

## A study on capability of financial ratios in predicting bankruptcy of firms: Evidence from Tehran Stock Exchange

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### ABSTRACT

This paper measures the likelihood of bankruptcy based on some financial ratios such as debt ratio, current ratio, sales to total assets, etc. using logistic regression and classification and regression tree techniques (CART). The proposed study gathers the information of 36 bankrupted firms and 36 non-bankrupted firms based on Tobin Q ratio. The study gathers the necessary information over the period 2005-2011. The preliminary results indicate that both methods have the capability to predict bankruptcy but with different accuracy. The likelihood of bankruptcy based on CART method were 97.2, 97.2 and 86.1 in the event of bankruptcy, one year before and two years prior to bankruptcy, respectively. These figures were changes to 98.6, 94.4 and 84.7 based on logistic method.

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## 1. Introduction

The issue of important bankruptcy cases has created motivation and interest in corporate bankruptcy prediction techniques since the 1960s (Takahashi et al., 1984; Mensah, 1984; Adler, 1993). Altman (1968) is believed as one of the pioneers who proposed a method, which has been widely implemented by many people around the world. There are many studies devoted to this subject by most of them are now obsolete. They do not offer a comprehensive comparison of the various approaches towards bankruptcy prediction and mostly fail to provide a remedy to the problem of model choice in empirical application. Aziz and Dar (2006) provided a comprehensive study of the techniques and empirical findings from these techniques in their applications across ten various countries. The predictive accuracies of various techniques appear to be generally comparable, although artificially intelligent expert system techniques performed marginally better than statistical and theoretical techniques. Individually, the implementation of multiple discriminant analysis (MDA) and logit models were used.

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Etemadi et al. (2009) investigated application of geometric programming (GP) for bankruptcy prediction modeling and classified 144 bankrupt and non-bankrupt Iranian firms listed in Tehran stock exchange (TSE). They also used a multiple discriminant analysis (MDA) to benchmarking GP model. They used McNemar test and reported that GP approach outperforms MDA to the problem of corporate bankruptcy prediction. Xie et al. (2011) used financial distress prediction based on MDA method for bankruptcy prediction.

Appiah and Abor (2009) implemented relevant financial information of private medium-sized failed and non-failed manufacturing companies in the UK, over the period 1994-2004 to detect whether corporate failure can be predicted by developing a Z-score model. They reported that the net profit margin was superior to the gross profit margin in discriminating between failed and non-failed UK manufacturing firms in terms of its significant contribution to the Z-score, though the latter exceeded the former slightly using the univariate analysis. Lee et al. (1996) presented a neural network technique to forecast bankruptcy likelihood. Youn and Gu (2010) used artificial neural network model along with a logistic regression model for predicting of Korean lodging firm failures. Liou (2008) presented a survey on how to detect fraudulent financial reports and business failure prediction models. Wu et al. (2010) in a comprehensive study compared all existing methods for prediction of bankruptcy. Tam (1991) used neural network models and the prediction of bank bankruptcy.

Classification and regression tree techniques (CART) has recently become interesting areas of research and there is a growing interest in this area. Brezigar-Masten and Masten (2012) used CART-based selection of bankruptcy predictors for the logit model. They discussed that balance-sheet data offer good predictors of corporate financial failure and presented a novel predictor selection procedure based on non-parametric CART and examined its performance within a standard logit model. They demonstrated that a simple logit model with dummy variables could create in accordance with the nodes of estimated classification tree outperforms both standard logit technique with step-wise-selected financial ratios, and CART itself. On a population of Slovenian companies their method achieved good rates of precision in out-of-sample bankruptcy prediction. Their selection technique seems to be an efficient method of introducing non-linear impact of predictor variables on the default probability in standard single-index models like logit.

In this paper, we present two methods for prediction of bankruptcy on some selected firms listed on Tehran Stock Exchange using two methods of logistic regression and CART. The organization of this paper first presents details of the proposed study in section 2 while section 3 presents details of our findings and finally concluding remarks are given in the last to summarize the contribution of the paper.

## **2. The proposed model**

This paper measures the likelihood of bankruptcy based on financial ratios such as debt ratio, current ratio, sales to total assets, etc. using logistic regression and classification and regression tree techniques (CART). There are two hypotheses associated with the proposed study of this paper as follows,

1. Logistic regression is capable of detecting the likelihood of bankruptcy.
2. Regression tree technique (CART) is capable of detecting the likelihood of bankruptcy.

The study gathers the necessary information over the period 2005-2011. There are five independent variables including Current ratio ( $X_1$ ), Total debt to total assets ( $X_2$ ), the ratio of working capital to total assets ( $X_3$ ), the ratio of net profit before tax to total assets ( $X_4$ ) and the ratio of revenue to total assets ( $X_5$ ). Therefore, the proposed study considers the following model for the analysis,

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \varepsilon_i \quad (1)$$

where  $Y_i$  is the likelihood of bankruptcy,  $\beta_i, i = 0, \dots, 5$  are coefficients to be estimated and  $\varepsilon_i$  represents the residuals. In our study, the shares of all firms must have been actively traded on stock exchange over the period of study, they must have had similar fiscal calendar and reported their financial figures on quarterly basis. We do not consider the information of banks, holding firms and insurance companies. The proposed study gathers the information of 36 bankrupted firms and 36 non-bankrupted firms based on Tobin Q ratio.

### 3. The results

Table 1 summarizes the results of logistic regression on Eq. (1). As we can observe from the results of logistic regression, all coefficients are statistically significance with  $\alpha=0.01$ . These results hold on the year of bankruptcy, one year and two years prior to bankruptcy.

**Table 1**

The summary of regression analysis

	Independent variables	Coefficient ( $\beta$ )	Standard Error	Sig.	df
Year of Bankruptcy	X <sub>1</sub>	-1172.846	34868.710	0.001	1
	X <sub>2</sub>	264.785	9481.102	0.001	1
	X <sub>3</sub>	1339.393	40348.837	0.001	1
	X <sub>4</sub>	-84.465	3222.801	0.001	1
	X <sub>5</sub>	-85.166	11127.421	0.001	1
	Intercept	1070.538	33233.117	0.001	1
One year before Bankruptcy	X <sub>1</sub>	-6.789	12.665	0.287	1
	X <sub>2</sub>	17.533	7.483	5.489	1
	X <sub>3</sub>	9.087	20.395	0.199	1
	X <sub>4</sub>	-2.497	1.709	2.135	1
	X <sub>5</sub>	-13.821	9.208	2.253	1
	Intercept	-2.928	16.014	0.033	1
Two years before bankruptcy	X <sub>1</sub>	-9.958	8.908	1.250	1
	X <sub>2</sub>	6.954	4.754	2.140	1
	X <sub>3</sub>	13.878	14.145	0.963	1
	X <sub>4</sub>	-1.115	0.883	1.595	1
	X <sub>5</sub>	-7.445	4.089	3.315	1
	Intercept	7.419	11.746	0.399	1

Table 2 shows the results of examining the accuracy of the proposed study in three consecutive years.

**Table 2**

The results of the likelihood of bankruptcy based on logistic regression method

Observed	Dependent variable	Year of bankruptcy			One-year prior to bankruptcy			Two years before bankruptcy			Average forecasted		
		Dependent variable		% of Accuracy	Dependent variable		% of Accuracy	Dependent variable		% of Accuracy	Dependent variable		% of Accuracy
		0	1		0	1		0	1		0	1	
Non-bankrupted	36	0	100	34	2	94.4	30	6	83.3	100	8	92.6	
Bankrupted	1	35	97.2	2	34	94.4	5	31	86.1	8	100	92.6	
Accuracy			98.6			94.4			84.7			92.6	

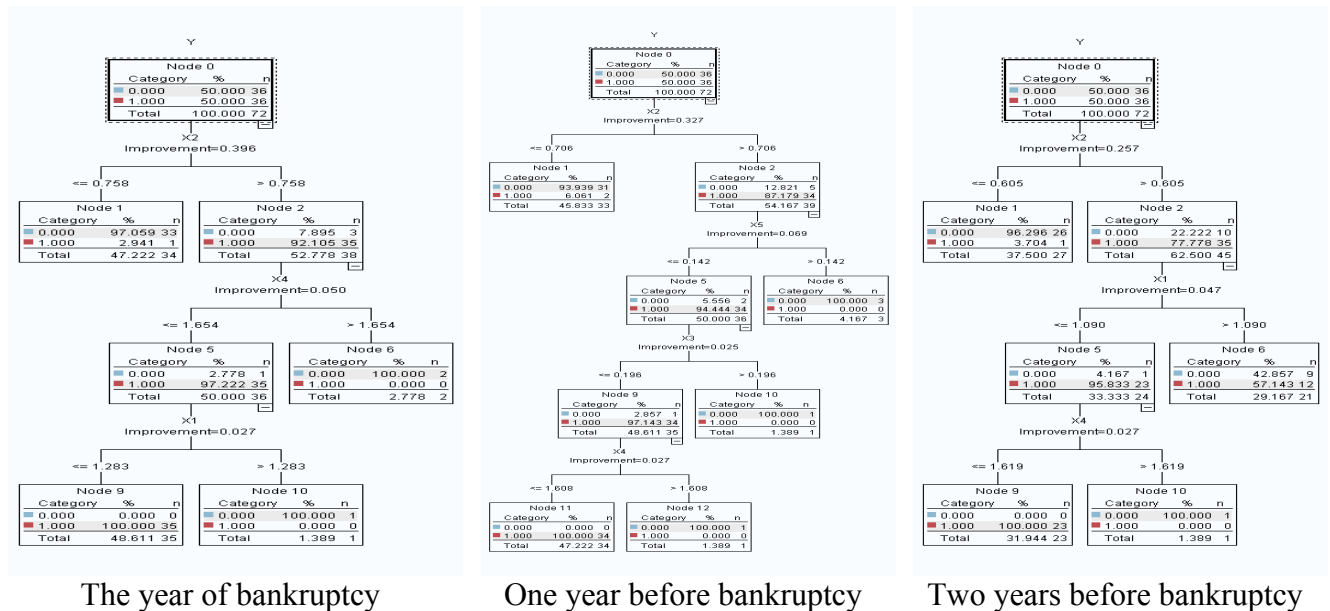
As we can observe from the results of Table 2, logistic regression is capable of predicting of 92.6% rate of success on average for bankruptcy prediction. The proposed study of this paper has also used

classification and regression tree techniques (CART) to verify the proposed model and Table 3 summarizes the results of our survey.

**Table 3**  
The results of the likelihood of bankruptcy based on CART method

Observed	Year of bankruptcy	One-year prior to bankruptcy						Two years before bankruptcy			Average forecasted		
		Dependent variable			Dependent variable			Dependent variable			Dependent variable		
		0	1	% of Accuracy	0	1	% of Accuracy	0	1	% of Accuracy	0	1	% of Accuracy
Non-bankrupted	35	1	97.2	36	0	100.0	27	9	75	98	10	90.7	
Bankrupted	1	35	97.2	2	34	94.4	1	35	97.2	4	104	96.3	
Accuracy	97.2			97.2			86.1			93.5			

In addition, Fig. 1 demonstrates details of the implementation of CART on the year of bankruptcy, one year before and two year before bankruptcy occur.



**Fig. 1.** Detailed results of the implementation of CART

As we can observe from the results of Table 4, two methods of have had good rate of success for predicting the rate of bankruptcy.

**Table 4**  
The summary of the results of logistic regression versus CART method

Title	Year of bankruptcy		One year prior to bankruptcy		Two years before bankruptcy		Three years average	
	LOGIT	CART	LOGIT	CART	LOGIT	CART	LOGIT	CART
Non-bankrupted	100	97.2	94.4	100	83.3	75	92.6	90.7
Bankrupted	97.2	97.2	94.4	94.4	86.1	97.2	92.6	96.3
sum	98.6	97.2	94.4	97.2	84.7	86.1	92.6	93.5

In summary, both hypotheses of this study have been confirmed and we can conclude that logistic regression as well as CART are able to predict bankruptcy, successfully.

## 4. Conclusion

In this paper, we have presented an empirical investigation to find the effect of five financial figures including Current ratio, Total debt to total assets, the ratio of working capital to total assets, the ratio of net profit before tax to total assets, and the ratio of revenue to total assets for predicting bankruptcy event. The study has implemented two methods of logistic regression as well as CART to forecast bankruptcy event. The results of our survey have indicated that both methods have had the capability to predict bankruptcy event. The results of this survey are consistent with some other studies accomplished in Tehran Stock Exchange by other researchers during the past few years (Moghadam et al., 2005) but the results are not consistent with what Adler (1993) have reported. Presently, in Iran, when a firm encounter a loss where it hurts half of equity is able to file bankruptcy with the government. This law seems to be approximately 50 years old and there is a need to reconsider the rules and regulation and setup some more sophisticated rules and regulation.

As a future study, it is an interesting area of research to consider macroeconomic factors along with firms' financial figures to predict bankruptcy with better precision. Inflation, unemployment and consumer price index are some important factors, which could be considered as part of existing models and we leave it for interested researchers for future studies.

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