and 6 businesses are into an uncertain territory. The model was properly applied, a 87.5% success rate resulting, without the area of uncertainty, and a rate of 88.46%, taking also into account the scale of this area. The difference between the success percentages obtained in this study and the corresponding model, 97.8% to 92.7% is due to the initial classification of the companies which did not include a complex ranking, based only upon the situations presented in the annual reports. Due to this classification, 4 companies were classified incorrectly, an error of 12.5% resulting.

The importance of the discriminant analysis for the evolution of stock market prices during the period 2010-2012, evaluated with the correlation index, becomes increasingly more complex from one period to another. During the period 2010-2011, we identified only two companies with a strong correlation between the evolution of their stock prices and their financial performances, whereas for the following period, 2011-2012, the number almost tripled. However, there is a high number of companies attesting that their evolution on the stock exchange market has not reflected the dynamics of their economic and financial situation reflected by the mean of the Anghel score function.

The complexity of this study demonstrated that the early health prediction of an enterprise can have a significant impact upon the evolution of Romanian companies' stock prices.

The research study is unquestionably a step in the direction of developing other studies to highlight the relevance of the discriminant analysis upon the evolution of the stock prices by applying the proposed models both in the country and abroad.

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