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Reconstruction of Z-score Model Based on Chinese Financial Data

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Abstract: The Z-score model is widely used. However, due to the short development period of China's capital market and its great difference with western countries, the traditional Z-score model needs to be adjusted according to the actual situation of China's capital market. This paper reconstructs the model by using Chinese financial data of listed companies in 2017, and tests the identification and prediction abilities of the reconstruction model. This paper finds that the accuracy of the re-construction model has been greatly improved, but the abilities to identify and predict enterprises with financial failure are weaken than the original model.

1. Introduction

Financial failure early warning is an important aspect of financial statement analysis. For shareholders, successful investment is not only related to the current financial performance, but also to whether the enterprise has enough growth potential in the future. If the enterprise will have a large financial risk or even financial failure in the future, the shareholders will withdraw investment to avoid risk or stop loss in time. Therefore, most of the existing valuation models are based on future earnings or cash flow. For creditors, whether they can receive the agreed principal and interest on schedule also depends on the future business situation and cash flow of the enterprise. If it is predicted that the debtor will encounter major business difficulties in the future, which will make it difficult for the cash flow to repay the principal and interest, then the creditor will also reduce the risk by taking back the loan in advance or terminating the later cooperation relationship. To sum up, it is of great significance to accurately predict the future financial situation of an enterprise and avoid financial failure in time, whether from the perspective of income orientation of shareholders or from the perspective of risk orientation of creditors.

2. Literature Review

As for the early warning model of financial failure, the most famous one is the Z-score model proposed by Altman, a professor of New York University [1]. The model has the advantages of

simple form, easy access to data, high prediction accuracy, and is widely used by accounting scholars and financial analysts. The specific form is as follows:

$$Z=0.012X_1+0.014X_2+0.033X_3+0.0064X_4+0.999X_5 \quad (1)$$

Where X_1 represents working capital/total assets, X_2 represents earnings/total assets, X_3 represents EBIT/total assets, X_4 represents the market value of shareholders' equity/book value of total liabilities, X_5 represents sales revenue/total assets. When the Z-score is lower than 1.81, it indicates that the risk of enterprise bankruptcy is high. When the Z-score is higher than 2.99, it indicates that the financial situation of the enterprise is good and there is no risk of financial failure. When the Z-score is between 1.81 and 2.99, it indicates that the financial situation of the enterprise is uncertain and whether there is bankruptcy risk needs to be further tested. The model firstly predicts a financial failure by using financial indicators and linear regression method.

The study of linear regression model for financial failure early warning in China originated in the beginning of this century. Wu and Lu selected the same number of financial failure companies and normal companies as the control [2]. After screening various financial variables, they used three methods to build financial distress model and selected six indexes with strong prediction ability, and confirmed the use of logistic regression method in financial failure prediction has the highest accuracy. On this basis, other scholars have carried out in-depth development on the linear regression model of financial failure early warning from two aspects of increasing variables and improving regression methods. For example, Wang used corporate governance variables instead of financial indicators to carry out logistic regression, and concluded that corporate governance variables can accurately predict whether a company will fall into financial distress [3]. Liang et al. made a comprehensive analysis of corporate governance variables and financial indicators, and screened them with the method of robust logistic regression, which ultimately effectively improved the accuracy of model prediction [4]. Furthermore, they used the logistic regression model of random effects to build another linear prediction model, which also improved the prediction accuracy of the model [5]. In addition, Guo and Hu added relevant macroeconomic variables to this study, and used comparative discrete-time risk model for sample discrimination [6]. On the one hand, the comprehensive analysis of financial information, corporate governance information and macroeconomic information can significantly improve the prediction ability of the linear model. On the other hand, comparative discrete-time risk model is also better than the traditional methods, such as logistic model or probit model. Of course, some scholars have also used other methods to predict financial distress, such as Zhang et al. used Kalman filter method in aerospace engineering to study the financial distress of power enterprises [7]. After empirical analysis of eight electronic ST and * ST companies, they believe that this method can accurately predict the financial distress of enterprises in the next year at least. Sun et al. proposed a new method of financial failure early warning by using support vector machine (SVM) based on rolling time window. They believed that this method considered the problem of financial distress drifting with time, and fully used the financial distress faced by enterprises to predict the future financial distress, which makes the whole research more objective and more in line with the actual situation [8]. Zhuang and Chen systemically combed the prediction methods of financial distress, optimized the forward-looking prediction by using the dynamic model of financial distress prediction and Kalman filter, and improved the accuracy of prediction in model to a certain extent [9].

It can be seen from literature above that with the continuous improvement of statistical technology, a variety of financial failure early warning models emerge in endlessly. However, the traditional linear regression model is still favored by accounting scholars and financial workers because of its convenient use, simple principle, easy access to data, and almost accuracy of prediction compared with other methods.

3. Problem Development

The traditional Z-score model is widely used in the empirical analysis of accounting and the financial decision-making of investors. However, there are at least two limitations in the application of this model in China's capital market: Firstly, the Z-score model was put forward in 1968, which is 52 years ago. However, today's capital market has changed dramatically, so the accuracy of traditional Z-score model prediction inevitably declined. Secondly, the Z-score model is based on the capital market of the western developed countries in the 1960s, while the Chinese capital market originated in the 1990s. With the unique socialist system of our country, the capital market of our country is quite different from that of the West. For example, from the perspective of the market index of the stock market, the U.S. stock market has been steadily improving, which is a typical efficient market. However, with the fluctuation of China's market index, it is difficult for retail investors to realize capital appreciation through value investment. Because of these 2 reasons, it is necessary to construct the Z-score model again according to the uniqueness of China's capital market. Therefore, this paper reconstructs the Z-score model based on the data of China's capital market, and test the accuracy of the prediction of the reconstructed model.

4. Results

4.1 Z-score model reconstruction

In this paper, the financial data of A-share listed companies in 2017 and the logistic regression method are used to reconstruct the Z-score model, and the data of 2018 are used to test the prediction ability of the new model. It should be pointed out that the finance-failed enterprises in this paper refer to the listed companies with ST or * ST in the stock abbreviation, and the rest are normal enterprises. Financial data comes from WIND database. Because there is a large premium in the stock market of listed companies in China, which may distort the prediction ability of the X_4. This paper replace it with book value of shareholders' equity (including minority shareholders)/book value of total liabilities. For the sake of simplicity, the variables are not standardized in this paper, so the model is reconstructed with constant term, and the regression results are shown in Table.1.

Table 1 Results of Z-score model reconstruction

	(1)
	Z_1
X_1	0.015***
	(3.455)
X_2	0.009***
	(5.542)
X_3	0.068***
	(5.736)
X_4	0.001*
	(1.673)
X_5	0.006**
	(2.283)
Constant	2.171***
	(11.577)
Obs.	3623
Pseudo R^2	0.198
T-values are in parenthesis	
*** p<0.01, ** p<0.05, * p<0.1	

It can be seen from Table 1 that the significance level of each variable in Z-score model is generally low, among which P-values of X_1, X_2, X_3 and constant term are less than 0.01, P-value of X_5 is less than 0.05, and P-value of X_4 is less than 0.1. This shows that there is a significant correlation between these indicators and financial failure. Once again, it proves the effectiveness of the Z-score model. The reconstruction results are written in the form of multiple linear regression equation, that is:

$$Z_1=2.171+0.015X_1+0.009X_2+0.068X_3+0.001X_4+0.006X_5 \quad (2)$$

4.2 Reconstructed Z-score model test

Referring to the relevant literature of financial early warning model, this paper uses financial data in 2017 and 2018 to test the accuracy of the reconstructed model, and compares the accuracy with the original Z-score model. Among them, financial data in 2017 are used to test the discriminant ability of the model, while financial data in 2018 are used to test the prediction ability of the model. From previous studies, the accuracy of model prediction will gradually decline with the passage of time [4-5]. Therefore, this paper only uses the data of the first period ahead to evaluate the maximum value of its prediction ability. The test results are shown in Table.2.

Table 2 Results of reconstructed Z-score model test

	Reconstructed model (2017)	Original model (2017)	Reconstructed model (2018)	Original model (2018)
Correct prediction (Failed enterprises)	43	57	78	91
Total (Failed enterprises)	138	138	138	138
Accuracy (Failed enterprises)	31.16%	41.30%	56.52%	65.94%
Correct prediction (Normal enterprises)	2901	2294	2737	1849
Total (Normal enterprises)	3487	3487	3486	3486
Accuracy (Normal enterprises)	83.19%	65.79%	78.51%	53.04%
Correct prediction (Population)	2944	2351	2815	1940
Total (Population)	3625	3625	3624	3624
Accuracy (Population)	81.21%	64.85%	77.67%	53.53%

On the whole, the accuracy of the reconstruction model has been significantly improved, whether it is the ability of discrimination or prediction, which shows that the reconstruction of Z-score model with the lag data of the first period can indeed improve the effectiveness of the model. However, compared with the original Z-score model, the ability to identify and predict the finance-failed enterprise is decreased, which shows that the reconstruction model is more likely to fail to identify the enterprise with financial failure or identify it as a normal enterprise by mistake. In the identification of finance-normal companies, the accuracy of the reconstruction model is far higher than the original Z-score model, which shows that the improvement of the discrimination ability and prediction ability of the reconstruction model is mainly for finance-normal companies, while the abilities for financial failure companies need to be improved.

5. Conclusion

Under the unique background of Chinese capital market, this paper reconstructs the traditional Z-score model, and compares the effectiveness of the reconstructed model and the original Z-score model. The results show that the discrimination and prediction ability of the reconstructed model are significantly improved, but the improvement mainly comes from the financial normal enterprises. For financial failure enterprises, the traditional Z-score model is still more effective. Of course, this paper only uses one period of data to reconstruct the Z-score model, and uses data in next year to test its prediction ability. The demonstration process is relatively simple. How to

integrate the traditional Z-score model into the development characteristics of Chinese capital market needs further study.

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