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Predicting the Financial Distress of Companies using Piotroski's F-Score Model

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Abstract

Financial distress is a severe issue for the economic life of countries, and its prediction is of great importance for different groups of users, including managers, banks, investors and policymakers. Therefore, this research aims to predict the financial distress of companies listed on the Tehran Stock Exchange using Piotroski's F-Score Model. For this purpose, company information was collected for 113 companies in 9 years from 2014 to 2022. The multivariable regression method based on the logistic analysis was used to test research hypotheses. The study results indicate a negative and significant relationship between the Piotroski F score and the possibility of financial distress. In other words, Piotroski's F-Score Model is well able to predict helpless companies so that companies can prevent their bankruptcy by making correct and logical decisions. Also, the results showed that the increase in operating cash flow and efficiency assets and reduction of accruals could reduce companies' financial distress in the Tehran Stock Exchange.

Keywords: Financial distress, Forecasting, F Piotroski.

1 | Introduction

Due to the global economic conditions, the number of helpless companies giving importance to this issue is increasing. Even the auditors who have good knowledge of the financial situation of the companies after the necessary procedures cannot make a correct judgment about the continuation of the companies' activities. The problem of financial helplessness and bankruptcy has always been an issue worthy of consideration, and due to its importance, accounting and financial experts worldwide are thinking of finding ways to predict financial helplessness. Predicting financial helplessness is one of the ways that can be done by using it to help take advantage of investment opportunities and better allocate resources. In fact, by providing the necessary warnings, companies can be informed about the occurrence of financial helplessness so that they can take

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appropriate measures according to these warnings. On the other hand, investors and creditors can distinguish favourable investment opportunities from unfavourable ones and financial resources. Financial helplessness is when the company cannot fully fulfil its obligations to financial providers and faces difficulties. Financial helplessness is the stage before bankruptcy; financial helplessness does not necessarily lead to bankruptcy. A set of management measures to get out of helplessness can save the company from the risk of entering the bankruptcy stage [1].

When a company goes bankrupt or fails to fulfil its financial obligations, it will negatively affect its stakeholders, such as lenders, creditors, customers, employees and shareholders. Lenders and creditors will lose their capital. Customers' business operations may be disrupted due to sudden interruptions in the supply of raw materials, adversely affecting revenue, profit margins and reputation. Employees will lose their income, and shareholders may suffer losses [2]. Therefore, a company's bankruptcy affects not only its direct beneficiaries but also the entire economy, and its severity depends on the size of the company. Considering the above, it is evident that business failure will have serious consequences for many parties. In this way, in the past few decades, the field of predicting helplessness and financial bankruptcy has attracted the attention of many researchers [3].

To date, many studies have been conducted to address the issue of predicting financial distress. Many forecasting models have been introduced since the 1960s. However, the performance of existing models is inconsistent [4]. Therefore, there is a need to continue the search to find a better model that fits the current and future market environment. The global economy has evolved, and the business environment differs significantly from the 1980s. Based on these bankruptcy drivers, companies may also have changed. One of the best prediction models for the current economic environment is the F score model developed by Piotroski in 2000 as a potential model. The difference between the present model and the previous bankruptcy forecasting models is that in this model, the quality of the company's profit was also used, which is shown by the variable of accruals in the model. This variable is an essential distinguishing factor because studies such as [5] showed that adding accruals can significantly improve the results of helplessness forecasts. Also, the study of [6] showed that the F-score model has predictive ability for Indian companies. Piotroski [7] first developed the F-score as a measure to select good stocks for investment. In this model, the score is between 0 and 9 based on the sum of scores based on 9 financial variables. [7] showed that companies with a high F-score will have better stock returns than companies with a low F-score [7]. Campbell et al. [8] believe that companies with a high probability of bankruptcy also provide a low average stock return. According to these results, it can be said that companies with a low F score, compared to companies with a high F score, have a greater tendency to financial distress [8]. Finally, according to the proposed issues, this research aims to predict the financial distress of companies listed on the Tehran Stock Exchange using Piotroski's score F model. Therefore, the usability of the total F score (model 1) and the discrete variables that comprise the F score (model 2) have been tested.

Therefore, the continuation of this research is organized in such a way that in the second part, the theoretical foundations of the research are discussed; in the third part, an overview of the background of the study is done. In the fourth part, the research hypotheses are stated. In the fifth part, the research method and regression models will be reviewed, and finally, the research findings and conclusions will be presented and explained thoroughly.

2 | Background of Research

Predictions are vital because they prevent material and moral damage by sending warning signals in time, resulting from correct and logical dealing with the situation [9]. One of the ways to help investors is to provide prediction models about the overall outlook of the company; the closer the predictions are to reality, the more correct decisions will be based on [10]. So far, various models have been used to evaluate financial helplessness. These patterns are beneficial in the decisions of financial market actors, and efforts have always been made to increase the accuracy of forecasting and evaluation of these patterns by using more advanced methods [11]. Also, the topic of bankruptcy prediction is a topic that has been well-researched among financial researchers; some of the first studies conducted by Beaver [12] and Altman [13] showed that the analysis of financial ratios calculated from the Financial indicators can be used to predict financial distress and bankruptcy risk. Decision-making in financial matters has always been associated with the risk of uncertainty. Matin et al. [14] applied deep learning to predict Danish companies' financial distress from text passages in annual reports. The audit reports contain more information than the management statements, and the model, including the audit report and the management statements, is not superior to the model containing only the audit report [14]. Acosta-González et al. [15] predicted financial distress using macroeconomic and accounting variables in Spanish-listed companies. They showed that a combined model of macroeconomic and accounting variables can predict the financial distress of companies [15]. In research, Rahman et al. [3] predicted the financial distress of companies using the F score model. They showed that the relationship between the F score and the probability of companies suffering from financial distress is significant [3].

Khodakarimi and Piri [16] showed in research that a combination of accounting and market information can predict the helplessness of companies, and considering the continuity of the companies' activities, it can improve the quality of decision-making by shareholders and stakeholders. Tahmasebi et al. [17], using factor analysis, decision tree and logistic regression models, showed that both decision tree and logistic regression models have the ability to predict financial helplessness. Still, the model in the decision line lacks predictive power. It is higher than the logistic regression model. In a study, Barg Beid et al. [18] concluded that the three-dimensional combined model (financial, economic, sustainability) has a high predictive power for helplessness.

3 | Research Methodology

Since the results of the research will be used by the Tehran Stock Exchange, the type of the current research is applied based on its purpose and descriptive correlation based on its nature and method. The statistical population of this research includes the companies admitted to the Tehran Stock Exchange, and the time domain of the study is from the beginning of 2013 to the end of 2014, which is 9 years. The number of investigated companies was a total of 113 companies.

Also, common statistical techniques in developing accounting-based bankruptcy prediction models are multiple discriminant analysis, logistic regression, probabilistic model and linear probability [19]. In this study, logistic regression was used to analyze the model. How to investigate the relationship between Piotroski's F score and the probability of financial distress in the form of four models in *Models (1)* and *(2)* after measuring Piotroski's F score for each company in each year and taking into account the condition of becoming zero and one Its relationship with the dependent variable of financial helplessness (Z_Score) has been tested. Then, each of the variables constituting the F score was tested again in multiple regression with the dependent variable of financial helplessness (Z_Score) to determine the effect of each variable on financial helplessness. It should be noted that the F-score model considering changes in return on assets (F_ROA) and accruals (ACC) has led to the creation of the F-score *Model (3)*, and without these variables, it has led to the creation of *Model (4)*. These models are taken from the research of [3] as follows:

Model 1:

$$\mathrm{Z\_Scoreit} = \beta_0 + \beta_1\, \mathrm{F\_Score1}_{it} + \varepsilon_{it} \quad \textbf{(1)}$$

Model 2:

$$\mathrm{Z\_Scoreit} = \beta_0 + \beta_1\, \mathrm{F\_Score2}_{it} + \varepsilon_{it} \quad \textbf{(2)}$$

Model 3:

$$\begin{aligned} Z\_Score = {} & \beta_0 + \beta_1 F\_ROA + \beta_2 F\_DROA + \beta_3 F\_CFO + \beta_4 F\_Accrual + \beta_5 F\_DMargin \\ & + \beta_6 F\_DTurnover + \beta_7 F\_DLeverage + \beta_8 F\_DLiquidity + \beta_9 F\_Eq\_Offe \\ & + \varepsilon it \end{aligned} \quad (3)$$

Model 4:

$$\begin{aligned} Z\_Score = {} & \beta_0 + \beta_1 F\_DROA + \beta_2 F\_CFO + \beta_3 F\_Accrual + \beta_4 F\_DMargin \\ & + \beta_5 F\_DTurnover + \beta_6 F\_DLeverage + \beta_7 F\_DLiquidity \\ & + \beta_8 F\_Eq\_Offe + \varepsilon it \end{aligned} \quad (4)$$

In the above models, the dependent variable Z-score is the risk of financial helplessness, a virtual variable. If the company is in financial helplessness, it takes the value of 1; otherwise, it takes the value of zero. To determine this variable, the following three conditions have been used according to the research of [20]:

- *FDE1: If the interest coverage ratio (dividing debt interest expense by profit before interest and tax) is less than 0.8 for 2 consecutive years and the market value growth is negative for two consecutive years, the number is 1; otherwise, it is zero.*
- *FDE2: If the profit before tax and interest is less than the interest payment, the profit before interest and tax is negative. The net profit is negative for 2 consecutive years; the number is 1; otherwise, it is zero.*
- *FDE3: If the profit before tax and interest is less than the interest payment, the net worth to the total debt is less than one, and the growth of the net worth is negative for two consecutive years, the number is 1, and zero otherwise.*

Also, independent variables are Piotroski's F score, used cumulatively and discretely in the above models.

$$\begin{aligned} F\_Score = {} & F\_ROA + F\_DROA + F\_CFO + F\_Accrual + F\_DMargin + F\_DTurnover \\ & + F\_DLeverage + F\_DLiquidity + F\_Eq\_Offe. \end{aligned} \quad (5)$$

$$\begin{aligned} F\_Score = {} & F\_DROA + F\_CFO + F\_DMargin + F\_DTurnover + F\_DLeverage \\ & + F\_DLiquidity + F\_Eq\_Offer. \end{aligned} \quad (6)$$

In Piotroski's F score model, variables are defined as follows:

- *ROA: return on assets, the ratio of net profit to total assets (1 point if it is positive in the current year, otherwise zero points).*
- *CFO: cash flow, the ratio of cash flow to total assets (1 point if it is positive in the current year, otherwise zero points).*
- *DROA: change in return on assets (1 point if this year is more than the previous year; otherwise, zero points).*
- *Accrual: accrual items, if the amount of cash flow is more than the return on assets in the current year, 1 point and zero otherwise).*
- *DLeverage: change in the ratio of financial leverage, the ratio of debt to total assets (if this year's ratio is lower than the previous one, 1 point and zero otherwise).*
- *DLiquidity: change in the current ratio, the ratio of existing assets to current liabilities (if it is more in the current year than the previous year, 1 point and zero otherwise).*
- *Eq_Offe: change in the number of shares (1 point if no new shares were issued in the last year and 0 otherwise).*
- *DMargin: change in gross margin, the ratio of net profit to sales (1 point if the change in gross margin in the current year is more than the previous year, zero otherwise).*
- *DTurnover: change in asset turnover ratio, net sales to total assets (if the change in asset turnover ratio in the current year is greater than the previous year, 1 point, otherwise zero).*

4 | Research Finding

4.1 | Descriptive Statistics

This section discusses descriptive statistics indices, including central indices (maximum, minimum, mean) and dispersion indices, including variance and standard deviation.

Table 1. Statistical index of reserch variables.

Symbol	Mean	Median	Max	Min	S.d
Z-SCORE	0.154	0	1	0	0.36
F-SCORE	4.74	5	9	0	1.92
ROA	0.86	1	1	0	0.33
DROA	0.503	1	1	0	0.5
CFO	0.83	1	1	0	0.372
ACC	0.416	0	1	0	0.49
DMARG	0.51	1	1	0	0.5
TURN	0.517	1	1	0	0.49
DLEV	0.47	0	1	0	0.49
DLIQ	0.509	1	1	0	0.5
EQ	0.11	0	1	0	0.317

Based on the results obtained (*Table 1*) from the descriptive statistics, it can be seen that there were companies that obtained all the F points entirely, and other companies in the Tehran Stock Exchange market had a higher rating than the average of 9 points.

4.2 | Model Estimation and Analysis

In this research, firstly, an independent t-test was performed to analyze the models presented in *Table 2* to determine the F score between companies with and without helplessness. As expected, on average, financially distressed firms have a lower F-score than non-distressed firms.

Table 2. Independent t test.

Variable	Non distress		Distress	
	Mean	S.d	Mean	S.d
F-SCORE	4.94	2.09	4.74	2.04

Also, the fitting results of *Models (1)* and *(2)* are shown in *Table 3*. The results of *Models (1)* and *(2)* show that in the 99% confidence interval, the higher the F score is, the higher the probability of helplessness decreases, so it can be concluded that the F score model has predictive power. 12% (according to McFadden's statistics) have the financial helplessness of companies.

Table 3. Results of fitting Models (1) and (2).

Variables	Model 1	Model 2
C	0.14	1.92
	(0.26)	(0.045)
FSCORE	-0.26	-9.71
	(0.000)	(0.000)
McFadden coefficient of determination	0.12	0.12

Table 4. The results of fitting Models (3) and (4).

Variabels	Model 3	Model 4
C	1.591 (0.0002)	-0.47 (0.001)
ROA	-4.407 (0.000)	- -
DROA	0.561 (0.1105)	0.032 (0.826)
CFO	-0.677 (0.000)	-1.429 (.000)
ACC	- -	1.815 (0.000)
DMARG	-.397 (0.2547)	-.279 (0.0584)
TURN	-0.14 (0.6447)	-0.009 (0.9387)
DLEV	-1.018 (0.006)	-0.346 (0.0155)
DLIQ	-0.485 (0.0041)	-0.4 (0.0048)
EQ	-0.78 (0.1777)	-0.173 (0.4426)
McFadden's	0.566	0.304

Based on the results obtained (*Table 4*) from *Models (3)* and *(4)*, all the financial ratios that make up the F score have no significant relationship with financial helplessness. As can be seen, the rate of return on assets, operating cash flow, financial leverage and changes in the liquidity ratio in the confidence interval of 99% lead to the reduction of the financial helplessness of companies, in which the return on assets has the most negative impact. That is, companies that improve one unit of return on their assets lead to a decrease in financial helplessness by 4.407 units. Also, accruals have positively affected financial helplessness, which was significant at the 99% confidence level. McFadden's coefficient of determination in *Models (3)* and *(4)* shows the model's predictive power as 56.6 and 30.4 percent, respectively.

5 | Conclusion

In today's era, companies face many challenges to survive in competitive markets. Financial health and identifying the factors that lead to financial crisis is critical. In the competitive environment, those companies that cannot align themselves with the growth and development process of the leading companies alternately leave the competition and become helpless and may reach the stage of bankruptcy [21]. Prediction of financial helplessness A company has always been a topic of interest to researchers and practitioners because it affects bankers, shareholders, potential investors, and creditors. In many cases, the inability of a group of companies to fulfil their obligations negatively affects the economic stability of a country. Based on the current literature, researchers have primarily used models based on accounting information to predict the financial distress of companies [22].

This research has been tested for the first time in the companies in the capital market of Tehran. The results show that the variables in Piotroski's F-score model can have valuable information for predicting financial helplessness. Based on this, if companies can improve their asset yield, operating cash flow and liquidity, they will lead to a reduction in distress. One of the noteworthy points is that even though the increase in debts increases the risk of helplessness, this research has led to a decrease. The reasons for this can be interpreted as the cheapness of debts considering the existing inflation in our country. Or that the companies acted optimally in determining their capital structure [23]. The results also showed that if the companies lead to an increase in accruals due to their credit sales and do not establish a correct credit policy, it can lead to a rise in financial helplessness and problems in their operational cycle to increase cash financial needs. Finally, according to the above, it is suggested that analysts, managers, auditors and investors check the financial health of the companies and whether they face the risk of continued activity or not, and if in the future periods subject to article 141 commercial laws should use the variables in this model, because the results of this model significantly support the financial and accounting researches on working capital policies, optimal capital structure and accruals that are implemented in the form of earnings quality.

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Data Availability

The datasets analyzed during the current study are available on request from the corresponding author.

Conflicts of Interest

The authors declare no conflicts of interest.

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