

## Studying the Efficiency and the Power of Predicting Bankruptcy of Firms Listed on the Stock Exchange using Springate, Fulmer, and Zavgren Models

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### Abstract

The ability of predicting bankruptcy of firms and enterprises is one way of helping investors and economic activists to make correct decisions and optimize resources and the more predictions become true, the more correct decisions will be made. In fact, bankruptcy prediction models are the combination of financial ratios which have been tested by experienced analysts for several years in different parts of the world and have been introduced to the world of science and knowledge. In this study, the ability of Springate, Fulmer, and Zavgren models in line with the prediction of financial crisis and bankruptcy of firms listed on stock exchange has been tested. This study has been done during 2007-2012 within the scope of firms listed on Tehran Stock Exchange. The proper model for the estimation of regression model was created by the use of Chow and Hausman Tests and also errors independence (lack of correlation) and Heterogeneity of variance Tests by the help of Mat lab software and finally the results of testing the accuracy average of predictive ability of models were studied at the same year, one year before occurring bankruptcy, and two years before that. The results of F Test used to compare the accuracy average of the prediction ability of mentioned triple models indicate that at confidence level of 95%, the accuracy average of the prediction ability of mentioned triple models is significantly different; it means that the accuracy of Fulmer Model results is higher than other models of research.

**Keywords:** Bankruptcy, bankruptcy prediction models, Springate Model, Fulmer Model, Tehran Stock Exchange

### 1. Introduction

The bankruptcy and the lack of success of firms is always the problematic and also notable issue. The bankruptcy is one of the factors that none of the users of financial statements do not expect it but always are worried about it. The directors, shareholders, employees, creditors and customers, investors, and other beneficiaries need information to make decision and this information is obtained through financial statements. Financial analysts' power of making decision increases using financial information contained in financial statements. One of the tools of analyzing financial statements is the use of ratios, and financial and non-financial indicators derived from financial statements. In this study, these predictions have been investigated and analyzed from two general points of views:

The first group focuses on the bankruptcy prediction ability using environmental information. This group has provided the evidences on this issue "whether financial ratios to predict bankruptcy are useful?"

The second group studies the accuracy of users' prediction. This group has studied the information processing by humans and the way of processing information by users and also their judgment on some issues such as bankruptcy or non-bankruptcy of companies.

### 2. Literature Review

Literature review involves two sections, which are competitive advantage theory as underpinning theory and hypothesis development.

#### 2.1 Competitive advantage theory

From economic point of view, bankruptcy can be interpreted as the detriment of the company that in this situation the company has suffered from the lack of success. In fact, in this case the rate of return is less than the cost of capital. Another case of bankruptcy occurs when the company fails to obey from one or more than one clauses of debt contract such as keeping current ratio or the ratio of equity to total assets according to the contract. This is called technical default. Other conditions of bankruptcy occur when the company's cash flow to repay debt is insufficient and also when the

company's equity is a negative number. (1)

According to the article 412 of the Iranian Commercial Code, bankruptcy includes:

*"The bankruptcy of the businessman or commercial company occurs as a result of cessation of payment of the funds which he is responsible for."*

The bankruptcy prediction models:

### 3. Fulmer Model

Fulmer (1984) using multivariate analysis to collect data related to 40 financial ratios for 60 companies; 30 bankrupt and 30 active companies. The model is as follows:

$$H=0.528x_1+0.212x_2+0.073x_3+1.27x_4-0.12x_5+2.335x_6+0.575x_7+1.083x_8+0.894x_9-6.075$$

X1= Total assets/ retained earnings

X2= Total assets/sales

X3= Equity/profit before taxes

X4= Total assets/cash flow

X5= Total assets/liability

X6= Total assets/ current liabilities

X7= Logarithm of total assets

X8= Total liabilities/working capital

X9= Interest/logarithm of profit before interest and taxes

If  $H < 0$ , the company is bankrupt.

Fulmer model accuracy in classifying companies one year before bankruptcy was 98% and more than one year before that was 81%. (2)

### 4. Zavgren Model (1985)

The model developed by MS. Christine Zavgren that uses logit statistical analysis is summarized as follows:

$$y=0.23883-0.108x_1-1.583x_2-10.78x_3+3.074x_4+0.486x_5-4.35x_6+0.11x_7$$

X1= Sales/ average assets

X2= Average assets/ average accounts receivable

X3= Total assets/ cash+ short-term investments

X4= Current liabilities/ future assets

X5= Total assets- current liabilities/ operating profit

X6= Total assets- current liabilities/ long-term liabilities

X7= Fixed assets and net working capital/sales

The bankruptcy risk=  $1 / (1+e^{-y})$

The numerical model output is the bankruptcy risk in a range between zero to one. Whatever the number is greater and closer to one, the risk of bankruptcy will be increased and vice versa, whatever the number is smaller and closer to zero, the risk of bankruptcy will be decreased. (3)

### 5. Springate Model

Springate like Altman used audit analysis to select 4 appropriate financial ratios among 19 ones:

$$Z=1.03A+3.07B+0.66C+0.4D$$

A= Total assets/ working capital

B= Total assets/ special profit before interest and taxes

C=Current liabilities/special profit before tax

D= Total assets/ sales

In this model, if  $Z < 0.862$ , the company will be bankrupted. Springate Model accuracy for 40 companies was 92/5%.

Kurschs et al (2015) examined the characteristics of small and medium companies in crisis (bankruptcy). In their study, they tried to use the characteristics of small and medium companies for the state of bankruptcy prediction

model, their reason is the ability of small companies to use different elements and flexibility under economic crisis condition. They believe that internal and external factors both are significantly related to the bankruptcy (4)

Rachisan et al (2014) examined the bankruptcy prediction models in the field of metal mining and smelting industries in Rom. In this study, it was said that critical condition affects the number of employees and financial suppliers of the company and in this article, other factors were examined by the authors. (4)

Adnan et al (2012) in a study, compared between z-score models of Altman and Springate model to predict the bankruptcy in private manufacturing companies. The variables used in this study is the same as the variables of z-score model of Altman and Springate model. The sample of this study includes six companies in New Zealand Stock Exchange studied from 2005 to 2009. The results showed that there was a significant difference between the results of Altman and Springate model for the bankruptcy prediction. (5)

Kumar et al (2012) in a study compared between the bankruptcy prediction models. They believed that financial analysis can provide the executives with vast information about various states in order to help them making essential and vital decisions.

In this study, they used z-score, Springate, and Zemijewski Models for predicting the bankruptcy of those firms that have been bankrupted within two years.

Ansari et al (2014) studied the bankruptcy prediction models by comparing Fulmer and Springate Models in the Stock Exchange. The results showed that the bankruptcy prediction model was significantly different in two mentioned models and therefore different results were obtained. They also said that according to the results, in terms of bankruptcy prediction, Fulmer Model acted more conservatively than Springate Model.

### 5.1 Hypotheses development

Are there any differences in the results of Springate, Fulmer, and Zavgren models in predicting the bankruptcy of those firms listed on stock exchange?

Research sub question:

Which of the above-mentioned models have the greater ability to predict bankruptcy?

Main hypothesis:

Springate, Fulmer, and Zavgren models are more efficient in predicting the bankruptcy of those firms listed on Tehran Stock Exchange.

Sub hypotheses:

Fulmer Model has the greater ability than Zavgren Model to predict the bankruptcy.

Springate Model have the greater ability than Zavgren Model to predict the bankruptcy.

Springate Model have the greater ability than Fulmer Model to predict the bankruptcy.

## 6. Research Method

The data required for this study will be collected through computer databases, referring to the library of Securities and Exchange Organization, using RahavardNovin Software, referring to www.rdis.ir web site which belongs to the Securities and Exchange Organization (Research and development management, and Islamic studies). Companies financial statements including the balance sheet, cash flow statement, notes accompanying financial statements, at the end of each fiscal year (9 March) have been used as research tools. In this regard, research hypotheses have been tested through appropriate statistical methods by Mat lab software. Since this research began from 2007 and lasted until the end of 2012, so the statistical population consists all firms listed on Tehran Stock Exchange. Systematic sampling method is done by applying the following conditions:

1. Information required for the calculation of research operational variables is available for them.
2. They are listed on the stock exchange at least from 2006 and should be active in the stock exchange until the end of the study.
3. 9 March should be their fiscal year.
4. They should not be classified among financial, investment institutions, and banks.

After considering all of these criteria, we observed 638 firms that 183 were bankrupt and 455 firms were not bankrupt.

After adjusting ineligible firms and also deleting outliers, all observations have been reached to 70 firms.

Descriptive statistics of the dependent and independent variables have been measured using the data of 70 firms during the test period (2007-2012).

According to the available research literatures as well as the nature of the research hypotheses, combined data has been used in this study.

In order to determine the appropriate model (combined or panel with fixed or random effects) to test hypotheses, Chow and Hausman Test have been used.

The results related to Chow Test for regression model have been shown in Table 1.

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## 7. Analysis

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**Table 1:** Chow and Hausman Test

Model	StatisticF	Risk	Result	test
Springate Model	284/..1	0/000	Panel Model	Chow Test
Zavgren Model	243/872**	0/000	Panel Model	
Fulmer Model	242/652**	0/000	Panel Model	
Zavgren Model	2/982	.378	Panel with random effects	Hausman Test
Fulmer Model	137/109**	0/0000	Panel with fixed effects	
Springate Model	281/012**	0/0000	Panel with fixed effects	

According to the significant level, the results of Chow Test show that combined model is not confirmed for the first, second, and third models. In other words, in the case of group or individual works panel data method should be used to estimate the regression model and then Hausman Test is used to determine the type of panel model (random or fixed effects).

After determining that y-intercept is not the same for different years, model estimation techniques (fixed or random effects) should be determined and for this purpose Hausman Test is used.

In Hausman Test, the hypothesis based random effects estimation adjustment is tested versus the hypothesis based random effects estimation maladjustment.

The results related to Hausman Test for the first, second, and third models have been shown in Table 1. The results show that the test statistic for the first and third models respectively is 281/012 and 137/109 which is significant at confidence level of 99% and suggests the hypothesis confirmation, so, According to Hausman Test, the regression models fitting (the first and third models) would be appropriate by using panel data model with fixed effects. The results show that the statistic of Hausman Test for the second model is equal to 0/378 which is not significant at confidence level of 99% which implies rejection of the hypothesis, so, according to Hausman Test, the regression model fitting (the second model) would be appropriate by using panel data model with random effects.

Durbin- Watson Test will test the serial correlation among the remainder of regression (errors) based on the following statistical null hypothesis.

H0: there isn't a correlation between errors.

H1: there is a correlation between errors.

Durbin- Watson statistics, along with critical values at 1% error level are presented in table 2. Regarding that the calculated Durbin- Watson statistic of regression model in current study is greater than critical value at 0.01 error level, so the lack of remainders serial correlation in the first and second regression models, will be confirmed at 0.01 significance level.

**Table 2:** Errors independence and Heterogeneity of variance Test

Results	P-value	White statistics	Durbin Watson statistics	Critical values (1% error level)		Regression model
				DI	du	
Absence of heterogeneity	.242	2,621	2.018	1.498	1.978	Springate Model
Absence of heterogeneity	.452	1,982	2.134	1.509	1.967	Zavgren Model
Absence of heterogeneity	.346	2,345	1.427	1.432	1.909	Fulmer Model

The variance heterogeneity is one of the important issues that we are encountered in econometrics. It means that in estimating regression model, the values of error terms have unequal variances. In order to estimate the variance heterogeneity in this research, "White Test" has been used. Obtained results are presented in Table 2. White Test results (F statistic), have been presented in table 2. Results indicates that: "F statistic", in the first, second and third models, are not significant at 0.05 error level. As a result, null hypothesis, based on the existence of variance heterogeneity among data model is rejected at the error level of 0.05. That's why OLS regression model can be used.

Studying and comparing the ability of predicting the bankruptcy by Springate, Zavgren and Fulmer models:

In table 3, the ability of triple models (Springate, Zavgren and Fulmer models) to predict the financial distressed and healthy companies in the year of occurring financial bankruptcy are presented. In order to compare the ability (overall accuracy) of mentioned triple models to predict the distressed companies, Compare Means Test of communities (F statistic) has been used. The results of this test are presented in table 6. H0 and H1 hypotheses in "F test", are as follows:

**Table 3:** Comparing the prediction ability of different models in the year of financial bankruptcy

Zavgren Model	Fulmer Model	Springate Model	Group name
29	33	30	Financial distressed
82,85%	94,28%	85,71%	
28	31	28	Without financial distress distressed
77,14%	88,57%	80,00%	
6.121			F statistic
0.018			P value significance

H0: Forecast accuracy average of Springate, Zavgren and Fulmer models are not significantly different.

H1: Forecast accuracy average of Springate, Zavgren and Fulmer models are significantly different.

According table 3, the results of F are presented to compare the forecast accuracy average of mentioned triple models which indicate that at confidence level of 95%, forecast accuracy average of mentioned triple models are significantly different since the F statistic in this test (6.121), is more than minimum acceptable value for confidence level of 95%. As a result, at the acceptable error level of 5%, statistical assumption of the significance of forecast accuracy average difference for mentioned triple models won't be rejected and H1 hypothesis based on the fact that the forecast accuracy average for Springate, Zavgren and Fulmer models are significantly different, is confirmed.

Models predictive ability Test one year before bankruptcy

In table 4, the ability of triple models (Springate, Zavgren and Fulmer models) to predict the distressed and healthy companies, a year before the financial bankruptcy are presented. To compare the ability (overall accuracy) of mentioned triple models to predict the distressed companies, Compare Means Test of communities (F statistic), has been used. The results of this test, are presented in table 4. In F test, H0 and H1 hypotheses are as follows:

**Table 4:** Comparing the prediction ability of different models a year before bankruptcy

Zavgren Model	Fulmer Model	Springate Model	Group name
28	31	29	Financial distressed
%80,00	%88,57	%82,85	
27	29	28	Without financial distress
%77,14	%82,85	%80,00	
55	60	57	Overall accuracy of model
%78,57	%85,71	%81,42	
8/943			F statistic
0/011			P value significance

H0: Forecast accuracy average of Springate, Zavgren and Fulmer models are not significantly different.

H1: Forecast accuracy average of Springate, Zavgren and Fulmer models are significantly different.

According to table 4, the results of F Test are presented to compare the forecast accuracy average of mentioned triple models which indicate that at confidence level of 95%, forecast accuracy average of mentioned triple models are significantly different since the F statistic in this test (8.943), is more than minimum acceptable value for confidence level of 95%. As a result, at the acceptable error level of 5%, statistical assumption of the significance of forecast accuracy average difference for mentioned triple models won't be rejected and H1 hypothesis based on the fact that the forecast accuracy average for Springate, Zavgren and Fulmer models are significantly different, is confirmed.

Models predictive ability Test two years before bankruptcy

In table 5, the ability of triple models (Springate, Zavgren and Fulmer models) to predict the distressed and healthy companies, a year before the financial bankruptcy are presented. To compare the ability (overall accuracy) of mentioned triple models to predict the distressed companies, Compare Means Test of communities (F statistic), has been used. The results of this test, are presented in table 5. In F test, H0 and H1 hypotheses are as follows:

**Table 5:** Comparing prediction ability of different models two years before the bankruptcy

Zavgren Model	Fulmer Model	Springate Model	Group name
26	30	28	Financial distressed
74,28%	85,71%	80,00%	
27	29	27	Without financial distress
77,14%	82,85%	77,14%	
53	59	55	Overall accuracy of model
75,71%	84,28%	78,57%	
12,56			StatisticF
00430/			Significance)P-Value(

H0: Forecast accuracy average of Springate, Zavgren and Fulmer models are not significantly different.

H1: Forecast accuracy average of Springate, Zavgren and Fulmer models are significantly different.

According to table 5, the results of F Test are presented to compare the forecast accuracy average of mentioned triple models which indicate that at confidence level of 95%, forecast accuracy average of mentioned triple models are significantly different since the F statistic in this test (12/565), is more than minimum acceptable value for confidence level of 95%. As a result, at the acceptable error level of 5%, statistical assumption of the significance of forecast accuracy average difference for mentioned triple models won't be rejected and H1 hypothesis based on the fact that the forecast accuracy average for Springate, Zavgren and Fulmer models are significantly different, is confirmed.

## 8. Conclusion

According to tables 4, 5 and 6, the results of F test have been presented for comparing the forecast accuracy average of mentioned triple models which indicate that at confidence level of 95%, forecast accuracy average of mentioned triple models are significantly different, so, since the overall accuracy of Fulmer Model (within the year, one year and two years before financial distress) are more than Zavgren Model (within the year, one year and two years before financial distress) and also the results show that the overall accuracy of Springate model (within the year, one year and two years before financial distress) respectively are (82.80%, 81.42% & 78.57%) more than Zavgren model (within the year, one year and two years before financial distress), respectively are (42% & 78.57%, 75.71%) and also the results show that the overall accuracy of Springate model (within the year, one year and two years before financial distress) respectively are (82.80%, 81/42%, 78/57%) more than Fulmer Model (within the year, one year and two years before financial distress), respectively are (91.42%, 85.71%, 84.28%).

According to the findings of this research, capital market participants, decision-makers, financial analysts and potential and actual investors of stock exchange are recommended that in analyzing investment projects in financial assets and securities to separate the bankrupt companies from non-bankrupt ones, use Fulmer model which has the higher ability and accuracy to predict, because the use of these models and techniques lead to choose the optimal investment portfolio with minimum risk and maximum return, moreover, the transparency of decision-making environment and obtained results, can also be doubled.

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