

Designing a bankruptcy prediction model based on account, market and macroeconomic variables (Case Study: Cyprus Stock Exchange)

Bagher Asgarnezhad Nouri^{1*}, Milad Soltani²

1. Department of Management, Faculty of Humanities, University of Mohaghegh Ardabili, Ardabil, Iran
2. Faculty of Business Management, European University of Cyprus, Nicosia, Cyprus

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Abstract

The development of the Cyprus Stock Exchange together with the increasing trend of investors' presence in financing activities has led to the importance of this market. In such circumstances, the first step towards a sustainable development of the Exchange is to support the investors. Risk of bankruptcy for the investee is a major challenge that an inexperienced stock investor encounters. In this study, for predicting bankruptcy, an attempt has been made to design a valid and accurate model that could act as a deterrent to improper stock selection. In most of the previous studies, non-native models have been used to predict bankruptcy in companies. However, the present study has attempted to overcome the shortcomings of the earlier studies through designing an indigenous model based on the data collected from 53 non-financial companies out of 103 listed companies in the Cyprus Stock Market from 2007 to 2012, using a complete set of variables affecting bankruptcy (accounting, market and macroeconomic variables), and with using the logistic regression method. The results showed that the accuracy of bankruptcy models that are based on accounting and market variables has been respectively 91.2% and 82.1%, respectively. On the other hand, it was shown that there is no significant relationship between macroeconomic variables and the probability likelihood of bankruptcy.

Keywords

Accounting variables, Bankruptcy prediction, Macroeconomic variables, Market variables.

* Corresponding Author, Email: asgarnezhad.research@uma.ac.ir

Introduction

The development of the Cyprus Stock Exchange in recent years has witnessed the gradual entry of many people in this market. In such a condition, the first step towards a sustainable development of the Exchange is to support the investors (Gord & Habibi, 2009). Bankruptcy is one of the greatest risks that companies may have to encounter (Newton, 2010; Hajiha, 2005). The direct and indirect costs of bankruptcy reveal the necessity of paying special attention to it in scientific studies. Predicting and reducing the risk of bankruptcy for investors in this Exchange and, in a wider level, for such stakeholders as sponsors, government, suppliers and so forth, is the top priority (Newton, 2010; Aziz & Dar, 2006; Hajiha, 2005).

The Cyprus Stock Exchange operates in a dynamic and competitive environment. While considering the conditions of the economic system in Cyprus, the activity in this market not only provides the investors with new opportunities, but also presents several threats. A report from the Cyprus Stock Exchange (2008) announced that the global financial crisis of 2008 confronted the economy of Cyprus with many challenges. Thus, because of the weak status of companies listed in the Exchange, the general index encountered a decrease of 77.15%, in 2008 (1101.42) compared with 2007 (4820.72). Moreover, debt crisis and increased of the bankruptcy process among various industries in Cyprus, such as the second largest banking group (Laiki Bank Group, 2011) and the Cyprus national air carrier (Cyprus Airways) led to a further reduction in value at the Exchange in 2011/2012. In this regard, evaluating financial conditions of the companies and predicting their bankruptcy will be a top priority for the Cypriot investors.

On the other hand, reviewing the previous studies shows a trend of changes in the choice of variables and bankruptcy prediction models (Tinoco & Wilson, 2013). Thus, nowadays, the researchers are not satisfied only with the use of accounting variables, and according to bankruptcy being influenced by several factors within and outside organizational variables, they use other sources of information, such

as market and macroeconomic variables, in designing their patterns (Agarwal, 2008). Employing market and macroeconomic variables together with analyses of financial ratios will lead to the higher predictive power of designed models (Tinoco & Wilson, 2013).

Moreover, in order to predict bankruptcy, a choice of several methods is available. According to Aziz and Dar (2006), univariable and multivariable statistical models are the most common techniques in modeling bankruptcy prediction. However, among the many different models, the logistic regression method is more prevalent in corporate bankruptcy prediction. The logistic regression model is widely used in financial and accounting research and to separate the companies into two groups of active and bankrupt companies (Gang *et al.*, 2004).

According to what was said, considering the variables of accounting, market and macroeconomic, the present study has attempted to use the logistic regression method and design an efficient model for corporate bankruptcy prediction.

Theoretical Basis of the Study

The Concept of Bankruptcy

In the financial literature, there are non-differential terms for bankruptcy, among which, distress, failure, unsuccessful business unit, failed, financial distress, and insolvency can be referred (Hajiha, 2005). In various studies, different definitions have been provided for bankruptcy. Gordon (1971) defines bankruptcy as the inability of the company's profitability, that increases the strain and inability to repay the principal and interest of their debts. According to Newton (2010), bankrupt companies consist of business units that cease their operations because of reasons such as divestiture, bankruptcy or loss by their creditors. Papadakis (2008) points out that bankruptcy occurs when a company's liabilities exceed the value of its assets. From an economic standpoint, bankruptcy can be interpreted as a company's unprofitability so that the company's rate of return is less than its capital rate (Whitaker, 1999). On the other hand, with regard to the

membership of Cyprus in the European Union, the legal definition of this union for bankruptcy should also be considered. According to the European Commission Law (see No. 20 (a) Meaning of undertaking in difficulty European Commission Law (2014) Brussels, p.9), a company will be declared bankrupt when the following -circumstance occurs: "In the case of a limited liability company, where more than half of its subscribed share capital has disappeared as a result of accumulated loss. This is the case when deduction of accumulated losses from reserves leads to a negative result that exceeds half of subscribed share capital" (European Commission, 2014).

Bankruptcy Prediction Techniques

Techniques used in designing bankruptcy prediction models can be classified into three groups: statistical techniques, artificial intelligence techniques, and theoretical models (Aziz, 2008). Each of these techniques will be explained below in detail.

Statistical Techniques

Statistical techniques are considered as the most basic and the most prevalent techniques for modeling bankruptcy prediction (Aziz & Dar, 2006). The variables used in designing these models generally consist of the information contained in the financial statements. Statistical models are themselves divided into two groups: univariable and multivariable (Hosmer *et al.*, 2013). Univariable statistical techniques focus on the analysis of financial ratios and assume that if the financial ratios of both bankrupt and active companies are significantly different, they can be used as the bankruptcy prediction variables. Of the considerable studies in this area, the studies of Beaver (1966) and Altman (1986) can be highlighted.

Beaver (1966), using some financial ratios, suggested a univariable technique for classifying firms into two groups. Altman (1986) was also the first person who offered multivariable prediction models. Using a multiple differentiation diagnosis method and employing financial ratios as independent variables, he tried to predict corporate bankruptcy (Bredart, 2014).

Artificial Intelligence Techniques

Models of artificial intelligence techniques are the results of technological advances and development of information and are highly dependent on computer technologies. The use of artificial intelligence in financial fields, especially bankruptcy prediction, does not have a long history; however, because of their high efficiency and not being subjected to restriction by the assumptions seen in other statistical methods, these models have been strongly welcomed by researchers. Intelligent techniques have been made of neural networks, genetic algorithms, recursive algorithm, rough sets, vector machine, backrest, and fuzzy logic and result-based reasoning (Aziz, 2008).

Theoretical Techniques

Unlike statistical and artificial intelligence techniques that focus on symptoms of business failure, theoretical models seek to determine the "qualitative reasons" of a commercial failure. Basically, these models are derived from information which can respond to the theoretical arguments raised in the context of business failure. Theoretical models are naturally multivariable and usually use statistical techniques to support theoretical issues quantitatively (Bredart, 2014).

Research Background

In general, bankruptcy prediction models can be divided into three groups. The first group consists of studies in the field of bankruptcy theorization; the second group includes the research conducted to identify the most appropriate variables of bankruptcy prediction; and the third group includes studies that are about finding the most effective bankruptcy prediction methods (Laitinen & Kankaanpää, 1999).

On the other hand, attempts to develop bankruptcy prediction models were initiated in the late 1960s, and till today, different bankruptcy prediction models have been developed based on different existing methods. Table 1 represents a summary of the studies conducted in the field of a bankruptcy prediction model:

Table 1. Summary of the literature

Researchers	Research title	Research variables	Research results	Study's selected variables
Tinoco & Wilson (2013)	Financial distress and bankruptcy prediction among listed companies using accounting, market and macroeconomic variables.	Accounting variables including total funds from operations to total liabilities, total assets, no credit interval and interest coverage. Macroeconomic variables including inflation rate (retail price index), interest rate (the UK short term (3-month) treasury bill rate) and economic growth rate. Market variables including equity price, lagged cumulative security residual return, the size of the company and ratio of market capitalization to total debt.	The results show the utility of combining accounting, market and macroeconomic data in financial distress prediction models for listed companies. The performance of the estimated models is benchmarked against models built using a neural network, a Multilayer Perceptron (MLP) model, and against Altman's model.	Total liabilities to total assets, inflation rate, interest rate, economic growth rate and ratio of market capitalization to total debt.
Karami & Hosseini (2012)	The usefulness of accounting information compared with market information in bankruptcy prediction.	Accounting variables including profitability, liquidity and leverage ratios. Market variables including real return, market value of the firm, risk, risk premium, expected return, systematic risk and Sharp ratio.	In predicting bankruptcy, accounting variables are more useful than market information, and market information cannot be a good complement to accounting information.	Profitability, liquidity and leverage ratios.
Fadaieenezhad & Eskandari (2011)	Designing bankruptcy prediction model in Tehran Stock Exchange.	Accounting variables including Earning Before Interest Tax (EBIT) to sales, return of equity, return of assets, interest coverage ratio, quick ratio, current ratio, working capital to total assets, total liabilities to total assets, total liabilities to equity, equity turnover ratio, asset turnover ratio. Market variables including risk, stock return, relative market price of stock, market to book ratio, type of industry, history of firm, firm size, stock free float, stock base volume.	In bankruptcy prediction, using market information is more effective than using financial ratios or simultaneous use of market data and financial ratios. Results also showed that the model which has used market data and has been trained by optimization algorithm of particle aggregation, can correctly predict corporate bankruptcy up to 92.6%.	Return of assets, working capital to total assets, total liabilities to total assets, asset turnover ratio, stock return, and relative market price of stock.
Christidis & Gregory (2010)	Some new models for prediction of financial distress in the UK.	Accounting variables including working capital to total assets, total liabilities to total assets, cash flow to total assets, change in net income, return on capital employed, quick assets to current assets, and funds	The results show that incorporating macroeconomic variables adds to the predictive power of the bankruptcy model. Researchers show that adding	Working capital to total assets, total liabilities to total assets, return on capital employed, stock return, stock price, inflation

Continue Table 1. Summary of the literature

Researchers	Research title	Research variables	Research results	Study's selected variables
		from operation over total liabilities. Market variables including total liabilities to market value of equity, stock return, cash flow to market value of total assets, standard deviation of firm stock returns over a 6-month period, stock price, net income to market value of total assets, total liabilities to adjusted total assets and log of firm's market equity to the total valuation of Financial Times and the London Stock Exchange (FTSE). Macroeconomic variables including inflation rate and interest rate.	industry controls gives a modest improvement to such models for firms in the case of models based on accounting, market and economic variables, but a greater improvement in terms of a pure accounting-based model.	rate, and interest rate.
Dastgir <i>et al.</i> (2009)	Predicting bankruptcy of firms by using the Logit model.	Accounting variables including quick ratio, total liabilities to equity, equity to total assets, operational earning to equity, operational earning to sales, inventory turnover ratio, accounts receivable turnover ratio and cost of goods sold to sales.	All accounting variables used in the study have the power to predict bankruptcy.	Operational earning to equity, and inventory turnover ratio.
Aliakbari (2009)	Prediction of corporate bankruptcy for the UK firms in the manufacturing Industry.	Accounting ratios including return on asset, net profit margin, profit margin, operating return on asset, operating profit margin, gross return on asset, gross profit margin, return on capital employed, current debt ratio, gearing ratio, debt ratio, current ratio, liquidity ratio, asset turnover ratio, inventory turnover ratio, account receivable turnover ratio, account payable turnover ratio, average cost of debt and interest coverage ratio.	By making a comparison between performances of models, it is concluded that logit outperforms Support Vector Machines (SVM) in bankruptcy prediction. It is also concluded that profitability and leverage indicators have discriminating power in bankruptcy prediction.	Return on asset, debt ratio, asset turnover ratio, and inventory turnover ratio.

A review of the literature shows that many previous studies have used non-native models, such as the traditional models of Beaver (1966), Altman (1986), Shirata (1998). Moreover, most researchers, in predicting bankruptcy, have only focused on accounting variables, and a few

researchers have used market and macroeconomic variables to improve the predictive power of bankruptcy models. In this regard, the present study, considering all industries and using a full set of variables that influence bankruptcy of the companies listed in the Cyprus Stock Exchange (i.e., accounting, market and macroeconomic variables), is an attempt to design a native model, and thereby overcome the weaknesses of the previous studies.

As shown in Table 1, for selecting market, accounting and macroeconomic variables, a hybrid approach has been used. This means that first of all, through examining the research literature, the most important variables were identified. Then, considering two limiting factors, namely, proportion with the economic conditions and characteristics of the Cyprus Stock Exchange, and the possibility of access to data, the study's final variables were selected.

The Research Hypotheses

As mentioned in Introduction Section of this study, the current research will be an attempt to examine the role of accounting, market and macroeconomic variables in corporate bankruptcy.

On the basis of the research objectives, the research hypotheses are as follows:

H₁: Accounting variables are effective in corporate bankruptcy

H₂: Market variables are effective in corporate bankruptcy

H₃: Macroeconomic variables are effective in corporate bankruptcy

H₄: Using market variables and macroeconomic variables along with accounting variables will improve the predictive power of a bankruptcy model.

Methodology

Data Collection Method

In terms of data collection method, the study categorized both library and field research. The field method was employed for data collection in order to carry out hypothesis testing. Techniques, such as interviews with the Chief Officer of the Liquidation Section of the

Republic of Cyprus, and the formal auditors of companies, to elicit information archived in the Cyprus Stock Exchange and the Central Bank of Cyprus, were utilized. The library method was used for the compilation of the research literature.

Sampling Method

The research population consisted of all companies listed in the nonfinancial sector in the Cyprus Stock Exchange. The sampling method of systematic elimination was used in this study. Therefore, the companies with the following characteristics will remain in the study:

1. The companies for which accounting, market and macroeconomic variables are available within the time period 2007_2012 .
2. The companies that are not in the financial sector of the Cyprus Stock Exchange.

Finally, 53 companies were selected from a total 103 listed companies in the Exchange.

Research Variables

The current study's variables are divided into two groups: dependent and independent variables. In the following section, each of these variables will be explained.

Dependent Variables

In the present research, there is a dependent variable with two modes. This means that the sample is divided into two groups; financially distressed firms (for simplicity, these kind of companies are called "bankrupt") and nonfinancial companies (in this research, they are called "active"). In this regard, the values of (0) and (1), respectively, are considered for the bankrupt and active companies (Brédart, 2014). In this study, given the membership of Cyprus in the European Union, the laws passed by the Union were used to classify the sample companies into two groups of active and bankrupt companies. The details of this law were referred to in defining the concept of bankruptcy.

Independent Variables

In order to improve the ability of bankruptcy prediction models, three groups of variables are used in the present study: accounting, market and macroeconomic variables which will be covered in the next section.

Accounting Variables

Financial ratios are proposed as one of the most important variables used in designing bankruptcy prediction models. In this study, the most important ratios listed in each of these groups have been applied as follows:

1. Profitability Ratios: Profitability ratios indicate the extent to which the organization is managed efficiently. The most important profitability ratios include return on asset and return on capital employed (Agarwal & Taffler, 2008; Sulaiman *et al.*, 2001).

2. Leverage Ratios: Leverage ratio shows to what extent the company uses debt and owners' equity to create the capital structure. The most important leverage ratio is debt ratio (Veronica & Anantadjaya, 2014).

3. Activity Ratio: Activity ratio determines the extent to which the organization uses its resources effectively. The most important activity ratios include asset turnover ratio and inventory turnover ratio (Veronica & Anantadjaya, 2014).

4. Liquidity Ratios: These ratios are particularly important for investors as they determine the company's ability in repaying its obligations resulting from receiving credit. The most important liquidity ratios include working capital and asset ratio (Veronica & Anantadjaya, 2014).

Market Variables

Regardless of the success of the bankruptcy models that are based on financial ratios, the theoretical basis for justifying the choice of ratios has been criticized. Some researchers have argued that accounting variable are mostly based on past information and may not reflect actual conditions of a company. In this regard, market variables together with financial ratios can be used to improve the capability of

bankruptcy prediction models (Agarwal & Taffler, 2008; Beaver *et al.*, 2005). The most important market variables affecting corporate bankruptcy were stock price, stock return and market capitalization to total debt (Altman, 2005).

Macroeconomic Variables

Tinoco & Wilson (2013) point out that the studied models, which only contain the information of financial statements, cannot definitively predict a company's failure or success. As a result, an appropriate model of bankruptcy prediction should not be solely based on financial ratios, but also other information, such as macroeconomic variables, can be helpful in corporate bankruptcy prediction. The most important macroeconomic variables affecting corporate bankruptcy include inflation rate, interest rate and economic growth rate (Tinoco and Wilson, 2013).

The variables used are shown in Table 2.

Table 2. Variables of research

Type	Group	Variable	Symbol	Calculation
Independent	Account variables	Bankruptcy	BRY	$\{0,1\}$
		Return on Asset	ROA	$\frac{\text{Net profit}}{\text{Equity}}$
		Return on capital employment	ROCE	$\frac{\text{earning before interest} - \text{tax (EBIT)}}{\text{capital employed}}$
		Leverage ratio	DR	$\frac{\text{Total Liability}}{\text{Total Assets}}$
		Liquidity ratio	WCAR	$\frac{\text{Current Assets} - \text{Current Liability}}{\text{Total Assets}}$
		Activity ratio	ATR	$\frac{\text{Sales}}{\text{Assets}}$
		Inventory turnover ratio	ITR	$\frac{\text{Cost of Sales}}{\text{Inventory}}$
		Market value to total debt	MCTD	$\frac{\text{Market Capitalization}}{\text{Total Debt}}$
		Stock price	SP	Log (stock price)
		Stock return	SR	$\frac{(\text{Stockprice} - \text{Stockprice}_{\text{year}(t-1)})}{\text{Stockprice}_{\text{year}(t-1)}} + \text{EarningPer Share}$
Dependent		Inflation rate	INR	$\text{Consumer price Index}$

Continue Table 2. Variables of research

Type	Group	Variable	Symbol	Calculation
		Interest rate	IRR	Interest rate on deposit from Households (up to 3 months)
		Economic growth rate	EGR	$\frac{\text{grossdomestic production at year} - \text{grossdomestic production at year}(t-1)}{\text{grossdomestic production year}(t-1)}$

Data Analysis Method

In this study, as the dependent variable of bankruptcy has two values, a logistic regression method was used to analyze the data. A logistic regression method is introduced as one the most widely used statistical methods in estimating bankruptcy prediction models (Hassani & Parsadmehr, 2012).

Designing a bankruptcy prediction model using the logistic regression method involves six steps, which will be described as follows:

First step: Verifying the sample's distinction into two groups of bankrupt and active companies by using an *F*-test.

Second step: Designing the initial model by using logistic regression.

Third Step: Judging the fit of a logistic regression.

Forth Step: Testing the ability of a bankruptcy prediction model.

For performing statistical tests, SPSS statistical software was used.

Fifth Step: Evaluating the role of accounting, market and macroeconomic variables in corporate bankruptcy prediction.

Sixth Step: Examining the effect of market and macroeconomic variables on improving the prediction ability of bankruptcy models that are based on accounting variables.

Results

Absolute and relative frequencies of bankruptcy variables among the companies in the sample during the period of the study are shown in Table 2.

Table 2. Descriptive statistic of the research-dependent variable

Financial position of firm	Absolute frequency (Year-firm)	Relative frequency (%)
Active	245	77
Bankrupt	73	23
Total	318	100

The results in Table 2 show that from the total of 318 firm-years, 245 firm-years are related to active companies and 73 firm-years are related to the bankrupt companies. Therefore, 77% of the research data belongs to the active companies and 23% to the bankrupt ones. Accordingly, much of the research data belong to active companies.

Testing the First Research Hypothesis

The first research hypothesis states:

H₁: Accounting variables are effective in predicting corporate bankruptcy.

In this regard, the initial model was designed based on an accounting variable. Accounting variables are summarized in Table 3.

Table 3. Designing a bankruptcy prediction model using logistic regression model and accounting variables

Accounting variables	B	Wald	Sig	Result
Constant	-7.158	55.431	0.000	-
Return on capital employed (ROCE)	-3.502	3.687	0.045	Accept
Return on assets (ROA)	-13.577	16.026	0.000	Accept
Debt ratio (DR)	8.182	40.333	0.000	Accept
Working capital to asset ratio (WCAR)	-5.106	10.614	0.001	Accept
Asset turnover ratio (ATR)	0.253	4.856	0.028	Accept
Inventory turnover ratio (ITR)	0.00	0.000	0.986	Reject

The results in Table 3 show that there is a significant relationship between the variables of ROCE, ROA, DR, WCAR and ATR, but, the variable of ITR is not significantly related to bankruptcy.

Given the significant level of accounting variables, a bankruptcy prediction model equation (1) will be as follows:

$$\ln\left(\frac{P}{1-P}\right) = -3.502ROCE - 13.577ROA + 8.182DR - 5.106WCAR + 0.253ATR - 7.158 \quad (1)$$

In addition, β coefficient of the independent variables of ROA, ROCE and WCAR are negative. This means that by increasing these ratios, the probability of bankruptcy will be decreased. Regarding the

independent variables of DR and ATR, the β coefficient is positive. This means that by increasing DR and ATR, the probability of bankruptcy will be increased.

In order to evaluate the goodness-of-fit of the suggested model to the data set, Nagelkerke R Square and Hosmer and Lemshow (Hosmer et al., 2013) were used. The result related to the goodness-of-fit test is given in Table 4.

Table 4. The goodness-of-fit based on a logistic regression method using account variable

Chi-square	df	Sig	Nagelkerke R Square
208.365	6	0.000	0.729

The results given in Table 4 show that the model's Chi-square is equal to 208.365, and the significance level of the suggested model is less than 0.05. It means that the estimated value of the suggested model is proportional to the actual value at an acceptable level. Likewise, Table 4 includes a column in Nagelkerke R Square whose value is 0.729. This indicates that 72.9% of the changes in dependent variable, which is the possibility of bankruptcy, are described by the model's accounting variables.

In order to test the ability of the bankruptcy prediction model, actual results can be compared with the model's prediction, and using it, the model's predictive power can be tested (Veronica & Anantadajay, 2014). The results of the model's prediction and the actual data related to bankruptcy and nonbankruptcy are illustrated in Table 5.

Table 5. Testing the ability of the bankruptcy prediction model based on the logistic regression method, and using accounting variables

Group	By model		Total	According of the model
	Active	Bankrupt		
Active	236	9	245	91.2%
Bankrupt	19	54	73	
-	-	-	318	

According to the results shown in Table 5, the proposed model, out of 73 year-firm bankrupt companies, has correctly recognized 54 companies as bankrupt, but 19 cases have been mistakenly recognized as active. On the other hand, out of 245 year-firm active companies, 236 cases have been correctly recognized as active and 9 cases have

been incorrectly recognized as bankrupt. Hence, it can be said that the overall accuracy of the proposed model has been 91.2% percent.

According to the above results, the first research hypothesis (H_1), regarding the effectiveness of accounting variable in corporate bankruptcy prediction, is approved.

Testing the Second Research Hypothesis

The second research hypothesis is as follows:

H₂: Market variables are effective in corporate bankruptcy prediction.

In this regard, the initial model will be designed based on the market variable. The results are summarized in Table 6.

Table 6. Designing a bankruptcy prediction model using a logistic regression model, and account variables

Market variables	B	Wald	Sig	Result
Constant	0.536	3.45	0.063	-
Market capitalization to total debt (MCTD)	-0.848	7.168	0.007	Accept
Stock return (SR)	-0.003	2.782	0.095	Reject
Stock price (SP)	-8.13	23.777	0.000	Accept

The results given in Table 6 show that there is a significant relationship between the variables of MCTD and SP, but, the variable SR is not significantly related with the bankruptcy.

Given the significance level of market variables, the bankruptcy prediction model equation (2) will be as follows:

$$\ln\left(\frac{P}{1-P}\right) = -0.848MCTD - 8.13SP \quad (2)$$

In addition, the coefficient of the independent variables of SP and MCTD are negative. This means that by decreasing these ratios the probability of bankruptcy increases.

The results related to the goodness-of-fit tests are given in Table 7.

Table 7. Hosmer and lemeshow test using a market variable

Chi-square	Df	Sig	Nagelkerke R square
94.256	3	0.000	0.389

The results given in Table 7 show that the Chi-square of the model is 94.256, and the significance level of the suggested model is 0.000,

which is less than 0.05. It means that the estimated value of the suggested model is proportional with the actual value at an acceptable level.

Likewise, Table 7 includes a column in Nagelkerke R Square whose value is 0.389. Therefore, 38.9% of changes of the bankruptcy-dependent variables are described by the market-independent variables.

The results of the model's prediction ability are given in Table 8.

Table 8. Testing the ability of a bankruptcy prediction model based on the logistic regression method, and using market variables

Group	By model		Total	According of the model
	Active	Bankrupt		
Active	230	15	245	82.1%
Bankrupt	42	31	73	
-	-	-	318	

According to the results in Table 8, the proposed model, out of 73 year-firm bankrupt companies, have correctly recognized 31 year-firm companies as bankrupt, but 42 cases have been mistakenly recognized as active. On the other hand, out of 245 year-firm active companies, 230 cases have been correctly recognized as active, and 15 cases have been incorrectly recognized as bankrupt. Hence, it can be said that the overall accuracy of the proposed model has been 82.1%.

According to the above results, the second research hypothesis regarding the effectiveness of market variables in corporate bankruptcy prediction is approved.

Testing Third Research Hypothesis

The third research hypothesis is as follows:

H₃: Macroeconomic variables are effective in corporate bankruptcy prediction.

The third objective of the study is to develop a bankruptcy model based on macroeconomic variables. For testing the third hypothesis, the means of each independent variable of macroeconomics will be examined for the two groups of active and bankrupt companies by using a *t*-test. Results are given in Table 9.

Table 9. Results obtained from t-test based on macroeconomic variables

Macroeconomic variables	t-test	Sig	Result
Inflation rate (INR)	-1.021	0.31	Reject
Interest rate (IRR)	-0.919	0.36	Reject
Economic growth rate (EGR)	-2.085	0.39	Reject

According to the results in Table 9, H_0 is confirmed for all three macroeconomic variables that are INR, IRR and EGR. In other words, the mean of these three variables is equal in both active and bankrupt companies. This result is also confirmed in the study of Veronica & Anantadjay (2014).

According to the given explanations, the third research hypothesis, regarding the impact of macroeconomic variables on bankruptcy, is rejected.

Testing the Fourth Research Hypothesis

The fourth research hypothesis is as follows:

H₄: Using market variables along with accounting variables will improve the predictive power of bankruptcy model.

To this end, a bankruptcy prediction model is estimated in two stages. In the first stage, only accounting variables are used, while in the second stage, along with accounting variables, market variables are also used. The results are given in Table 10.

Table 10. Fit indices for comparing the effectiveness of accounting and market variables in bankruptcy prediction

The fit indices		Accounting model	Accounting-market model
Nagelkerke R square		0.729	0.78
-2 log likelihood test	Chi-square	208.365	229.706
	Sig	0.000	000
Overall predictive accuracy		91.2%	91.8%

The value of Nagelkerke R Square is equal to 0.729 for the accounting model. This value is 0.78 for the account-market model. The high level of this value for the account-market model shows that this model has a greater ability than the account model to predict bankruptcy, and thus, H_1 is accepted.

Finally, overall prediction power is obtained at 91.2% and 91.8%,

respectively, for account and account-market models. It means that the account-market model is better than the account model.

Conclusion and Recommendations

The results obtained from the bankruptcy prediction model by using the accounting variable indicates that the variable of bankruptcy was negatively related to the return on capital employed, return on assets, debt ratio, working capital to asset ratio, and asset turnover ratio. However, it was not significantly related to the variable of inventory turnover ratio.

It is noteworthy that bankrupt companies, because of their inability to achieve sales goals, are faced with a decrease in profitability or even loss. Thus, according to the research findings, it is expected that the values of return on assets and return on capital would be at a higher level for the active companies. These results are in line with the study conducted by Vasantha *et al.* (2013).

The positive relationship between variables of debt to equity ratio and bankruptcy probability shows that excessive use of debt as the financing method increases the risk default caused by the company's inability to repay the loans and interest. Therefore, it will lead to the company's bankruptcy. This result is in line with the study conducted by Veronica and Anontadjaya (2014).

The result obtained from bankruptcy prediction model based on market variables indicate that the variable of bankruptcy was negatively related to the market capitalization to total debt, and also to stock price.

Generally, a company with a better performance will be gradually welcomed by investors, and demand for its stock will increase, which ultimately increases the value of the stock price and market capitalization. This result is in line with the study done by Tinoco and Wilson (2013).

The results of the Fisher test show that the variables of inflation rate, interest rate and economic growth rate are not significantly related to the variable of bankruptcy. In other words, it can be concluded that the macroeconomic conditions prevailing in Cyprus

have had no specific impact on corporate bankruptcy. These results are in line with the study of Anantadgaya and Veronica (2014).

In order to compare designed models, all tests showed that the accounting-market model has been more powerful than the accounting model. In this study, the prediction power of the bankruptcy model that was designed based on market and accounting variables, and by using logistic regression method, was obtained as 91.8%. While the prediction accuracy of Tinoco and Wilson's models (2013) (one based on accounting variables) has been obtained as 73% and 89% (on based on market variables) by using artificial networks method, this indicates the complementary role of market variables in estimating the bankruptcy models that are based on accounting ratios.

According to the stated hypotheses, the study's suggestions are as follows:

1. The investors in the Cyprus Stock Exchange are recommended to evaluate the probability of corporate bankruptcy, to mainly use financial and market ratios, such as return on capital employed, return on assets, debt ratio, working capital to asset ratio, asset turnover ratio, stock price and market capitalization. Stock return and inventory turnover ratios cannot provide specific information regarding the companies' financial situation.
2. According to the negative relationship between debt ratio and bankruptcy risk, in order to supply the required financial sources, managers of the companies listed in the Cyprus Stock Exchange are recommended to use the debt method more than the equity method.
3. Given the negative relationship between WCAR and the probability of bankruptcy, the managers of the companies with a financial crisis are recommended to increase the company's current assets to an optimal level.
4. The researchers are recommended not to use macroeconomic variables in designing a bankruptcy model.

Suggestions for future research are as follows:

1. It is suggested that other methods, such as Neural Network,

Linear Vector, and so on, be used for predicting bankruptcy, and to compare the results obtained with those of the suggested model.

2. In this study, only active companies in the Cyprus Stock Exchange were selected as the target statistical population. However, it is suggested that the models be tested internationally.

Limitations

Taking steps towards achieving a given goal is usually accompanied with certain limitations. Therefore, in what follows, the limitations to the study have been given so that the generalization of the models may be enhanced:

1. The data collected from the companies' financial statements have not been modified in terms of inflation rate. If so, the obtained results may have been different from what they are now.
2. Since the financial date of certain companies active in the Cyprus Stock Exchange were out of reach, crossing them out of the study was inevitable.

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طراحی مدل پیش‌بینی ورشکستگی با به‌کارگیری متغیرهای حسابداری، بازار و اقتصاد کلان (مطالعه موردی: بورس اوراق بهادار قبرس)

باقر عسگرنژاد نوری^{۱*}، میلاد سلطانی^۲

۱. گروه مدیریت، دانشکده علوم انسانی، دانشگاه محقق اردبیلی، اردبیل، ایران

۲. دانشکده مدیریت بازرگانی، دانشگاه اروپایی قبرس، نیکوزیا، قبرس

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چکیده

هدف: توسعه بورس اوراق بهادار قبرس همراه با روند صعودی حضور سرمایه‌گذاران در فعالیت‌های مالی سبب شده است تا این بازار از اهمیت خاصی برخوردار شود. در چنین شرایطی، اولین گام جهت توسعه پایدار بورس اوراق بهادار قبرس حمایت از سرمایه‌گذاران است. ریسک ورشکستگی سرمایه‌گذاری یکی از چالش‌های اصلی است که سرمایه‌گذاران بی‌تجربه با آن مواجه‌اند. بر این اساس در این پژوهش تلاش شده است تا مدلی معتبر و دقیق برای پیش‌بینی ورشکستگی طراحی شود تا بدین طریق از انتخاب سهام نامناسب توسط سرمایه‌گذاران اجتناب شود. **روش:** در بسیاری از پژوهش‌های قبلی، مدل‌های غریبومی برای پیش‌بینی ورشکستگی شرکت‌ها استفاده شده است. با وجود این، در پژوهش حاضر قصد بر این است تا با طراحی مدلی بومی، ضعف‌های مدل‌های قبلی پوشش داده می‌شود. بدین منظور داده‌های پژوهش بر اساس انتخاب ۵۳ شرکت غیرمالی از ۱۰۳ شرکت پذیرفته‌شده در بورس اوراق بهادار قبرس طی دوره زمانی ۲۰۱۲-۲۰۰۷ گردآوری شد. مدل مورد نظر نیز با به‌کارگیری مجموعه کاملی از متغیرهای حسابداری، بازار و اقتصاد کلان و با استفاده از روش رگرسیون لجستیک تخمین زده شد. **نتایج:** دقت مدل‌های ورشکستگی مبتنی بر متغیرهای حسابداری و بازار به ترتیب برابر با ۹۱/۲ و ۸۲/۱ درصد است. از سوی دیگر، ارتباط معناداری بین متغیرهای اقتصاد کلان و احتمال ورشکستگی شرکت‌ها وجود نداشت.

کلیدواژه‌ها

پیش‌بینی ورشکستگی، متغیرهای اقتصاد کلان، متغیرهای بازار، متغیرهای حسابداری.