

Early Warning Model Construction Based on Z-Score Financial Risk: China's U.S. Stock Information Technology Companies

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Abstract: Information technology is the foundation for the development of digital economy and the key support for the construction of digital China. The U.S. stock market has a faster financing speed and is the preferred place for Chinese enterprises to list abroad. Based on the Z-Score financial risk early warning model, this study takes China's U.S. stock information technology companies as samples, adds 23 financial indicators to the measurement indicators, and utilizes Fisher's discriminant method for discriminant analysis and validation. The research results show that compared with the Z model, the new model, except for X1, the rest of the variable indicators, indicator coefficients and risk interval thresholds have been revised, and the revised Z1 model has a higher discriminatory correctness rate, and is also more suitable for discriminating the financial risks of China's U.S. stock information technology enterprises at present.

Keywords: U.S. information technology companies, Z-Score model, Fisher's discriminant, financial risk.

1. Introduction

The Ministry of Industry and Information Technology released the "14th Five-Year Plan" for the development of software and information technology services on November 15, 2021, which made an important deployment of the development tasks of China's software and information technology services during the "14th Five-Year Plan" period (Cao Chunping and Liu Xinyu, 2023). Financial risk exists objectively in the process of enterprise operation, it is a risk that can only be reduced but not eliminated, and it has an important impact on the development of enterprises. The U.S. securities market, as one of the world's largest capital markets, with its rich layers, abundant funds, and faster financing, is the preferred place for Chinese enterprises to list abroad.

Most of the previous literature on financial risk is classified according to financing channels or single-factor research on the four major capabilities, and there are fewer comprehensive multi-factor studies using the Z-Score model, and most of them are dominated by enterprises in the real estate industry. Based on the principle and method of Z-Score model, the article uses Fisher's discriminant method of SPSS software to modify the model, and provides the basis for financial risk identification of China's U.S. information technology enterprises through the optimized model.

2. Introduction to Z-Score Model

Z-Score score model was proposed by American scholar Altman in 1986 to measure the financial risk situation. By selecting a large number of financial indicators and U.S. companies to conduct experiments resulted in three models, which are applicable to listed manufacturing industry, non-listed manufacturing industry, and other non-manufacturing enterprises (Xu Xiao, 2022). Because the research object is listed in the United States of China's information technology enterprises belong to the non-manufacturing industry, so the third model as the basis for research. The model formula is:

$$Z=6.56X1+3.26X2+6.72X3+1.05X4$$

X1=(current assets - current liabilities)/total assets, which measures the asset liquidity ability; X2=(undistributed profit + surplus reserve)/total assets, which illustrates the cumulative profitability; X3=(total profit + interest expense)/total assets, which expresses the profitability; and X4=owner's equity/total liabilities, which indicates the ability to withstand the market shock.

$Z \geq 2.60$, indicating a safe zone with less financial risk; $Z \leq 1.10$, indicating a bankruptcy zone with greater financial risk; $1.10 < Z < 2.60$, indicating a gray zone with moderate risk. By bringing the enterprise financial data into the Z-Score model and comparing the calculated Z value with the interval value, the size of the enterprise financial risk is judged.

3. Research Design

3.1. Data Sources

The information technology industry enterprises in China's conceptual stocks under Sina Finance - U.S. Stocks in November 2023 are selected as the research object, a total of 45, of which 31 are listed on NASDAQ and the rest are listed on NYSE. The financial statement data comes from Snowball.com and EXCEL calculation and organization, excluding 4 enterprises without financial data, the actual valid data sample is 41.

Since the bankruptcy boundaries of both China's old and new Bankruptcy Laws involve insolvency, total assets are used as the basis for categorization. The total assets are sorted with odd numbers as a group and even numbers as a group. The first group is used for experiment and the second group is used for test. The financial type of the enterprise is divided into normal operating conditions and abnormal operating conditions, 1 represents in the safe zone of small financial risk, normal operating conditions of the enterprise; 2 represents in the bankruptcy zone of large financial risk, abnormal operating conditions of the enterprise; 1.5 represents in the

gray zone of moderate financial risk, unknown operating conditions of the enterprise.

3.2. Validation of the applicability of Z-Score model

Z-Score model research object is a U.S. enterprise, the article research object although listed in the U.S., but its actual manager or organization in China, coupled with, with the rapid development of China's market economy in recent years, Z model financial indicators can be sensitive to reflect the current market changes, so the applicability of the Z model is open to question.

In order to verify whether the selected enterprises apply the Z model to judge their financial risks, the Z-Score model formula 1 is selected for verification. If the actual financial status of the enterprise is consistent with the type of Z model judgment or the correct rate is high, it means that the Z model can still be used as a judgment standard. Compare the actual financial type of the sample enterprises with the calculated discriminant type, the discriminant type is the same as the actual type indicating that it is applicable and the discriminant result is correct, otherwise it is wrong. According to the above data source, the number of correct and incorrect Z-model discriminations is 28 and 13, with a correct rate of 68.29%, which is not very accurate. Next, we explore whether there is a financial risk early warning model with higher correct rate to discriminate the financial risk of China's U.S. information technology companies.

3.3. Selection of indicators

In order to explore the financial risk early warning model with higher accuracy, based on the basic principles and methods of Z-Score model, referring to the literature of scholars (Xiao Zhigang,2019; Liang Xue,2021). the "Enterprise Performance Evaluation Standards" (Deng Ji,2023; Du Xiaoqin and Li Lu,2023). the characteristics of the information technology industry(Wei Yuexin,2022; Wang et al.,2023). other information, 23 indicators are added on the basis of the 4 indicators of the Z Model, with a total of 27 variable indicators for exploration and validation. Among them, X1 to X6 indicate the asset liquidity capacity, and their indicator expressions are (current assets - current liabilities)/total assets, current assets/current liabilities, sales revenue/average accounts receivable balance, operating costs/average inventory, operating income/average current

assets, operating income/total assets; X7 to X12 indicate the cumulative development capacity, and their expressions are (undistributed profit + surplus reserve)/total assets, growth in total assets for the year/total assets at the beginning of the year, operating income/total assets, growth in operating income for the year/total operating income at the beginning of the year, growth in operating profit for the year/total operating profit at the beginning of the year, and growth in net assets per share for the year/net assets per share at the beginning of the year; X13 to X21 indicates profitability, with the expressions of (total profit + interest expense)/total assets, R&D cost/ total expenses*(1 - gearing ratio), net profit/average net assets, net profit/average total assets, net profit/sales revenue, cost of sales/net sales revenue, net profit/total operating income, net cash flow from operating activities/operating income; X22 to X27 indicate the ability to withstand market shocks, expressed as owner's equity/total liabilities, total liabilities/total assets, current assets/total assets, net operating cash flow, net operating cash flow, net operating cash flow. total assets, net cash flow from operations/current liabilities, total assets/total shareholders' equity, and current liabilities/total liabilities.

Since the Z model adopts Fisher's discriminant method, and the premise of Fisher's discriminant method is that the data need to satisfy the normality test, so before validating the modified model, we need to test the normality of each variable index. The results of K-S normality test of each variable indicator show that the significance of each of X1, X10, X14, X18, X19, X21, X24 is > 0.05, the normality test meets the requirements, and it can be used to construct a new financial risk early warning model. The rest of the significance are <0.05, and will not be considered in the construction of financial risk early warning model.

3.4. Z-Score model construction

In the Z-Score model formula, only one indicator is selected as an explanatory variable for each capability. Among the selected variable indicators, X1, X10, X14, X18, X19, X21, and X24 represent each ability. The four variable indicators of profitability were combined with the rest of the capability indicators respectively, and there were four combination programs. In order to test whether each program is suitable for discriminant analysis, Wilke Lambda test is conducted respectively, and the test results are shown in Table 1.

Table 1. Summary of Wilke Lambda test results for each scenario

programs	Combination of variable indicators	Wilke Lambda	chi-square	significance
program1	X1、 X10、 X14、 X24	0.613	7.825	0.098
Program2	X1、 X10、 X18、 X24	0.399	14.708	0.005
Program3	X1、 X10、 X19、 X24	0.381	15.458	0.004
Program4	X1、 X10、 X21、 X24	0.54	9.86	0.043

From Table 1, we know that the significance of program1 is more than 0.05, which is invalid, so the discriminant analysis will not consider its correctness of discrimination. The significance of the remaining programs is less than 0.05,

indicating the programs are valid. Summarizing the coefficients of the canonical discriminant function for each scheme yields the discriminant expressions for the Z1, Z2, and Z3 models as shown in Table 2.

Table 2. Discriminant expressions

programs	discriminant expression
Program2	Z1=-2.41X1+2.024X10+3.172X18+4.104X24
Program3	Z2=2.411X1-1.63X10+3.489X21-4.042X24
Program4	Z3=2.848X1-2.381X10+2.18X21-3.274X24

In order to preliminarily screen to get the most accurate financial risk early warning model, the results of actual types

and predicted discriminant types of Program2, Program3 and Program4 are shown in Table 3.

Table 3. Table of actual and projected types

	Actual type	Program2 forecast type		Program3 forecast type		Program4 forecast type	
		1	2	1	2	1	2
count	1	35	1	35	1	35	1
	2	3	2	3	2	4	1
%	1	97.2	2.8	97.2	2.8	97.2	2.8
	2	60	40	60	40	80	20

According to Table 3. the number of actual type 1 in Program 2 is 36, the number of predicted type 1 is 35, and the rate of correct discrimination is 97.2%; the number of actual type 2 is 5, and the number of predicted type 2 is 2, and the rate of correct discrimination is 40%; and the overall rate of correct prediction in Program 2 is 90.2%. The overall prediction rate is 90.2%. The same analysis can be obtained program3, scheme four overall correct prediction rate of 90.2%, 87.8%. Since the overall prediction rate of Program2 and Program3 is higher than that of Program4, the Z1 model of Program2 and the Z2 model of Program3 have the best discriminative effect.

3.5. Z-Score model test

Z-Score model test is based on the initial screening, the second set of financial data as a test, brought into the Program2, Program3, Program4 discriminant, and then come up with the highest rate of discriminatory correctness of the financial risk early warning model. The second set of data were brought into Z1, Z2, Z3, the calculation results can be obtained scheme two and scheme four discriminate the highest correct rate, scheme two Z1 model and scheme four Z3 model discriminate the best effect.

Considering the Z-Score model construction and Z-Score model test conclusions, Scheme II has the highest correct rate, and Z1 model of Program2 has the best discriminative effect. Therefore, the Z1 model will be used as the financial risk early warning model of China's U.S. stock information technology companies, and the model expression is $Z1 = -2.41X1 + 2.024X10 + 3.172X18 + 4.104X24$.

The first and second sets of data are brought into Z1, which results in a maximum value of Z1 of 2.49 and a minimum value of -1.86, so the critical value of the bankruptcy zone of the model with a greater financial risk is -1.86, and the critical value of the safety zone with a lesser financial risk is 2.49.

4. Conclusion

For China's U.S. information technology companies, the Z1 model has a higher correct rate and a better discriminatory effect than the Z-Score model, which has been modified and adjusted in the following three aspects compared with the Z model: (1) Variable indicators. The growth rate of operating

income, gross profit margin, and current assets/total assets are used to replace (undistributed profit + surplus reserve)/total assets, (total profit + interest expense)/total assets, and owner's equity/total liabilities in the original model, respectively. (2) Variable indicator coefficients. The coefficients of the four variable indicators have changed, and the coefficients of the Z1 model expression are -2.41, 2.024, 3.172, and 4.104, respectively. (3) In terms of the interval critical value. The critical value of each interval becomes smaller, the critical value of bankruptcy zone and gray zone changes from 1.1 to -1.86, and the critical value of safety zone and gray go changes from 2.6 to 2.49.

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