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A Study of the Application of Springate and Zmijewski Bankruptcy Prediction Models in Firms Accepted in Tehran Stock Exchange

[1]Peyman Imanzadeh, [2]Mehdi Maran-Jouri, [3]Petro Sepehri

[1]Talesh Branch, Islamic Azad University, Talesh, Iran.
[2]Chaloos Branch, Islamic Azad University, Chaloos, Iran.
[3]Astara Branch, Islamic Azad University, Astara, Iran.

Abstract: Bankruptcy prediction is one of the main issues in the classification of firms. Owners, managers, investors, creditors, business partners, and state institutions are interested in assessing the financial status of firms, for they will be burdened with so many costs in case of bankruptcy. Nowadays, various models are used for bankruptcy prediction. The purpose of this study is to present the theoretical bases of the research and compare the results obtained firm applying the Springate and Zmijewski models for firm bankruptcy prediction. Thus, the data collected during the period 2004-2008 were tested. Binomial non-parametric methods were applied for data analysis. The results suggest that there is a significant difference between the two models in bankruptcy prediction. Moreover, the Springate model is more conservative in bankruptcy prediction than the Zmijewski model.

Keywords: Bankruptcy, Springate Model, Zmijewski Model, bankruptcy prediction

INTRODUCTION

Nowadays, the rapid technological advancement and environmental changes has increasingly accelerated economy and the increasing competition of institutions has limited profit and increased the possibility of bankruptcy. Therefore, financial decisions have become more strategic.

A scientific, real index is needed in the financial decisions for any institution. One of the proper indices for this purpose is the correct assessment of the possibility of firm insolvency. Financial ratios are one of the instruments for analyzing financial issues and researchers have managed to introduce multivariate models for bankruptcy prediction by combining these ratios (Mehrani S., Mehrani K. and Karami Q.R., 2004). Bankruptcy prediction models are of the techniques and tools for anticipating the future condition of firms which estimate the possibility of bankruptcy by combining a group of financial ratios. The ability to predict financial and business bankruptcy is important, both from the viewpoint of the investor and from a social viewpoint, since it is a clear sign of incorrect allocation of resources. An early warning of possible bankruptcy enables the management and investors to take preventive measures and distinguish favorable investment opportunities from unfavorable ones (Mehrani S., Bahramfar N., and Qayoor F., 2005). Bankruptcy prediction models are among the tools for estimating the future condition of firms. Investors and creditors are much willing to predict the bankruptcy of businesses, for they will be burdened with too many costs in case of bankruptcy. Each of these models has its advantages and disadvantages (Aziz M.A. and Dar H.A., 2002). In the present research, we applied the Springate and Zmijewski models for predicting bankruptcy of firms and then compared the prediction results of these two models.

In 1930, official research was initiated to study the reasons for business failure. Researchers demonstrated that the financial ratios of bankrupt (failed) firms do not enjoy favorable conditions in comparison with successful firms and the analysis of financial ratios can be helpful in predicting bankruptcy. Researchers presented multivariate models for bankruptcy prediction by combining these ratios which are practically among the most successful academic products and decision-making tools (Harvankolayee K. and Kadkhodayee H. 2003).

The first research on bankruptcy prediction was carried out by Thomas Woodlock (1900). He performed a classic analysis in the railroad industry and presented the results of his research in an article titled “the percentage of operational costs to gross retained earnings” (Rasoulzadeh M., 2001).

Edward Altman (1968) - in an article on financial ratios, discriminant analysis, and bankruptcy prediction of institutions - presented a model for bankruptcy prediction which is known as the Altman’s Model. He used five financial ratios in this model whose accuracy was 95%. A few years later, he introduced a modified version of his model. The Z-score model is still applied as a general practical tool for assessing the financial well-being of firms. Due to its characteristics, this model has been used for small samples of manufacturing firms as well as bankrupt and non-bankrupt firms with equal sizes (Grice J.S. and Ingram R. 2001).

Leonid and Vladimir Philosophov (2002) studied the problem of predicting a firm’s bankruptcy by a simultaneous assessment of the time interval within which the bankruptcy must occur. Then, using comparative statistical analyses, they extracted the financial indices and identified four relatively dependent factors that had a

Corresponding Author: Peyman Imanzadeh, Talesh Branch, Islamic Azad University, Talesh, Iran.
E-mail: pi_imanzade@yahoo.com

considerable potential in predicting bankruptcy. Two of these factors were the quantity and quality of corporate debt, while the other two characterized the ability to pay the debt - interest to total assets ratio, current liabilities to total assets ratio, earnings before interest and taxes to total assets ratio, and retained earnings to total assets ratio. The efficiency of the variants of the prognostics rule developed in this research showed that in comparable situations (equal conditions), these variables are a lot more efficient that Altman's Z-score rule and tested logistic rules (Philosophov L. and Philosophov V., 2002).

Min and Lee (2005) developed a model for bankruptcy prediction using the support vector machine. Their research revealed that SVM is more efficient than conventional statistical models (Rayee R. and Falahpour S., 2008).

Some of the research studies carried out on bankruptcy prediction models in Iran are as follows: Faghani (2001) studied the relationship between financial ratios and bankruptcy prediction. To test research hypothesis and compute the financial ratios of interest from sample firms, the data related to one and two years before success or failure (bankruptcy) was collected for each participant group - successful and unsuccessful firms - and the main research variables were computed including five financial ratios. The results of data analysis revealed that the obtained Z-score model correctly separated the sample firms and classified them in one of the successful or failed (bankrupt) groups without any error, indicating the ability of financial ratios in predicting success or failure (Faghani M., 2001).

Rasoulzadeh (2001) studied the two groups of bankrupt and non-bankrupt firms using the original Z-score model and showed that Altman's model has correctly predicted the non-bankruptcy condition of firms during a four-year period (1996-1999) with 92% accuracy and their bankruptcy condition before it occurs with 81% accuracy (Rasoulzadeh M., 2001).

Mehrani *et al.*, (2005) studied the application of Zmijewski and Shirata models for bankruptcy prediction in the firms accepted in Tehran Stock Exchange and presented a new model based on these two familiar models which corresponded to the circumstances of Iran. The results of hypothesis testing revealed that both models have the ability to divide firms into bankrupt and non-bankrupt firms and the independent variables of the models do not have equal efficiency in bankruptcy prediction (Mehrani S, Mehrani K, Monsefi Y, and Karami Q.R., 2005).

Considering the extent and variety of financial ratios and the increasing advances in presenting bankruptcy prediction models, the question that arises is whether there is a significant difference between the results of the financial models used for predicting firm bankruptcy. Are different bankruptcy prediction models able to equally identify bankrupt and non-bankrupt firms?

The following hypotheses are meant to be tested to extract necessary answers to the chief questions of the research:

Hypothesis 1:

There is a significant difference between Springate and Zmijewski models in predicting bankruptcy of firms.

Hypothesis 2:

The Springate model is more conservative than the Zmijewski model.

Methodology:

The present research is applied in terms of its purpose, for the results obtained in the research can be applied in the process of using financial data. The research design is semi-empirical which takes a post-hoc approach (using prior data) and it is carried out based on the financial statements of the firms accepted in the stock exchange. The research is cross-sectional in that it studies the data related to specific time periods.

The theoretical discussions and required data for the present research were extracted by referring to library sources such as books, weekly and monthly journals, quarterlies, and related dissertations and theses, as well as searching through electronic databases like the internet and proceeding to Tehran Stock Exchange, and the data were studied and analyzed to come to a conclusion.

Population and Sample:

The population of the research includes the pharmaceutical and textile firms accepted in Tehran Stock Exchange. Because the characteristics of industries are different, it is better to choose the sample from similar industries in order to increase the quality of the comparison between the firms. Thus, from the existing industries in the stock exchange, the textile industry was chosen since these firms were identified as bankrupt in previous research studies, and the pharmaceutical industry was chosen which is an average industry.

Due to inability to access the precise data of the financial statements of the firms outside stock exchange, the studied population consists of the firms accepted in Tehran Stock Exchange during the period 2004-2008; thus, all the firms included in the sample had the following conditions:

- They were accepted in stock exchange before 2004.
- Their financial statements were presented to the stock exchange during the period 2004-2008.

Models and Variables:

Carrying out any research entails defining each of its variables. Variables are divided into two groups depending on the role they play in the research:

a. Independent variables.
b. Dependent variables.

***Dependent Variable*:**

There is one dependent variable in the present research with two conditions: firms' financial condition which are either bankrupt or successful.

***Independent Variable*:**

The independent variables in the present research involve financial ratios. Since two models are used, first the Springate model and its variables will be mentioned and then, we will deal with the Zmijewski model and its related variables:

The Springate Model:

$$Z = 1.3A + 3.07B + 0.66C + 0.4D$$

$$A = \frac{\text{Working Capital}}{\text{Total Assets}}$$

$$B = \frac{\text{Earnings Before Intersts and Taxes}}{\text{Total Assets}}$$

$$C = \frac{\text{Earnings Before Taxes}}{\text{Current Liabilities}}$$

$$D = \frac{\text{Total Sales}}{\text{Total Assets}}$$

The firm will go bankrupt if $Z < 0.862$.

The Zmijewski Model:

$$Z = -4.3 - 4.5x_1 + 5.7x_2 + 0.004x_3$$

$$x_1 = \frac{\text{Net Profit}}{\text{Total Assets}}$$

$$x_2 = \frac{\text{Total Liabilities}}{\text{Total Assets}}$$

$$x_3 = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

The firm will go bankrupt if $Z < 0.5$.

Data Analysis and Findings:

Hypothesis 1:

There is a significant difference between Springate and Zmijewski models in firm bankruptcy prediction.

Regarding this hypothesis, after measuring the necessary variables, the value of Z of both models was calculated for 44 firms from the two studied industries. The purpose of this hypothesis was to compare the results of Springate and Zmijewski models in identifying bankruptcy of each of these firms. Therefore, each of the bankrupt firms in each model took the value of 1 and the non-bankrupt firms took the value of 0, and then Wilcoxon signed-rank test was used to examine the existence of a relationship between the two models. The null

hypothesis in these tests is the absence of a significant relationship between the results of the two models; while on the contrary, the hypothesis of the researcher supports the existence of a significant relationship. In the Wilcoxon signed-rank test, if the value of *sig* or *p* in the table is greater than 0.05, the hypothesis of the researcher is rejected and the null hypothesis will be accepted and vice versa.

As can be seen in the following table, the value of *sig* is 0.007 which is less than 0.05 and this output indicates that the null hypothesis is rejected or in other words, there is a significant difference between the results of Springate and Zmijewski models.

Ranks:

	N	Mean Rank	Sum of Ranks
RUINF-RUINZ Negative	0[a]		
Positive Ranks	11[b]	0.00	0.00
Ties	32[c]	4.42	27.00
Total	44		

a. RUINF< RUINZ
b. RUINF > RUINZ
c. RUINF = RUINZ

Test Statistics:

	RUINF-RUINZ
Z	-2.721
Asymp. Sig	0.007

a. Based on negative ranks.
b. Wilcoxon signed-rank test.

Hypothesis 2:

The Springate model is more conservative than Zmijewski model in bankruptcy prediction.

To test this hypothesis, since the values obtained from the two models for each of the firms are continuous, dependent paired t-test has been applied. The table below displays the testing of this hypothesis.

Paired Samples Statistics:

	Mean	N	Std. Deviation	Std. Error Mean
Pair z	-1.02514	44	4.21457	0.21457
1 z	1.28141-	44	4.45819	0.56421

Paired Samples Test:

	Paired Differences					T-value	DF	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95%Confidence Interval of the difference				
				Lower	Upper			
Pair Z-Z	1.33452	2.25641	0.35214	0.41501	1.85421	3.215	44	.003

Considering the table above, we can see that the value of sig is 0.003 which is less than 0.05 or in other words, there is a significant difference between the values from the two models. The Z-score of the Springate model is significantly higher than the Z-score of the Zmijewski model. Thus, we can conclude that Springate's Z-score is more conservative than Zmijewski's Z-score. The result of this hypothesis is that the Springate model is more efficient than the Zmijewski model in bankruptcy prediction, which indicates that the hypothesis of the researcher is accepted.

Conclusion:

Based on the results from the statistical tests presented in the previous section, the research hypotheses were accepted. Most of the textile industry firms that were considered as "industrially poor" in previous research were identified as bankrupt according to Springate and Zmijewski models. In the Springate model, firms with Z-scores less than 0.862 and in the Zmijewski model, the firms with Z-scores less than zero are considered as bankrupt; hence, the Springate's Z-score acts more strictly and this issue was confirmed through dependent paired t-test. The firms identified as bankrupt in the Springate model according to the data for each year were considerably more than those in the Zmijewski model.

To test the second hypothesis, dependent paired t-test was applied and the references show that the Springate model is more conservative than the Zmijewski model in bankruptcy prediction, since the firms that were identified as bankrupt based on the data from financial ratios are more in the Springate model than the Zmijewski model. The results of the present research are consistent with the results of Yaghoubnejad and Sheikhi (2009) and Rahnamai-Roodposhti *et al.*, (2010).

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