Factors that affect the probability of bankruptcy of a firm
An empirical review on Athens Stock Exchange

Tziotzou Magdalini

SCHOOL OF ECONOMICS, BUSINESS ADMINISTRATION & LEGAL STUDIES
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ABSTRACT

This dissertation was written as part of the MSc in Banking and Finance at the International Hellenic University. The purpose of this paper is to examine whether a set of selected ratios are capable to be used as predictors for bankruptcy of corporations. The first section presents a literature review of the most classic and modern bankruptcy prediction models, as well as the main causes that lead to firms’ bankruptcy. In order to test the hypotheses an equal sample of twenty bankrupt and another twenty non-bankrupt companies will be used, all listed on the Athens Stock Exchange (ATHEXGROUP). Afterwards, the sample is examined, through the performance of parametric and non-parametric tests, the run of robust regression and the use of Spearman correlation coefficient, in order to determine whether these indicators can predict bankruptcy, as well as whether these indicators are correlated. The programs EVIEWS and SPSS were used for this research that conclude that all tested indicators affect bankruptcy. Nevertheless, some of them can be replaced as they are correlated and so, they provide same information.

Keywords: Causes of Corporate Bankruptcy, Corporate Bankruptcy Prediction Models, Financial Ratios, Parametric and Non-Parametric Tests, Correlation Test
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PREFACE

It is an inescapable fact that corporate bankruptcy is a phenomenon which affects directly the economic development of a country. For this reason, many academic researchers from around the world have tried to capture the causes of bankruptcy of a business. In addition, they have developed bankruptcy prediction models to help businesses take timely steps to survive. In recent years, one of the most important factors that has led many Greek businesses to bankruptcy or a step before bankruptcy is the international crisis and the prolonged recession facing our country. The outburst of the global financial crisis in 2008 led to thorough changes in the economy, as there was a huge decline in Greece’s gross domestic product, causing one of the most serious international recessions in our time.

The importance of developing a reliable prediction model has long been recognized by the industry. However, there are numerous of variables that could be used in these models. These factors that can lead an enterprise to bankruptcy may be due either to external (macroeconomic) or internal (microeconomic) factors. Macroeconomic factors such as high interest rates, inflation, evolved production techniques etc., are difficult to predict and to eliminate. On the other hand, microeconomic factors such as bad firm’s organization, lack of control of the firm, poor economic performance for many continuous years etc. can be avoided through better management.

There have been many studies in the past regarding the efficiency of the forecasting models, while there have been made attempts to find out the best one. Even though many of them have been considerable, none of them have been very successful. In this sense, the decision of the best prediction model provides a great opportunity to work on this thesis and study about corporate prediction models. Studying the accuracy of different types of models is of essential importance in order to make correct evaluation of the financial state of corporations and specifically in times of crisis. In summary, there is a need for a better understanding of these models and a structured approach in identifying and modeling the variables that contribute in firm’s default.

The purpose of this thesis would be the analysis of some traditional statistical methods and some more “unconventional” methods for predicting financial distress. It is very important for analysts, stockholders, creditors of business firms and firms’ managers to identify an impending financial crisis. The bankruptcy models can be used as early signals warning management that the firm may be faced with financial crisis, even if corrective actions are undertaken. This indicates that a study on business failures of Greek firms is very interesting and may prove useful for practical applications.

Furthermore, it is necessary to determine and examine the factors that connect with the probability of default of a company, especially under disturbed macroeconomic circumstances like the ones in Greece for the years 2009-2016. The aim of this dissertation is to test if the variables and ratios that would be used for the empirical analysis can be considered as accurate predictors of corporate bankruptcy during economic recession periods.
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INTRODUCTION

Corporate bankruptcy is a particularly important problem, as it can affect the economic development of a whole country. One of the most important causes that led to the rapid growth of bankrupt companies in recent years is the Global Economic Crisis that has hit the economies of many countries. The spread of the economic crisis in almost all of Europe has led to prolonged tensions in the financial markets. Funding conditions as well as the confidence of both businesses and consumers in Europe year after year is worsening. This crisis has resulted in a decrease in the turnover, profits and liquidity of many companies, mainly due to the inability of the management to respond to adverse financial statements. The importance of the problem of corporate bankruptcy is also reflected by the fact that many academic researchers, despite having developed a wide variety of bankruptcy prediction models, continue to look for new and improved models.

Regarding this dissertation, the first chapter contains a detailed description of the main models of a firm’s bankruptcy forecasting that have been developed by 1930 until today. They are described both classic and modern methods developed by many academic researchers.

In the second chapter of the thesis, the internal and external factors lead a business to bankruptcy are presented. Furthermore, the factors that led Greek firms into bankruptcy are introduced.

Finally, the third chapter includes the empirical part of this thesis, which aims to investigate the case that a set of financial indicators are associated to the bankruptcy of a firm and whether these indicators are correlated. The sample selected refers to a group of Greek companies whose shares are traded on Athens Stock Exchange, while the above investigation was made through the use of parametric and non-parametric tests, and the Spearman correlation coefficient. At the end of the chapter, there comments on the results of the study and are suggested possible proposals for future research.
REVIEW OF BANKRUPTCY PREDICTION MODELS

According to Sundal and Hatlestad (2015), there is an incredible range of factors that affect the financial state of a company including factors such as the internal processes, liquidity, competition in the and macroeconomic conditions. A large number of academic researchers from around the world have developed bankruptcy prediction models based on various methods and techniques. The two main categories of methods used were the univariate and the multivariate statistical method. These two methods, in order to address the problem of bankruptcy, were based on the idea of classifying companies into two groups, bankrupt and non-bankrupt companies, and the use of financial ratios.

1.1 Classic prediction models of bankruptcy

The most widely used models for the prediction of bankruptcy of a company are the classic statistical models. They use a distribution method in two groups of bankrupt and non-bankrupt companies, with a certain degree of accuracy or an incorrect classification rate. The two different types of error that may arise of the application of a predictive model are Type I error, that concerns the wrong categorization of bankrupt companies as non-bankrupt and error Type II, that concerns the wrong categorization of non-bankrupt companies as bankrupt.

The two most important categories of methods that are used are the univariate and the multivariate statistical analysis. Specifically, multiple discriminant analysis is the dominant classic statistical method and it is followed by the logit analysis. Some other classic methods are the probit analysis and linear probability models. In the following paragraphs they are described the characteristics and the most known models of each category (Balcaen & Ooghe, 2006).

1.1.1 Univariate Statistical Analysis

The univariate analysis is considered as the simplest statistical method, as it is based on the usage of a small number of financial indicators. In a univariate prediction model of bankruptcy, the process of classification is accomplished separately for each indicator. Subsequently, the price of each indicator is compared to an optimal cut-off point, defining the categorization of firms in the two different groups of bankrupt and non-bankrupt companies. The accuracy of this classification is measured by the percentage of error Type I and error Type II.

A significant advantage of this method is its simplicity, as no statistical knowledge is required. Therefore, the analysis is based on the hypothesis that there is linear relationship between financial indicators and the corporate’s failure. In real life, the relationship may not be linear, and this hypothesis can be biased, leading to doubtfully results.
Apart from the simplicity, this method has many drawbacks. The first problem concerns the inconsistency, as the classification of the company is based on a single indicator every time and this can lead to inconsistent results if different indicators are used for the same firm. Furthermore, indicators are correlated, and it is difficult to test the significance of each one individually. Finally, the accuracy of classification may be lower as the optimal cut-off point is set randomly (Balcaen & Ooghe, 2006).

1.1.1.1 Univariate Studies from 1930 to 1965

The first studies for the prediction of bankruptcy were univariate, which means that they were focused on individual indicators and compare them between healthy and unhealthy firms, without the usage of models or other statistical analysis. These studies are particularly important, as they set the basis for the further creation of multivariate prediction models of bankruptcy. The most important studies according to Bellovary, Giacomin and Akers (2007), that were based on univariate analysis and the use of financial indicators are analyzed bellow.

In 1930, the Bureau of Business Research published a bulletin with results of a study of ratios of failing industrial companies. In order to determine common characteristics of failing firms, it was used a sample of 24 ratios from 29 firms and were developed average ratios, which were compared with the ratios of each company. It was observed that failed companies displayed certain similar characteristics or trends. From the study occurred the following ratios that were considered satisfying indicators of the “growing weakness” of a corporation: Working Capital to Total Assets, Surplus and Reserves to Total Assets, Net Worth to Fixed Assets, Fixed Assets to Total Assets, the Current Ratio, Net Worth to Total Assets, Sales to Total Assets, and Cash to Total Assets. What is more, BBR mentioned that even though both ratios considered to be good measures of weakness, the Working Capital to Total Assets outmatched the Current Ratio (Bellovary et al., 2007).

In 1932, Fitzpatrick examined 13 indicators of failed and successful corporations and found that in most cases, compared to the standard ratios and ratio trends, successful companies had propitious ratios, in contrast with the failed ones. Moreover, he pointed out that Net Worth to Debt and Net Profits to Net Worth were considerable ratios and supported that in firms with long-term liabilities should not be given great importance on the Current and Quick Ratio.

In 1935, Smith and Winakor continued the study of BBR and analyzed a series of indicators of 183 failed industrial firms. The result of the study indicated that Working Capital to Total Assets predicted better the financial problems than both Cash to Total Assets and the Current Ratio. They also found that the Current Assets to Total Assets ratio declined as the corporation approached bankruptcy.

In 1942, Merwin published a study emphasizing on small manufacturers and reported that in the comparison of successful with failing companies, the second ones showed signs of failure just four or five years before bankruptcy. In addition, he suggested Net
Working Capital to Total Assets, the Current Ratio, and Net Worth to Total Debt as good indicators for business failure.

In 1945, Chudson examined patterns of financial structure to define if there was a “normal” pattern, but he got a negative answer. However, Chudson [1945, p. 6] found "that within particular industry, size, and profitability groups there is a clustering of ratios.". This ascertainment had an important role in the development of further bankruptcy prediction models.

In 1962, Jackendoff made a comparison between the ratios of profitable and unprofitable companies and outlined that Current Ratio and Net Working Capital to Total Assets present higher values in profitable firms, while Debt-to-Worth ratio present lower values.

All these studies concluded that the analysis of ratios proved to be useful for the bankruptcy prediction, with the most important to be the indicators of profitability, liquidity and solvency. Moreover, they had significant contribution in the predicting sector as they set the basis for the development of future models, leading in the creation of the first statistical models. However, their adaptation both theoretically and practically was questionable, as the analysis of the indicators was prone to misinterpretation and led to possible confusion.

1.1.1.2 Beaver’s model (1966)

In 1966, William Beaver constructed the first predicting model of a firm’s bankruptcy, by applying the univariate analysis using as variables a set of financial indicators. The difference of this study from its predecessors is that Beaver examined the ability of predicting of each indicator individually for the classification in the two groups of bankrupt and non-bankrupt firms.

More specifically, using a univariate discriminant analysis, he compared 30 financial ratios for 79 bankrupt and 79 non-bankrupt companies of 38 sectors. The technique used for the selection of the sample was the one of the “firms’ matching”, i.e. each bankrupt business corresponded to a healthy one. Afterwards, he calculated each indicator separately and compared it with a cut-off score to assort the companies in the two groups.

After the completion of his study, he observed that only 6 of the 30 selected indicators could be used as predictors. The first one was Net Profits to Total Debt (92% accuracy one year before bankruptcy) and they followed up the Net Profits to Sales (91% accuracy one year before bankruptcy), Net Profits to Equity, Cash Flow to Total Debt and Cash Flow to Total Assets (90% accuracy each one).

Criticism to the study William Beaver published in 1966 was made by Wilcox in his study at 1971. Wilcox claimed that it wasn’t provided any logical or theoretical explanation to the reader about why these 6 indices in which he reached have a great foresight ability. Therefore, in this study he recorded the basis of a theoretical model, which could explain
the empirical results of Beaver, and suggested some hypotheses to improve the predictability for the financial failure of the enterprises.

Generally, all models based on univariate analysis were criticized by many scholars, such as Altman (1968) and Edmister (1972), because of the subjective usage of financial indices. It was, also, mentioned that the small number of variables and the lack of their correlation have negative result in the prediction’s accuracy. Nevertheless, these studies and especially Beaver’s aspect about the possible importance of multiple indices in the prediction models of bankruptcy, resulted in the appearance of multivariate analysis and discriminant analysis.

1.1.2 Multivariate Statistical Analysis

In contrast with the univariate, multivariate statistical analysis examines a set of financial ratios at the same time in order to conclude to results about the prediction of bankruptcy of a firm. Fisher in 1936 was the first one that was involved with the multivariate statistical analysis and created the first multivariate classification method, that was named Linear Discriminant Analysis (LDA). Furthermore, Smith in 1947 continued Fisher’s study and developed Quadratic Discriminant Analysis (QDA), so as to deal with problems occurred when the tables of variance-covariance of the categories are not equal. The most significant study that was based in multivariate analysis and specifically, in discriminant analysis, was the one by Altman (1968), which is discussed in the next paragraphs (Gaganis et al., 2006).

1.1.2.1 Discriminant Analysis

Discriminant analysis and more specifically, multiple discriminant analysis (MDA), is a statistical technique used to classify an observation into one of several a priori groupings dependent upon the observation's individual characteristics. It is mostly used to classify qualitative variables in groups of bankrupt and non-bankrupt corporations.

After the construction of the groups, it is created a linear combination of independent variables, that can be quantified for all the examined firms. The most important advantage of this analysis is that it can examine simultaneously a big number of financial indices that are common in the related firms and their interaction. In contrary, the univariate analysis examines one index at a time.

The formula of Discriminant Analysis in its sample form is the following:

\[ Z = a_1X_1 + a_2X_2 + \cdots + a_nX_n \]

where \(a_1 + a_2 + \cdots + a_n\) are the discriminant function coefficients, while the independent variables \(X_i\) represent the indices of bankruptcy prediction of each firm.
The result of this equation is Z-score, according to which is done the classification of firms in the two groups (Altman, 1968).

Even though discriminant analysis constitutes the most used practice for bankruptcy prediction, there are some difficulties in its application. The first drawback is that it depends on three restrictive hypotheses, according to which the independent variables follow the multivariate normal distribution, the tables of variance-covariance are equal for both bankrupt and non-bankrupt companies and the probability of bankruptcy and misclassification costs are predetermined beforehand. Another disadvantage is the hypothesis of linearity, as well the dichotomous dependent variables. As far as the selection of variables is concerned, even though in most studies the initial sample is random, the selection of final variable’s sample is of highly importance, as it can lead to a specific unstable model if there is not any theoretical background. Besides, the usage of financial indices for bankruptcy prediction can conduct to falsified outcomes, as they are based on data that come from annual financial statements which does not, always, depict the real condition of the company. Other problems related to this method are that the relative importance of the indicators is unknown, the independent variables appear the problem of multicollinearity, the time dimension is not taken into account and it is ignored the fact that businesses change over time. That is, this method assumes the bankruptcy as a stable situation, while in reality is a process characterized by different stages (Balcaen & Ooghe, 2006).

1.1.2.1 Altman’s Z-score (1968)

Many academics tried to eliminate the use of traditional analysis of indices as an analytical technique for the evaluation of firm’s performance, and to replace it with a more “severe” statistical technique. However, in his study at 1968 Altman attempted to bridge the gap created between these two techniques. To be more specific, he investigated a set of financial and economic ratios as indices for bankruptcy prediction using the Multivariate Discriminant Analysis method.

The initial sample consisted of 66 industry companies and it was separated in to groups (pair-matched sample of firms). The first one was composed by 33 bankrupt firms, which had declared bankruptcy between the period 1946 to 1965. The average assets of these companies fluctuated between $0.7 and $25.9 million, with a mean asset size of 6.4$ million. Nevertheless, because of the different market sectors bankrupt companies belonged and the wide range of asset size, group 1 was not totally homogeneous. For this reason, the selection of the second group was made with further attention. It was consisted of a matched sample with group 1 of 33 healthy companies, with matching by industry and approximate size (assets), that were selected by stratified random sampling and their asset fluctuated between $1 and 25$ million. Even though healthy companies continued to exist in 1966, the data used concerned the same years as those of the bankrupt companies, due to the need of matching of two groups. What is more, the data for bankrupt companies were extracted from their financial statements one year before they bankrupt.
As independent variables, Altman initially selected 22 indices, that were considered capable to predict corporate problems. These indices were sorted in five big categories: ratio about liquidity, profitability, leverage, solvency and activity. From the initially list of 22 ratios, he finally ended up to 5 financial ratios and the final discriminant formula had the following form:

\[ Z = 0.12X_1 + 0.14X_2 + 0.33X_3 + 0.006X_4 + 0.999X_5 \]

Where:

\( X_1 = \text{Working Capital} / \text{Total Assets} \)

This index measures the net cash available to an enterprise in relation to the total capitalization. Working Capital is defined as the difference between Current Assets and Current Liabilities. Two characteristics taken into account in the calculation of this indicator are the liquidity and size of the firm. Normally, when an enterprise is experiencing continuing operating losses, its Current Assets are shrunk in relation to Total Assets. Moreover, compared with the other two liquidity ratios, Current ratio and Quick ratio, this proved to be the most valuable according to Altman.

\( X_2 = \text{Retained Earnings} / \text{Total Assets} \)

This indicator measures the cumulative profit of an enterprise in the course of time. It was considered one of the new indicators that was used in the study, that was taking into consideration the age of a firm. For instance, when a business has only a few years of operation, it is reasonable that the price of the index is low as it did not have time to gain multiple cumulative profits. Thus, the probability of bankruptcy for newer firms is bigger.

\( X_3 = \text{Earnings Before Interest and Taxes} / \text{Total Assets} \)

This index is a measure of the actual productivity of the assets of an enterprise, regardless of any taxing or leverage factor. Since the existence of an enterprise is based on its ability to generate profits, this indicator was considered particularly suitable for predicting bankruptcy.

\( X_4 = \text{Market Value of Equity} / \text{Book Value of Total Liabilities} \)

This indicator shows how much the value of a company's assets can be reduced before the total liabilities exceed its assets and the firm becomes insolvent. Equity is measured by the sum of the market value of the common and preferred shares, while the obligations include both short-term and long-term. In addition, Altman argued that this index is a more effective indicator of bankruptcy than that the Net Value / Total Debt ratio.

\( X_5 = \text{Sales} / \text{Total Assets} \)

This indicator illustrates the relationship of sales of an enterprise with its total assets. It is a measure of the ability of the business’ administration to cope with competitive conditions. Although this indicator was not particularly important on its own, due to its
unique relationship with the other indicators of this model, it significantly contributed to the predictive capacity of the model.

It is important to mention that for the calculation of variables $X_1$ to $X_4$ should be used the percentages, i.e. if the variable $X_1$ is 10% it should be taken the value 10. Nevertheless, if the variable $X_5$ is 10% it should be taken the value 0.10 and not 10.

Afterwards, to examine the individual discretionary capacity of the variables, Altman used an “F” test and calculated the average indices of both bankrupt and non-bankrupt companies. From the results of the test it was observed that the index contributed more to the differentiation of the groups of discriminant equation was the profitability index $X_3$ and then, the indices $X_5$, $X_4$, $X_2$ and $X_1$ in turn.

The result of the above function gives a general index or score on the basis of which companies are classified as bankrupt or non-bankrupt. Altman discovered that firms with Z price over 2.99 were non-bankrupt companies, while those who had Z price lower than 1.81 were firms that eventually bankrupt. Additionally, the area between 1.81 and 2.99 was characterized as “zone of ignorance” or “gray zone”, where wrong classifications can be observed. Also, with regard to the predictability of the model, it was found that, just one year before the bankruptcy, its accuracy was extremely high as it reached 95%, while the second, third, fourth and fifth year it reduced to 72%, 48%, 29% and 36% respectively. Consequently, the model’s predictive ability is accurate up to 2 years before bankruptcy and then decline substantially.

After many years of this model’s application, Altman in 2000 found a new more convenient form. In particular, he did not use the percentages for the variables $X_1$ to $X_4$ as he did in the initial model. Hence, if for example the variable $X_1$ = 10% it will take as price 0.10 and not 10.

Therefore, the model took the following form:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

However, Altman continued to accept a lot of criticism despite the change he made, as his model was not applicable to non-listed companies, coming from the private sector. In order to control this parameter, in his study in 2000 he revised the model and gave it the form below:

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5$$

Even though the revised equation seems to be very different from the original model, the only change made by Altman was to replace in the variable $X_4$ the Market Value of Equity with the Book Value. This change had the effect of significantly reducing the coefficients of the variables $X_1$, $X_2$ and $X_4$. Moreover, gray zone is larger, as the lower limit is now 1.23 and not 1.81 as in the initial Z-score model. Thereafter, the revised model was probably less reliable than the original. The next modification made by Altman in his model was the removal of variable $X_5$. This variable, due to sales in its numerator, is easily affected by the size of each sector. Thus, so its omission minimizes
this probability. The form in which the function ended after the second modification was the following:

\[ Z'' = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \]

This model is particularly useful when firms of a business sector have a different type of financing of their assets and when there are no significant adjustments to them.

More generally, the Altman’s model was one of the most important models in the area of discriminant analysis, as it laid the groundwork for creating newer models. A large number of researchers were interested and still are even today in his study, creating many fans, but also critics. Indicatively, according to Gaganis et al. (2006), those who were strongly critical of Altman were Eisenbeis (1977), who argued that the use of discriminant analysis in the model created problems as it disrupted the assumption of the multivariate distribution of the sample, the linear discriminant analysis was applied in cases where the use of quadratic discriminant analysis was preferable, the groups were not clearly defined, the significance of the independent variables was misinterpreted etc., and Zopounidis (1995), who pointed out the need to create new models that will allow the integration of new techniques and the use of qualitative variables.

1.1.2.1.2 Zeta Model (1977)

In their study in 1977, Altman, Haldeman and Narayanan created a bankruptcy prediction model, based on multivariate analysis, which improved a lot the initial model of Altman’s Z-Score, as well as the use of different statistical techniques. Despite the abundant existence of earlier models to predict bankruptcy, the construction of a new model was considered imperative for the following reasons:

1. The increased number of bankrupt companies, the change in size and maybe the economic profile, necessitated the creation of a new model, the sample of which would include bankrupt companies of a larger size.
2. A model should be as contemporary as possible to better respond to current conditions.
3. The sample of previous bankruptcy models was mainly consisted of industrial firms or specific sectors. For this reason, it is necessary to make appropriate adjustments, so as to allow for the analysis of more vulnerable groups such as retailers.
4. The need to analyze the data in accordance with financial reporting standards and generally accepted accounting principles, so as to have a future effect.
5. The need to monitor and evaluate the most recent developments and the weaknesses of the discriminant analysis.

The data used for the construction of model ZETA as it was named, were reported in the period 1969-1975. The sample of companies consisted of 53 bankrupt firms and a matched sample of 58 non-bankrupt entities, which came from the construction and retail sectors. The latter are matched to the failed group by industry, asset size and year.
of data. In addition, the multivariate analysis, also known as discriminant analysis, was used to classify companies in bankruptcy and non-bankruptcy and a large number of financial indicators and new measures were calculated for the selection of the most reliable sample variables. Thus, after many trials Altman, Haldeman and Narayanan concluded to the 7 following variables:

**X₁ = Return on assets**

This indicator was measured by the ratio of Earnings Before Interest and taxes to Total Assets. It expresses the profitability of all assets and, as has been shown by previous studies, is particularly useful for assessing the performance of businesses.

**X₂ = Stability of earnings**

It is measured by the standard error of the estimation of the trend of the variable X₁ around 5 to 10 years. Business risk is often expressed on the basis of profits fluctuations. This indicator has also proved to be particularly effective in predicting bankruptcy.

**X₃ = Debt Service**

It is similar with the interest coverage ratio, i.e. Earnings Before Interest and Taxes / Total Interest Payments (including that amount imputed from the capitalized lease liability). To improve the normality and the homoscedasticity they took the log 10.

**X₄ = Cumulative profitability**

It is measured by the firm's Retained Earnings / Total Assets and takes into consideration factors such as the age of the firm, debt and dividend policy and its profitability. As it was discussed earlier, it was found to be the most helpful ratio in the bankruptcy prediction.

**X₅ = Liquidity**

This index is given by the Current ratio (Current Assets / Current Liabilities) and even thought in the past it was not considered as effective as the Working Capital / Total Assets ratio, in this study it is the most significant of all the other liquidity ratios.

**X₆ = Capitalization**

It is measured by Common Equity / Total Capital. The common equity in both the numerator and the denominator, is measured by a five-year average of the total market value, rather than book value. Furthermore, the denominator includes preferred stock at liquidating value, long-term debt and capitalized leases.

**X₇ = Size**

It is measured by Total Assets and due to the application of International Accounting Standards and generally the accepted accounting principles, a logarithmic transformation was applied so as to normalize the distribution due to outlier observations.
With regard to the predictive ability of this model, it was accurate up to 5 years before the bankruptcy of the business. Specifically, one year before bankruptcy the predicted success rate exceeded 96%, while five years before bankruptcy the percentage remained high enough at 70%. Consequently, model ZETA proved to be more accurate in predicting bankruptcy than the Altman’s Z-score model. Another benefit of this model is that the data used refer to current conditions, and in addition to industrial companies is also applicable to small and medium-sized retail companies.

1.1.3 Linear Probability Model

Linear probability is a quality selection model and is a special case of least squares method. It belongs in the category of probability models, so the result of the function is not a score, as has been mentioned so far in previous studies, but a probability of bankruptcy. In addition, it assumes that the probability of a company belonging to the group of bankrupt or non-bankrupt enterprises is a linear function of its variables. Hence, the formula of this model is the following:

\[ Y = b_0 + b_1X_1 + b_2X_2 + \cdots + b_nX_n \]

Where \( b_0, b_1, b_2, \ldots, b_n \) are the coefficients of least squares and the independent variables \( X_1, X_2, \ldots, X_n \) represent the financial ratios of the firms. The depended variable \( Y \) is a binary variable which takes the prices of 0 and 1. Therefore, when \( Y=1 \) the firm belongs to non-bankrupt companies, while \( Y=0 \) it belongs on the other group of bankrupt companies.

Nevertheless, the basic drawbacks of linear probability model are the statistical and interpretive problems that faces. The second ones arise from the fact that the values of the dependent variable may not be within the specified time \((0,1)\). Also, the residuals of the equation are not homoscedastic, do not follow the normal distribution and have no equal dispersions (Gaganis et al., 2006).

1.1.4 Multivariate Conditional Models

Multivariate conditional models are non-linear models based on a cumulative probability function, which, as before, gives the likelihood that a business will fail. The most important models belonging to this category of models are the logit and probit analysis.

1.1.4.1 Logistic Model (Logit analysis)

Logit analysis, as well as the probit model to be analyzed below, belong to the category of multivariable conditional models and appeared at the end of the 1970s. However, they did not manage to become as popular as multivariate discriminant analysis until the end of 1980s. The Logit model is based on a cumulative probability logistic regression, the value of which gives us the likelihood that a firm of the sample belongs to one of the examined groups. Thus, the probability of an enterprise \( i \) becoming bankrupt, given the variables of \( X_i \), arise by the following equation:
\[ P(X_i, b) = F(a + bX_i) = \frac{1}{1 + e^{-(a+bX_i)}} \]

Where \( F(a+bX_i) \) is the cumulative distribution function of the logistic distribution.

The value of this function will always be within the interval of (0,1), which means that the closer the price to 1, the lower the probability of the bankruptcy, while the closer the price to 0, the more it increases. Then the probability \( P(X_i, b) \) of an enterprise is compared with a probability that has been set as a limit, so as to make the classification of the companies in groups and at the same time, minimize the type I and type II errors.

The advantages of this model are that it is not subject to statistical constraints such as discriminant analysis, that is, independent variables are not required to follow a multivariate normal distribution, nor are the tables of variance-covariance of the categories to be equal. However, several studies that have been carried out comparing these two methods have concluded that both are equally accurate in the classification of enterprises (Zopounidis & Dimitras, 1998).

1.1.4.2 Probit Analysis

Probit model is an alternative approach to Logit model. Their main difference is that Probit model uses the cumulative distribution function of the standard normal distribution to find the probability of bankruptcy rather than cumulative distribution function of the logistic distribution that Logit model uses. Then, the cumulative probability of bankruptcy is mathematically defined as:

\[ P(X_i, b) = F(a + bX_i) = \int_{-\infty}^{a+bX_i} \frac{1}{(2\pi)^{1/2}} e^{-z^2/2} dz \]

Where \( F(a+bX_i) \) the cumulative distribution function of the standard normal distribution.

What is more, for the estimation of model’s coefficients, as in the Logit analysis, Maximum Likelihood Estimator is used. Even though similarities exist between these two models, Probit analysis is not used due to the complexity of calculations of non-linear estimators (Zopounidis & Dimitras, 1998).

1.2 Modern bankruptcy prediction methods

In addition to the classic statistical methods analyzed previously, new alternative methods have been discovered in recent years to analyze and predict business failure. The reason that led too many researchers in creating modern models was the complexity of the data related to the bankruptcy of an enterprise and the need to use qualitative variables, in addition to the quantitative used in the classical models.

The most popular alternative methods according to Balcaen and Ooghe (2004), is the survival analysis, machine learning and neural network. Moreover, other alternative methods could be considered the fuzzy rules-based classification model, CUSUM model, dynamic event history analysis, the catastrophe theory and chaos theory model, the
multidimensional scaling, the multi-criteria decision approach, the rough set analysis, the expert systems etc. Afterwards, some of these methods are analyzed.

1.2.1 Survival Analysis

Business failure can be modeled by statistical techniques coming from survival analysis. This result in the creation of a hazard model. Survival analysis assumes that both failing and non-failing companies belong to the same population of firms. Also, in survival analysis model the dependent variable is not dichotomous, as in the statistical models. In a hazard model, the dependent variable depicts the time that a company “spends” in the group of non-bankrupt firms, known as “survival time”, and the independent variables are selected from a wide range of possible independent variables. The basic idea of this analysis is the hazard rate of a company, which consist the conditional probability of failure of the following period, since the company will survive this period. Hazard function, which is given bellow, is the most significant function of the analysis, as it models the hazard rate.

$$h(t) = \lim_{\Delta t \to 0} \left[ \frac{P(t < T < t+\Delta t \mid T < t)}{\Delta t} \right]$$

It is, also, vital to mention that the purpose of survival analysis is not only to compute the hazard rate, but to define the effect of independent variables on it.

Compared with statistical models, hazard models have more advantages. First of all, they take into consideration time dimension, which means that a firm’s bankruptcy is not a stable situation, but changes over time. As a result, it is possible to scrutinize at the same time many companies that are in different phases of the bankruptcy process. Furthermore, it is allowed the use of time-varying explanatory variables, as well as macroeconomic variables that are the same for all businesses at a given time. Secondly, hazard models do not require any specialization on the distribution of the data, and so there are no problems of sample biases. Thirdly, hazard models allow the use of more variables rather than statistical models. Moreover, when a company no longer belongs to the group of non-bankrupt companies for reasons other than bankruptcy (e.g. merger), they are considered as “censored”, contrary to the statistical models that consider them wrongly as “healthy”. Another advantage is that hazard models can easily be interpreted and can analyze a big number of variables.

There are also many disadvantages of hazard models. Firstly, a specific process is required so as hazard models could be used as classification models. In addition, survival times’ calculation is arbitrary. A third disadvantage is sample’s structure, namely the number of bankrupt and non-bankrupt companies, may affect the hazard rate. Fourthly, the effectiveness of survival analysis in predicting failure is largely affected by the diversity of the failure processes found in the estimation sample. This means that the more homogeneous is the time length of the failure process, better the results will be. A last drawback is that there may be problem of multicollinearity and thus, strong correlations between the independent variables must be avoided.
Some of the researchers that have used hazard models in their studies are Crapp and Stevenson (1987), who used a big number of variables consisting of financial ratios and variables that concerned macro-economic conditions, management, firm’s growth and assets’ quality. Moreover, Shumway (1999) used a combination of market-oriented accounting indices and variables, so that to conclude in more accurate forecasts. Finally, Luoma and Laitinen (1991) and Kauffman and Wang (2001) created bankruptcy prediction models that were based on survival analysis (Balcaen & Ooghe, 2004).

1.2.2 Machine Learning

In the middle of the 1980s, a new non-parametric technique was introduced to classify companies into bankrupt and non-bankrupt, which was named machine learning. This technique involves recognition of patterns and in accordance with a learning process, a set of rules is resulted. The main mechanisms used to learn these rules are covering approach, decision tree approach and genetic algorithm approach.

The most commonly used approach to forecasting bankruptcy studies is the one of decision tree, that consists of: a) “root nodes”, which contain decision rules and splitting rules (quantitative or qualitative evaluation criteria), b) “branches”, which are paths from the root to the leaf nodes and with the conditions contained therein, the evaluation criteria are checked and c) “leaf nodes”, in which the classification categories are located. In the case where it is applied for the classification of corporate failure, the decision tree classifies each firm on the basis of a set of variables and characteristics. To be more specific, a sample of enterprises starts from the root of the tree and in order to examine the characteristics defined by the node, the sample is divided into a number of sub-regions of companies and moves along the tree’s branch until the companies are classified in the appropriate category.

One of the benefits of this classification technique is that there are no strict statistical restrictions, as it is a non-parametrical method. Moreover, a decision tree can process incomplete and qualitative data. A third advantage is its ease of use and the clarity of the results. Finally, the process used to construct the tree is simple, requires a minimum of time compared to other techniques and is understandable.

On the other hand, apart from the advantages, this method has some disadvantages. First of all, it is necessary to determine the ex-ante probabilities and misclassification costs, as is the case with the statistical methods, with the only difference that the decision trees are more susceptible to changes. A second drawback is that the relative importance of the variables or the characteristics of the model cannot easily be interpreted and there is no direct relationship between the variables and the result of the decision tree, making their contribution to the model ambiguous. What is more, decision tree is a discrete rating system that classifies companies into risk categories, so it cannot be used to compare businesses that are in the same category. Last but not least, it cannot be applied in new cases, as in each case a new decision tree with new variables is created (Balcaen & Ooghe, 2004).
1.2.3 Neural Networks

In 1990, artificial neural networks were used for the first time as a technique for firm’s failure prediction and from then, they have become very popular. They are computer systems that imitate human learning processes, as well as human intuition. Their purpose is to understand human thinking processes, so they can be configured and programmed into a computer.

Neutral networks, as shown in the figure below, consist of layers and each of them contains a large number of highly interconnected processing elements called “neurons”. To be more specific, a typical neutral network is composed of an input layer, a middle or “hidden” layer and an output layer.

![Neural Network diagram](image)

*Figure 1: Neural Network diagram
Source: Abbas (2005)*

In the case it is applied as a technique for firm’s bankruptcy prediction, the input layer will be composed of as many nodes as the financial indices, while the output layer will consist of as many nodes as the categories of classification. To produce an output, each neuron receives information from the input layer and after processing at the different intermediate levels, a single output is produced, but cannot be justified by a neutral network.

Furthermore, researchers in order to build a neutral network to predict bankruptcy should choose a training algorithm. The most common training method is back-propagation algorithm, which is based on the principle of continuous error feedback. This means that every result is compared with known current prices, it is re-adjusted and new results are generated. This process is repeated until the neural network becomes a good prediction model.

In comparison with other methods, neutral networks present many advantages. Firstly, they can analyze complex patterns, quickly and with a high level of accuracy, without using any knowledge bases. In addition, they are not subject to strict statistical restrictions. A third benefit is the possibility of using qualitative variables, as there is no limitation of linearity. Fourthly, neutral networks can classify noisy data which are
incomplete and incomplete. As well, a neutral network can overcome the problem of autocorrelation and finally, this method is easy to use and flexible in relation to the other methods.

On the other hand, this method presents some weaknesses. The most important problem refers to the black box, the name of which comes from the fact that a neural network cannot justify the result that has been created. That means that it cannot explain the way in which companies are classified as bankrupt and non-bankrupt. Another disadvantage is the requirement to collect high data quality, which is extremely time consuming. In addition, there is the risk of over-fitting, i.e. when the training sample data is used, the results of the model are very accurate, but if new data is used, predictive accuracy is reduced. A fourth disadvantage is the fact that long processing time is required until the end of the training phase and eventually may result in unreasonable behavior. A final drawback is that a large sample of variables is required to train the network adequately.

With regard to the studies conducted with the use of neural networks, according to Gaganis et al. (2006), the first ones that implemented neural networks as a technique of predicting corporate bankruptcy were Odom and Sharda (1990). In their study they compared the results obtained with the use of neural networks with the corresponding of the ones of discriminant analysis and concluded that the first ones gave higher success rates for both the training set and the examined sample. Also, Salchengerger et al. (1992) and Zhang et al. (1999) compared a neutral network model with a Logit model and a logistic regression model respectively and found that the level of anticipation of bankruptcy with the use of neutral networks was higher. Lastly, other researchers that used this technique are Fletcher & Goss (1993), Altman et al. (1994), etc. (Balcaen & Ooghe, 2004).

1.2.4 Expert Systems

Expert systems are one of the most outstanding development of artificial intelligence. One of the studies that used expert systems as a method for predicting bankruptcy was that of Messier and Hansen in 1988. Expert systems are computer programs that use pre-defined knowledge databases similar to those used by specialists, in order to solve a complex issue. In essence, these knowledge bases consist of a set of IF – THEN rules and once the bases are defined, then these rules are examined on a sample of bankrupt and non-bankrupt companies called "training sample". After testing, expert systems provide a number of if-then rules and becomes the classification of businesses in the two groups.

A first benefit of this method is that both qualitative and quantitative variables can be used. Moreover, there are no statistical restrictions and they can be used in new sample of companies. One last advantage is the ability of an expert system to provide explanations about the method followed for exporting the result.

In spite of that there are many disadvantages associated with the use of experienced systems as corporate bankruptcy predictors. First of all, it is difficult to determine the
knowledge base to be used. Furthermore, the process of transforming knowledge into rules is time consuming and costly, so this method is not recommended when the immediate solution of a problem is needed. A third disadvantage is the lack of flexibility of expert systems, as they cannot use inductive learning in a possible change of the knowledge base. Finally, expert systems should not have incomplete and incorrect information to function (Balcaen & Ooghe, 2004; Zopounidis et al., 1996).

1.2.5 CUSUM model

CUSUM model is a dynamic extension of discriminant analysis, which considers the behavior of time series, as well as non-transitory changes in financial variables. This means that it has the ability to distinguish the transient changes in the financial variables from a serial correlation, as well as non-transitional ones result from permanent changes in the average structure due to economic problems. Kahya and Theodossiou in 1996, used this model so as to anticipate business failure and corporate financial difficulty.

CUSUM model is a successive procedure that allows the detection of the starting point from which the performance of a company's financial variables changes, and in particular decrease. Thus, this change in the performance of the company prognosticates its possible bankruptcy. In addition, the CUSUM model solves parameters' optimization problems, which determine the model's "sensitivity" to any changes.

The main advantage of this method is that it can analyze a company's financial condition based on its past and present returns. A second advantage is that it takes into account both the good and bad performance of the company for a long time (Balcaen & Ooghe, 2004).

1.2.6 The ‘catastrophe theory’ or ‘chaos theory’ model

The catastrophe theory was first used as a prediction model of business’ bankruptcy by Scapens et al. in 1981, who considered bankruptcy as a devastating event. Similarly, Lindsay and Campbell in 1996, used the theory of chaos and considered the operations to be chaotic systems with chaotic behavior. These two theories assumed that businesses are predictable for a short time only, because of their sensitivity to the original conditions. Another assumption of this theory was that non-bankrupt companies present more chaotic behavior than bankrupt companies.

Lindsay and Campbell in their study in 1996, measured each enterprise's chaotic behavior for different periods of time and then categorized them in the two groups (bankrupt and not bankrupt). They used Lyapunov index according to which the higher the price, the sooner the business becomes unpredictable.

An important advantage of chaos theory as a prediction method of the bankruptcy of a business, is that it provides a dynamic analysis of the firm’s financial situation and can also count the chaotic behavior over different periods of time. On the contrary, a disadvantage of this theory is that its validity is based on the assumption that non-
bankrupt companies are more chaotic. In practice, however, this assumption may be violated, making the model invalid.
FACTORS INFLUENCING BUSINESS BANKRUPTCY

2.1 Definition of Firm in Difficulty

A firm is in difficulty when it is unable to fulfill its obligations for a long time because of two main factors, either because its earnings are inadequate or because of debt problems. This result in firm’s bankruptcy and then, the liquidation of its assets in order to repay its creditors. In addition, a business can be characterized to be in difficulty when its liquidity has been reduced significantly but continues to fulfill some of its current obligations (Katsou, 1988).

2.2 Factors of Creation of Problematic Companies

The importance of developing a reliable prediction model has long been recognized by the industry. However, there are numerous of variables that could be used in these models. These factors that can lead an enterprise to bankruptcy may be due either to external (macroeconomic) or internal (microeconomic) factors (Argenti, 1976). Macroeconomic factors such as high interest rates, inflation, evolved production techniques etc., are difficult to predict and to eliminate. On the other hand, microeconomic factors such as bad firm’s organization, lack of control of the firm, poor economic performance for many continuous years etc. can be avoided through better management (Charan and Useem, 2002).

2.2.1 Internal Factors

A) Inadequate business administration

The most important cause that can lead an enterprise to bankruptcy according to Argenti (1976), (as cited in Katsou, 1988), is the inadequate and bad management of a business. The most significant cases of inadequate administration are initially the management of the business by only one person, as well as the lack of looking into the administration. When decisions about firm’s activity and all-important business-related issues are taken by only one person, then it is reasonable in case of expansion of the business, this person to loses control and manage it improperly. Moreover, when there is no communication and sincere cooperation between the upper and lower layers of a business, then there may be a lot of problems as the staff messages do not reach the administration and vice versa the command of the administration does not reach the staff.

In addition, another instance of maladministration is sluggishness and bad structure of the Management Board. Where a board has inactive members, then the company may end up in one person's administration (as mentioned above) and consist of people who do not have the required administrative capacities. It is also important for the board to be made up of people of different specialties, so that issues can be discussed all the business activities.
Another cause for concern is the non-representation of the financing operation on the board of directors. Several enterprises where the financial operation was not represented by the board of directors and therefore were not control significant indicators, such as the liquidity indices, were led to bankruptcy.

Finally, one more instance of inadequate administration that may lead to a firm in difficulty is the existence of an uncontrolled managing director. This is the case when firm’s president and CEO are the same person, so his actions are not checked up.

B) Incomplete accounting information

Another internal reason that can lead a firm to bankruptcy is, according to Argenti (1976), insufficient accounting information. When a company fails to draw up its budget and to check whether it is followed, to apply a costing system, to monitor the change in the value of its assets and many other key accounting issues, then it is reasonable to show up many financial problems in the business.

C) Disproportionate spread of commercial activity

Many businesses in order to dominate the market are constantly expanding using their profits, making their turnover disproportionately large in relation to their assets. However, in order for this turnover to be served, shareholders need to contribute continuously, otherwise the company should move toward borrowing. Nevertheless, because of its low profit margin, banks are hard to finance the firm and shareholders can not cover by themselves all the capital required, resulting in cash difficulties (Katsou, 1988).

D) High proportion of borrowed funds

Excessive borrowing is a serious cause that can lead a business to bankruptcy. When the outcome of an investment or business activity is different than expected, the company is forced to borrow in order to survive. In many cases, the company has been borrowing since its establishment, with the result that the proportion of borrowed funds has risen steadily and its economic situation to deteriorate (Katsou, 1988).

E) Ambitious investment plans

Businesses often carry out investment activities that are beyond their capabilities and this is mainly because they underestimate costs and overestimate revenue. Thus, in order to continue their operations and to meet their current obligations, they constantly resort to borrowing. Therefore, a wrong investment is a serious factor that leads in problems (Katsou, 1988).

F) Mistakes of administration

According to Charan and Useem (2002), another internal factor is the mistakes made by the administration. One of the major mistakes made by the administration is its complacency after many years of success. However, this does not lead to proper decisions. Another reason that no proper decisions are made is the lack of information
the senior executives have, due to the fact that there is no close employee cooperation and the sense of fear prevails. On the other hand, there are businesses where high-ranking workers have the right to make decisions without any supervision. In addition, many businesses, due to their persistence in continuous and rapid growth, are at high risk and are exposed to overdose of danger without any particular reason. All these mistakes, combined with the existence of inadequate individuals in the administration, lead the company to bankruptcy.

2.2.2 External Factors

As regards the external factors that can lead a firm to bankruptcy, they usually arise from changes in the economic, social, technological and political environment.

Concerning the economic environment, the most important factors that may affect the process of a business are, initially, the recession that can occur within and outside the country, which is mainly revealed as a decline in GDP growth. Furthermore, the company is required to monitor the process of inflation, as a change may affect the ability to predict investment costs, but also the importance of financial ratios. Other economic factors that if they are not timely addressed by the management of the business can lead to its financial difficulty, is the competition that prevails in the firm's industry, the fluctuations of international interest, the devaluation of currencies, the entry of new businesses into the industry, incomes and changes in consumer preferences, etc. (Argenti, 1976).

What is more, other social issues that the firm needs to deal with caution are employees' desire to reduce their working hours or their participation in different production processes. Such issues directly affect the business and should be managed, as communication and cooperation between employers and employees is essential for the smooth operation of the business (Katsou, 1988).

Last but not least, the evolution of technology is an important external factor as it affects the performance of the business. The simplest example is its technological equipment, which should follow the rapid evolution of technology and be renewed, while it is advisable to modernize the entire industrial policy of the company. These actions are considered necessary as an old technological equipment is not able to produce products that the market wants and as a result, they are not competitive as well. Many times, however, technology is evolving so fast that it is reasonable for the company to be unable to follow it (Tsolka, 1987).

Apart from all these changes in the environment that can be treated, there are also variations in which, according to Argenti (1976), even the most advisable administrations cannot react, such as control of product price as well as environmental control. An enterprise is not able to prevent the rising prices of raw material or wages, nor to meet the high cost for reducing pollution. Thus, when these controls from the state side are too tight, then they can cause problems or even lead the company to close down.
2.3 Factors that led Greek companies in bankruptcy

The problematic enterprises that emerged in Greece in the early 1980s are due according to Sakellaropoulos (1992), in three main factors. The first one is the decline in Gross Domestic Product, as well as productivity in comparison to other European countries. Secondly, the increase in the services sector and the reduction of the industrial sector, especially manufacturing, led to the deindustrialization of the economy. A third factor that helped in the creation of problematic businesses in Greece was the decline in investments in industrial sector due to its inability to invest in new products and technology and thereby increase its competitiveness.

In recent years, one of the most important factors that has led many Greek businesses to bankruptcy or a step before bankruptcy is the international crisis and the prolonged recession our country faces (Bourletidis, 2013).

The recession, as mentioned above, is depicted as a decline in GDP growth rate, so the more the average GDP growth rate in our country decreases, the more the number of bankruptcies is rising.

Furthermore, another important factor is the liquidity problem that companies face, due to the difficulty of raising funds. The provision of liquid money by the banking system is now difficult because of the banks' reluctance to finance them. Moreover, the lack of purchasing interest from investors, the inability of the state and private customers to meet their debts to the company, the low level of profits, the low capital adequacy, international competition etc. are the main factors that led many Greek companies to lodge an application for bankruptcy.

Apart from these external factors, some internal factors also have an important role. A series of ambitious investments, which were the result of the company's expansionary policy, especially in times of crisis, resulted in problems in the execution of its projects. Also, a number of unfortunate investments and bad choices were due to the lack of organization and management of the business. What characterizes many Greek businesses is mismanagement and misdirection of the owners.

Below are the statements of a set of listed and unlisted Greek companies on the Athens Stock Exchange regarding the factors that led them to submit an application under Article 99 of Law 3588/2007:

- **NUTRIAT ABEE**

Nutriart SA, in a statement to the Securities and Exchange Commission, said that "the most important reason for the bankruptcy petition was the significant delay in the implementation of the financial restructuring. Thus, despite the volume of funds allocated, the fact that these funds were given gradually and with delays and in combination with the international crisis (high increase in wheat / flour prices) and the prolonged recession in the Greek market, had the effect of not avoiding the shrinking of production, which in turn led to a lack of supply of the company's products to the market and loss of sales. As a result, the company was deprived of the necessary working capital..."
and was no longer able to meet its financial obligations" (www.tovima.gr access in: 15/10/2018).

- BABIS VOLOS INTERNATIONAL CONSTRUCTION S.A.

The most important reasons that led the company to Article 99, was the decision of many companies to stop renting the offices that the company has rented to them for years, the tragic financial situation of Greece in the real estate sector, as well as the unfinished project of Votanikos. Mr. Vovos stated in his statements about the company's financial situation that "the company has been profitable since its inception and for many decades, until the outbreak of the financial crisis in Greece in 2008 and the decision of the plenary session of the Council of State at the beginning of 2009, which led to the cancellation of the construction of a commercial center of interests in the Votanikos area" (www.newpost.gr access in 15/10/2018· www.protothema.gr access in: 15/10/2018).

- ATLANTIK SOUPER MARKET COMMERCIAL S.A.

The well-known supermarket chain "Atlantic" in August 2011 declared bankruptcy as it failed to fit into Article 99. The bad handling of many years by administration coupled with the poor course of the country, led enterprise in disaster, along with its suppliers (www.protothema.gr access in: 15/10/2018).

- SPRIDER STORES AEBE (Commercial & Industrial S.A.)

The expansive policy of the branch network inside and outside Greece with easy loan money followed by the company over a period of time when more and more business groups in Greece were closing, was one of the key reasons that led the company to bankruptcy. Sprider Stores in a statement argued that "the prolonged recession of the Greek economy, the reducing of disposable income of consumers, the increasing financing costs, the devastating consequences of fire in central warehouses and company premises, the refusal of insurance companies to compensate even partially the firm, but also the bankruptcy petition filed the supplier of Sprider Stores, further aggravated the situation and led the company in bankruptcy" (www.tovima.gr access in: 16/10/2018· www.fimes.gr access in: 16/10/2018).

- EDRASI – X. PSALIDAS (Technical Société Anonymé)

The main reason that led the company to the bankruptcy petition was the liquidity problems resulting from the reduction of the construction object, but mainly the weakness of the state and private customers to meet their debts to the company (www.tovima.gr access in: 15/10/2018).

- NEOSET

The company has attributed the submission of application for Article 99 in two factors, to the competition of foreign chains, IKEA etc., and to the crisis the Greek economy is experiencing. These two factors led the company to suffocation as the reduced sales and
the accumulated losses do not allowed it to meet its obligations (www.newsbomb.gr access in: 20/10/2018).

- SATO

A series of bad investments in both commercial centers (Athens Heart) and in real estate, as well as the fall in furniture sales in our country, were two of the reasons that led the company to bankruptcy. Another reason was bad management, as while the company was going bankrupt, its owner continued to spend money on great shopping malls (www.protothema.gr access in: 15/10/2018).

The biggest mistake of all these businesses that were forced to fill an application under Article 99 of the Bankruptcy Code, was that even though they had all the basic evidence for the unfavorable business conditions that will follow, they did not make the proper manipulations to handle them. In particular, the delayed response of most Greek firms to start the restructuring process, in combination with the lack of specialized executives in terms of restructuring and refinancing their obligations, has increasingly resulted more businesses to face problems and close down (http://www.topontiki.gr access in: 20/10/2018).
EMPIRICAL ANALYSIS

3.1 Collection and Processing of the Sample Data

The economic crisis that has plagued our country over the last few years has led an increasing number of businesses to bankruptcy. The purpose of this research is to examine, through the use of econometric and statistical programs, whether a set of indicators can affect the bankruptcy of a business, as well as examine which of these indices are correlated with one another. The sample used in this study concerns a number of Greek companies listed on the Athens Stock Exchange.

As regards the procedure followed for data collection which were necessary for the selection of the final sample, the sample was initially separated into two groups, where one group includes bankrupt companies or firms that have been suspended due to the examination of their application to be subjected to Article 99 of the Bankruptcy Code, while the second group includes non-bankrupt companies.

For the selection of the first group, a survey was initially conducted on the number of Greek businesses that have been bankrupt or suspended for the last ten years. The main source of this information was financial newspapers, as well as reliable websites such as the Athens Stock Exchange website and the website of Naftemporiki. From these companies they were selected those that were or are still listed on the Athens Stock Exchange, but are in a suspension of operation and, there are, also, published financial statements for the year of bankruptcy or suspension, or one year before bankruptcy or suspension.

Afterwards, the period for the collection of data from each company's financial statements was set to five years before its bankruptcy or its suspension. At this point, the sample was further reduced, because before 2004 the preparation of the financial statements was not in accordance with the International Accounting Standards and thus, the companies that had gone bankrupt before 2009 were not included in the sample. Finally, the first sample group includes companies that have been bankrupt or in standby from 2010 to date, and the period of data collection from the financial statements has been limited to the years 2005 to 2015. These enterprises were chosen randomly and come from different sectors.

The second group includes non-bankrupt Greek companies that are also listed on the Athens Stock Exchange. Altman (1968) had set 2 main rules regarding the matching of bankrupt and nonbankrupt firms. Following his methodology, both bankrupt and non-bankrupt firms should have total assets on average almost equal and the firms of a pair must operate in the same industry. It is worth noting that the annual financial statements for both bankrupt and non-bankrupt companies were drawn from the Athens Stock Exchange website.
3.2 Final Sample

Following the above procedure, the final sample is composed of a total of 40 companies of which half are bankrupt or in suspension and the other non-bankrupt. Detained firms are not technically bankrupt, but still they are considered to be financially distressed and they are under suspension in the stock exchange market. In the most cases a firm whose operation is detained is considered to be almost bankrupt. As mentioned above, the sample selection was randomized and firms come from different market sectors. The following tables show the companies selected and the sectors to which they belong.
Table 1: Bankrupt or Detained Companies

<table>
<thead>
<tr>
<th>“Year 0”</th>
<th>Group 1 (bankrupt companies)</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>Hellenic Sugar Industry SA</td>
<td>Food &amp; Beverage - Food</td>
</tr>
<tr>
<td>2015</td>
<td>Maritime Co of Lesvos</td>
<td>Travel &amp; Leisure</td>
</tr>
<tr>
<td>2015</td>
<td>Hellenic Fish Farming SA</td>
<td>Food &amp; Beverage</td>
</tr>
<tr>
<td>2015</td>
<td>Mochlos SA</td>
<td>Construction &amp; Materials</td>
</tr>
<tr>
<td>2013</td>
<td>Nutriart SA</td>
<td>Food &amp; Beverage - Food</td>
</tr>
<tr>
<td>2013</td>
<td>Sprider Stores SA</td>
<td>Retail – Clothing Retail</td>
</tr>
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<td>Construction &amp; Materials</td>
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<td>Health - Medical Services</td>
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<td>Autohellas SA</td>
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<td>Medicon Hellas SA</td>
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<td>Fourlis SA</td>
<td>Personal &amp; Household Goods - Lasting Consumer Goods</td>
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<td>2010</td>
<td>Minerva Knitwear SA</td>
<td>Personal &amp; Household Goods - Clothing &amp; Accessories</td>
</tr>
</tbody>
</table>
3.2 Definition of Sample’s Varieties

The indicators selected to be examined, cover all financial characteristics of an enterprise, i.e. capital profitability, liquidity, capital structure and solvency, etc. In addition, the data needed to calculate these indices, are derived from the annuals Balance Sheets, as well as the Income Statements of each firm that are available in the website of Athens Stock Exchange and calculated at 31/12 of each year. The seven selected indicators are analyzed below:

1. CURRENT RATIO = CURRENT ASSETS / CURRENT LIABILITIES

This indicator is calculated by dividing the current assets by short-term liabilities. It is the most common instrument for measuring the company’s liquidity and short-term creditworthiness, as it shows whether all its short-term liabilities can be covered by its assets. Therefore, the higher the value of this indicator, the greater the creditors' security margin, as the company will be in a better position in terms of liquidity and thus, will be able to meet its short-term requirements. However, this is not unquestionable as it depends to a large extent on the ability of liquidation of current assets (Lazaridis & Papadopoulos, 2005 · Vasilatou, 2001 · Weston & Brigham, 1985).

2. RETURN ON ASSETS (ROA) = EARNINGS BEFORE INTEREST AND TAXES / TOTAL ASSETS

This ratio measures the company's profitability and in particular the rate of return of its total investments. Thus, through the use of this index, it is shown how efficiently the total capital of the company is used and how profitable it is to its total assets. It is calculated by dividing net profit before tax and interest to total assets. A high value of this ratio indicates that the company's management uses effectively its assets to generate profit (Lazaridis & Papadopoulos, 2005 · Efthimoglou, 1999).

3. RETURN ON EQUITY (ROE) = NET INCOME / SHAREHOLDERS’ EQUITY

The return on equity ratio is calculated by dividing the net profit, that is, profits derived from both operating and non-operating activities of the firm, by shareholders’ equity. It shows the profitability of the shareholders' investments and the size of profits which correspond to total equity. The higher the value of this index, the more appropriately the company uses its capital and is effective, while low values of this indicator display the existence of bad conditions in firm (Weston & Brigham, 1985).

4. RETAIN EARNINGS / TOTAL ASSETS

This indicator measures the cumulative profitability of a business over time, as a percentage of total assets. Retained earnings are the profits that were not distributed to the shareholders but stayed in the business for financing new investments. Thus, a high price of this indicator means that the funding of assets and new investments was made using the retained earnings, so the company did not need to resort to high borrowing. However, what needs to be taken into consideration in this indicator is the
age of a business, as newer businesses are reasonably to have lower prices because of the small amount of their cumulative profits (www.stockopedia.com).

5. **NET PROFIT MARGIN RATIO = NET INCOME / SALES**

This is calculated by dividing the net income by the amount of sales and represents the percentage of sales that turned into profits. It shows which amount of money collected by a firm as revenue have been translated into profit. Hence, it is used as a profitability indicator of a business activity, as firms can evaluate whether the polices they use are working and make forecast of profits based on revenues. It is the percentage by which a company's total sales or revenue exceeds or is less than the sum of its expenses. Therefore, a high price of this ratio indicates that the company made more money during that period than it spent and a high amount of revenues was translated in real money (Lazaridis & Papadopoulos, 2005 · Weston & Brigham, 1985).

6. **DEBT RATIO = TOTAL DEBT / TOTAL ASSETS**

This ratio measures the amount of total funds which comes from lenders and is calculated by dividing total short- and long-term liabilities with total assets. Lenders prefer a low price for this index so that in case of liquidation their collateral to be higher, while the owners of the company prefer a high debt in order to increase their profits and in case of damage the investment will be relatively small. Therefore, the higher the value of this index, the greater the likelihood the firm will become insolvent before fulfilling its obligations to the creditors. Instead, the lower the price, the greater the margin of creditors' security against losses (Lazaridis & Papadopoulos, 2005 · Vasilatou, 2001).

7. **WORKING CAPITAL / TOTAL ASSETS**

An important indicator for determining the liquidity of an enterprise is the working capital ratio, which is calculated by dividing working capital by total assets. Working capital is the difference between current assets and short-term liabilities and presents the safety margin of short-term creditors and lenders, as well as of the company itself. Furthermore, it shows the available liquidity stock of the company, expressed as a percentage of total assets. As with other liquidity indices, the higher the price of the index, the greater the liquidity of the company (Weston & Brigham, 1985 · Efthimoglou, 1999).

**3.4 Performance of parametric and non-parametric tests**

In order to determine whether the above-mentioned figures are associated with a company's bankruptcy, both parametric and non-parametric tests were performed through the use of the SPSS statistical program, the results of which are presented below.
3.4.1 Parametric t-test

Initially, the parametric t-test was performed to determine whether the means of the two types of business, i.e. bankrupt and non-bankrupt, varied for each of the seven indices. Thus, the assumptions on which this audit was based are as follows:

H0: $\mu_0 = \mu_1$

H1: $\mu_0 \neq \mu_1$

Where:

- $\mu_0$ is the mean price of index for bankrupt companies
- $\mu_1$ is the mean price of index for non-bankrupt companies

The results obtained from this test are shown in the following table.
### Table 3: Results of Parametrical T-test

<table>
<thead>
<tr>
<th>RATIO 1</th>
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<td>.000</td>
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<td>99.077</td>
<td>.050</td>
<td>1.4252</td>
<td>.71833</td>
<td>-.8505</td>
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<td>1.76533</td>
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<td>6.691</td>
<td>198</td>
<td>.000</td>
<td>.42309</td>
<td>.06323</td>
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<td>120.959</td>
<td>.000</td>
<td>.42309</td>
<td>.06323</td>
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<tr>
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<td>.000</td>
<td>-7.235</td>
<td>198</td>
<td>.000</td>
<td>-.48740</td>
<td>.06736</td>
<td>-.62024</td>
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<td>-.35401</td>
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</tbody>
</table>
On the left side of this table is the Levene test, which informs us about the equality of variances. Observing the significance column, we notice that for all the seven indicators the probability is less than 5%, so we can conclude that the variances are not equal. This test was made to determine which of the two t-tests, presented in the table we will choose. Since we found from the Levene test that the variances are not equal, we will look at the second line of the table (Equal variances not assumed), so we can draw conclusions for the parametric t-test.

From the significance (2-tailed) column of the t-test, we observe the p-value for indicators 1, 2, 5, 6 and 7 are less than 5%, therefore the null hypothesis is rejected. This means that the means of current ratio, profitability index of invested capital, asset turnover index, the debt ratio and the working capital ratio for the two business groups are not equal.

However, in order for the results of this test to be reliable, it is required satisfaction of two basic assumptions. The former refers to the regularity distribution of the observations of the two samples, while the second one refers to the the existence of extreme observations. If these two assumptions do not apply, non-parametric controls are performed.

3.4.1.1 Normality Test

As mentioned above, the reliability of the t-test control requires the normality of the distribution of observations of the two samples. Therefore, the two cases to be tested are:

H₀: The samples are derived from a normal distribution

H₁: The samples are not derived from a normal distribution

In order to test whether the null hypothesis is supported, i.e. the samples are derived from a normal distribution, we will use two well-known statistic tests for normality, the Kolmogorov-Smirnov and Shapiro-Wilk test. The difference between these two tests is that the Shapiro-Wilk criterion is mainly chosen for small samples (n ≤ 50), while the Kolmogorov-Smirnov criterion for large samples (n > 50). The results of the normality test for both bankrupt and non-bankrupt companies are presented in the following tables.
From the above table we note that the Sig. (p-value) = 0.000 < 0.05 for all the indices, therefore the null hypothesis of normality for all bankrupt companies is rejected.

In this table, we can also see that the probability values for indices 1, 2, 3 and 5 are less than 0.05 (or 5%), which means that there is problem of normality in non-bankruptcy companies, too. Thus, we proceed directly to the non-parametric tests.

3.4.2 Non-parametrical Tests

Non-parametric test used in this study are Mann-Whitney U and Wilcoxon W, which are considered as alternatives to t-test in case the sample observations do not follow the normal distribution. The results of non-parametric tests are presented in the following table.
Table 6: Results of Non-parametric Tests

<table>
<thead>
<tr>
<th>Test Statistics</th>
<th>RATIO 1</th>
<th>RATIO 2</th>
<th>RATIO 3</th>
<th>RATIO 4</th>
<th>RATIO 5</th>
<th>RATIO 6</th>
<th>RATIO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann-Whitney U</td>
<td>1667.500</td>
<td>931.500</td>
<td>3843.500</td>
<td>1284.500</td>
<td>886.500</td>
<td>1501.500</td>
<td>1459.500</td>
</tr>
<tr>
<td>Wilcoxon W</td>
<td>6717.500</td>
<td>5981.500</td>
<td>8893.500</td>
<td>6334.500</td>
<td>5542.500</td>
<td>6551.500</td>
<td>6509.500</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.005</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
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</tbody>
</table>

a. Grouping Variable: TYPE

From the non-parametric table, we see that the p-value for all seven indices is less or equal to 0.05. This means that the means of the indices vary according to whether the firm is bankrupt or not bankrupt. Specifically, as we can see from the following table, the mean value of current ratio (Index 1) is higher in the non-bankrupt firms (2,047) than in the bankrupt (0,865). The same applies to the index of ROA (Index 2), the ROE ratio (Index 3), the index of retained earnings (Index 4), the net profit margin ratio (Index 5) and the working capital ratio (Index 7). But there is a differentiation with the debt ratio (Index 6), while the mean value is higher for bankrupt companies (0,947), rather than this of non-bankrupt (0,524).

Table 7: Indicators' Statistics

<table>
<thead>
<tr>
<th>TYPE</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error of Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATIO 1</td>
<td>Bankrupt</td>
<td>100</td>
<td>.865078</td>
<td>.673446</td>
</tr>
<tr>
<td></td>
<td>Non-bankrupt</td>
<td>100</td>
<td>2.04790</td>
<td>1.40826</td>
</tr>
<tr>
<td>RATIO 2</td>
<td>Bankrupt</td>
<td>100</td>
<td>-1.04113</td>
<td>.346446</td>
</tr>
<tr>
<td></td>
<td>Non-bankrupt</td>
<td>100</td>
<td>.068674</td>
<td>.045115</td>
</tr>
<tr>
<td>RATIO 3</td>
<td>Bankrupt</td>
<td>100</td>
<td>-0.64127</td>
<td>2.08071</td>
</tr>
<tr>
<td></td>
<td>Non-bankrupt</td>
<td>100</td>
<td>.086483</td>
<td>.095553</td>
</tr>
<tr>
<td>RATIO 4</td>
<td>Bankrupt</td>
<td>100</td>
<td>-1.28811</td>
<td>7.18195</td>
</tr>
<tr>
<td></td>
<td>Non-bankrupt</td>
<td>100</td>
<td>.137146</td>
<td>1.41884</td>
</tr>
<tr>
<td>RATIO 5</td>
<td>Bankrupt</td>
<td>96</td>
<td>-0.699705</td>
<td>2.2494</td>
</tr>
<tr>
<td></td>
<td>Non-bankrupt</td>
<td>100</td>
<td>.065633</td>
<td>.082003</td>
</tr>
<tr>
<td>RATIO 6</td>
<td>Bankrupt</td>
<td>100</td>
<td>.94726</td>
<td>.599597</td>
</tr>
<tr>
<td></td>
<td>Non-bankrupt</td>
<td>100</td>
<td>.52417</td>
<td>.200933</td>
</tr>
<tr>
<td>RATIO 7</td>
<td>Bankrupt</td>
<td>100</td>
<td>-2.85892</td>
<td>.64187</td>
</tr>
<tr>
<td></td>
<td>Non-bankrupt</td>
<td>100</td>
<td>.201511</td>
<td>.204433</td>
</tr>
</tbody>
</table>

In general, the conclusion that we could come from the above tables is that the lower the value of indices 1, 2, 3, 4, 5 and 7, the greater the probability of bankruptcy of the enterprises. Instead, the higher the value of index 6, the greater the probability of bankruptcy of a business.

The conclusion we have reached is logical, because as the liquidity of the company (measured by indices 1 and 7), its effectiveness in managing its funds (indicators 2 and
3) and the money spends over that it makes (index 5), as well as its cumulative profitability (index 4) decrease, so its position is more difficult, and the probability of bankruptcy of the business is rising. On the contrary, as the debt ratio rises (index 6), the more likely the company is to become insolvent and bankrupt.

3.5 Run of the regression model

In addition to performing parametric and non-parametric test, a robust regression was also performed to determine whether the values of the indicators actually differ according to the type of business.

The regression estimated is as follows: $Y = \alpha + \beta X + \epsilon$

Where $Y$ is one of the seven indices, $X$ is a dummy variable which takes the value 0 for the bankrupt companies and 1 for the non-bankrupt companies and $\epsilon$ is the regression residuals or errors.

The type of regression used is quantile regression. An advantage of quantile regression, relative to normal regression of least squares, is that its estimates are more robust than those of extreme values. The regression assessment was made using the EVIEWS econometric program and the results for each index are presented in the following tables.

Table 8: Quantile Regression for Index 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.725765</td>
<td>0.074782</td>
<td>9.705061</td>
<td>0.0000</td>
</tr>
<tr>
<td>TYPE</td>
<td>0.976483</td>
<td>0.137665</td>
<td>7.093188</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

The regression equation can be written as follows:

$$R1 = 0.7257 + 0.9764TYPE + \epsilon$$

$$(0.0747) \quad (0.1376)$$
From the table we notice that the dummy variable is statistically significant as $t$-Statistic $= 7.09 > 2$. In addition, the constant term ($C$) is the estimation of average for bankrupt companies, while the sum of the fixed term and the dummy variable ($C + TYPE$) is the average of bankrupt companies. Therefore, we find that the value of the Current Ratio (Index 1) is influenced by the type of business, and in particular non-bankruptcies are priced by 0.976 higher than the bankrupt companies.

Table 9: Quantile Regression for Index 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>$t$-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.033257</td>
<td>0.013640</td>
<td>-2.438206</td>
<td>0.0156</td>
</tr>
<tr>
<td>TYPE</td>
<td>0.092020</td>
<td>0.014988</td>
<td>6.139464</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

The regression equation can be written as follows:

$$R^2 = -0.0332 + 0.0920TYPE + \varepsilon$$

$$(0.0136) \quad (0.0149)$$

From the above table we see that the dummy variable is statistically significant as $t$-Statistic $= 6.13 > 2$. In addition, the estimate of mean value of Return on Assets Ratio (Index 2) for the bankrupt business is -0.033, while for non-bankrupt is 0.058. So, we see that value of the invested funds efficiency index is 0.092 higher to non-bankrupts than to bankrupt companies.
Table 10: Quantile Regression for Index 3

Dependent Variable: RATIO_3
Method: Quantile Regression (Median)
Date: 12/23/18   Time: 23:13
Sample: 2005 2015
Included observations: 200
Huber Sandwich Standard Errors & Covariance
Sparsity method: Kernel (Epanechnikov) using residuals
Bandwidth method: Hall-Sheather, bw=0.16613
Estimation successful but solution may not be unique

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.011343</td>
<td>0.039464</td>
<td>-0.287417</td>
<td>0.7741</td>
</tr>
<tr>
<td>TYPE</td>
<td>0.078187</td>
<td>0.040994</td>
<td>1.907252</td>
<td>0.0579</td>
</tr>
</tbody>
</table>

The regression equation can be written as follows:

\[ R3 = -0.0113 + 0.0781 \text{TYPE} + \epsilon \]

\[(0.0394) \quad (0.0409)\]

From the table of regression, we observe that the t-Statistic = 1.90 is close to 2 and the p-value of dummy variable is a little higher from 5, so we have to consider the consequences of error Type I before rejecting the null hypothesis. Thus, it seems that this indicator is not quite statistically significant as the other ratios.

Table 11: Quantile Regression for Index 4

Dependent Variable: RATIO_4
Method: Quantile Regression (Median)
Date: 12/23/18   Time: 23:13
Sample: 2005 2015
Included observations: 200
Huber Sandwich Standard Errors & Covariance
Sparsity method: Kernel (Epanechnikov) using residuals
Bandwidth method: Hall-Sheather, bw=0.16613
Estimation successful but solution may not be unique

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.320585</td>
<td>0.063872</td>
<td>-5.019192</td>
<td>0.0000</td>
</tr>
<tr>
<td>TYPE</td>
<td>0.437502</td>
<td>0.067582</td>
<td>6.473669</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Pseudo R-squared 0.087008
Mean dependent var 0.014175
S.D. dependent var 0.082397
Objective 5.125749
Quantile dependent var 0.014175
Restr. objective 75.26601
Sparsity 0.656395
Quasi-LR statistic 79.81460
Prob(Quasi-LR stat) 0.000000
The regression equation can be written as follows:

\[ R4 = -0.3205 + 0.4375 \text{TYPE} + \varepsilon \]

(0.0638) (0.0675)

From the regression table we see that the dummy variable is statistically significant as t-Statistic = 6.47 > 2. Moreover, the results show that average value of the retained earnings index to total assets (Index 4) are influenced by the type of business, and in particular non-business bankruptcies are priced at 0.437 higher than the bankrupt businesses.

### Table 12: Quantile Regression for Index 5

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.108664</td>
<td>0.029879</td>
<td>-3.636770</td>
<td>0.0004</td>
</tr>
<tr>
<td>TYPE</td>
<td>0.152474</td>
<td>0.030700</td>
<td>4.966590</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

The regression equation can be written as follows:

\[ R5 = -0.1086 + 0.1524 \text{TYPE} + \varepsilon \]

(0.0298) (0.0307)

From the above table we conclude that the dummy variable is statistically important as t-Statistic = 4.96 > 2. Moreover, we can also see that the average value of the net profit margin rate (Index 5) in the non-bankrupt is higher by 0.152 than the bankrupt firms.
The regression equation can be written as follows:

\[ R_6 = 0.857 - 0.3322 \text{TYPE} + \varepsilon \]

From the regression table we see that the dummy variable is statistically significant as t-Statistic = -7.63 < -2. The results from the table regression show that the debt ratio (Index 6) is influenced by the type of business. However, this indicator behaves opposite from the other indices, as non-bankrupt companies have a price 0.332 lower than the bankrupt companies.
The regression equation can be written as follows:

\[ R7 = -0.1675 + 0.3921 \times TYPE + \epsilon \]

\[ (0.0441) \quad (0.0534) \]

From the regression table, we see that the dummy variable is statistically significant as \( t \text{-Statistic} = 7.33 > 2 \). In addition, the results show that the working capital index (Index 7) is influenced by the type of business, and in particular, non-bankrupt companies have a price by 0.392 higher than bankrupt companies.

To sum up, the general conclusion drawn from the use of regression is that the price of indicators is influenced by the type of business and non-bankrupt firms have a higher average value of all indices compared to bankrupt companies, excluding the debt ratio.

### 3.6 Test for indicators’ correlation

Another issue that has been dealt with is the correlation of the indicators, so that it can be found which indicators have a high degree of correlation with each other and therefore provide same information. As a correlation control measure was used the Spearman correlation coefficient, which is a non-parametric measure of the statistical dependence between variables. In order to interpret the results and to describe the correlation, it was used the following guide at absolute value.

- - 0.19 “very weak”
- 0.20 - 0.39 “weak”
- 0.40 - 0.59 “moderate”
- 0.60 - 0.79 “strong”
- 0.80 - 1.00 “very strong”

The results of correlation test of indicators for bankrupt and non-bankrupt companies, as estimated by the SPSS program, are presented below.
### Table 15: Correlation Test for Bankrupt companies' Indices

<table>
<thead>
<tr>
<th></th>
<th>Correlation Coefficient</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RATIO 1</td>
<td>RATIO 2</td>
<td>RATIO 3</td>
<td>RATIO 4</td>
<td>RATIO 5</td>
<td>RATIO 6</td>
</tr>
<tr>
<td>Spearman’s rho</td>
<td>Correlation Coefficient</td>
<td>1.000</td>
<td>.581**</td>
<td>-.081</td>
<td>.646**</td>
<td>.753**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>RATIO 2</td>
<td>Correlation Coefficient</td>
<td>.581**</td>
<td>1.000</td>
<td>-.016</td>
<td>.519**</td>
<td>.861**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>RATIO 3</td>
<td>Correlation Coefficient</td>
<td>-.081</td>
<td>-.016</td>
<td>1.000</td>
<td>-.178</td>
<td>.073</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.421</td>
<td>.875</td>
<td>.077</td>
<td>.479</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>RATIO 4</td>
<td>Correlation Coefficient</td>
<td>.646**</td>
<td>.519**</td>
<td>-.178</td>
<td>1.000</td>
<td>.600**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.077</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>RATIO 5</td>
<td>Correlation Coefficient</td>
<td>.753**</td>
<td>.861**</td>
<td>.073</td>
<td>.600**</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.479</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>RATIO 6</td>
<td>Correlation Coefficient</td>
<td>-.703**</td>
<td>-.537**</td>
<td>.376**</td>
<td>-.794**</td>
<td>-.631**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>RATIO 7</td>
<td>Correlation Coefficient</td>
<td>.956**</td>
<td>.550**</td>
<td>-.157</td>
<td>.672**</td>
<td>.671**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.118</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>100</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
From the table above for bankrupt companies, we notice that there is a very strong, negative correlation between the retained earnings index to total assets (Index 4) and the debt ratio (Index 6), as the correlation coefficient is -0.794 and is statistically significant (p = 0.000). That is, as one index increases, the other tends to decline. Also, a strong, negative correlation exists again between debt index (Index 6) and current ratio (Index 1), net profit margin Index (Index 5) and working capital ratio (Index 7) with a correlation factor of -0.703, -0.631 and -0.737 respectively. In addition, a very strong positive correlation exists between return on assets ratio (Index 2) with net profit margin ratio (Index 5) with a correlation factor of 0.753. What is more there is also strong correlation between return on assets ratio (Index 4) and current ratio (Index 1), net profit margin ratio (Index 5) and working capital ratio (Index 7). Lastly, net profit margin ratio is also strong correlated with the current ratio (Index 1) and the working capital ratio (Index 7). The rest correlations of the indicators presented in the table belong to the category of moderate correlation and below, so they are not analyzed.

From the above results, the conclusion we reach is that a current ratio can replace the index of working capital as they provide same information, and, moreover, net profit margin ratio can be replaced from almost all indicators. What is more, the index of retained earnings to total assets can replace debt ratio and working capital index. Therefore, for the bankrupt companies the indices that they could use is current ratio, the return on assets, the return on equity and the ratio of retained earnings to total assets.
Table 16: Correlation Test for Bankrupt companies’ Indices

<table>
<thead>
<tr>
<th>RATIO 1</th>
<th>RATIO 2</th>
<th>RATIO 3</th>
<th>RATIO 4</th>
<th>RATIO 5</th>
<th>RATIO 6</th>
<th>RATIO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>1.000</td>
<td>.248*</td>
<td>.174</td>
<td>.674**</td>
<td>.483**</td>
<td>-.694**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.</td>
<td>.013</td>
<td>.084</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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</table>

<table>
<thead>
<tr>
<th>RATIO 2</th>
<th>RATIO 3</th>
<th>RATIO 4</th>
<th>RATIO 5</th>
<th>RATIO 6</th>
<th>RATIO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>.248*</td>
<td>1.000</td>
<td>.860**</td>
<td>.184</td>
<td>.654**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.013</td>
<td>.</td>
<td>.067</td>
<td>.000</td>
<td>.511</td>
</tr>
<tr>
<td>N</td>
<td>100</td>
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<td>100</td>
<td>100</td>
<td>100</td>
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</table>

<table>
<thead>
<tr>
<th>RATIO 3</th>
<th>RATIO 4</th>
<th>RATIO 5</th>
<th>RATIO 6</th>
<th>RATIO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>.174</td>
<td>.860**</td>
<td>1.000</td>
<td>.097</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.084</td>
<td>.000</td>
<td>.337</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
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<td>100</td>
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</table>

<table>
<thead>
<tr>
<th>RATIO 4</th>
<th>RATIO 5</th>
<th>RATIO 6</th>
<th>RATIO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>.674**</td>
<td>.184</td>
<td>.097</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.067</td>
<td>.337</td>
</tr>
<tr>
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<td>100</td>
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<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RATIO 5</th>
<th>RATIO 6</th>
<th>RATIO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>.483**</td>
<td>.654**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RATIO 6</th>
<th>RATIO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>-.694**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>100</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>RATIO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Regarding the correlation of indicators of non-bankrupt companies, some variations are presented. Initially, the correlation between current ratio (Index 1), return earnings indicator to total assets (Index 4), debt ratio (Index 6) and working capital ratio (Index 7) remains the same as before, i.e. between index 1 and 7 there is a very strong positive correlation, between index 1 and index 4 there is a strong positive correlation and between index 1 and index 6 there is a strong negative correlation. What changes is the very strong positive correlation that occurs between the return on assets ratio (Index 2)
and return on equity ratio (Index 3), while for the bankrupt companies the correlation between them was not statistically significant. The same applies to correlation between the net profit margin ratio (Index 5) and the index of working capital (Index 7). Finally, while on non-bankrupt companies, return on assets (Index 2) and net profit margin ratio (Index 5) are very strongly correlated, at bankrupt firms there is only strong correlation.

Therefore, we conclude that the current ratio can replace the working capital index, the index of the retained earnings to total assets and the debt ratio and, moreover, the return on assets can replace the return on equity and the net profit margin. Hence, for bankrupt firms the indicators that could be used are current ratio and return on assets ratio.

The conclusion we reach for both types of business through the Spearman correlation coefficient, is that several indicators are highly correlated with each other, so they can be replaced by other indicators, providing the same information.
RESEARCH CONCLUSIONS

This econometric implementation has been carried out to examine if a number of financial indicators affect the bankruptcy of a business. The sample used comprised of 40 Greek companies, listed on the Athens Stock Exchange and is equally divided into 20 bankrupt or suspended companies and 20 non-bankrupt.

In summary, the results of the implementation of parametric t-test and in particular, of non-parametric tests Mann-Whitney U and Wilcoxon W, indicate that the mean values of all seven indices vary according to the type of business. Specifically, the mean value of current ratio, return on assets, return on equity, index of equity retained earnings to total assets, net profit margin and working capital index is higher in non-bankrupt companies than in bankrupt. Instead, the mean value of the debt ratio is greater for bankrupt firms than on non-bankrupt. These results are also confirmed by the estimates made by the Quantile regression according to which, the higher the prices of the six above indicators, apart from the debt ratio, the probability of bankruptcy of a company is reduced.

Finally, the correlation between the indicators was tested by the Spearman correlation coefficient and it appeared that for both types of enterprises there is both a positive and a negative correlation between some indicators. Therefore, the overall conclusion of the present investigation is that all indicators are associated with the bankruptcy of a corporation, so they can also be used as bankruptcy predictors. However, because of the high correlation they present with each other and as consequence of same information they provide, some of them can be replaced.
PROPOSALS FOR FURTHER INVESTIGATION

This dissertation examined in a sample of Greek companies listed in the Athens Stock Exchange whether a number of indexes are associated to bankruptcy and whether there is a correlation between them. Beyond this study, it is suggested the use of different ratios in order to determine whether the new indices affect bankruptcy. Also, other than different indicators, they can be used different econometric tests and methods, so as to examine whether the study will result in the same conclusions.

In addition, it is suggested the selection of a different sample which will be consisted of Greek companies that are not listed in the stock exchange. The same could be applied to foreign businesses whose shares may be traded or not in the stock market.

Another proposal for future research could be using classic or modern bankruptcy prediction techniques, as analyzed in Chapter 2, to examine predictive capacity of the indicators. Finally, the examination of the non-financial variables forecasting capacity such as technology, market share etc. and the use of models which combine both qualitative and financial features would be an important approach to further research.
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