Study on Prediction Model of Financial Risk in Chinese Listed Companies

----Based on the Empirical Data From Shanghai and Shenzhen Stock Market

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Abstract::With the development of Chinese stock market,,more and more attentions have been paid to the prediction of financial risk of listed companies. So far, our studies on financial risk prediction model have achieved a lot, but there still existed some faults because of the limitation of surrounding conditions, the most prominent of which was the simplification of variables selection. Theoretically, earnings per share(EPS) can reflect the profitability of firm most, but operating cash flow per share can reflect the quality of EPS most. In addition, firm's cash numbers can be influenced by the change of market and financial environment directly, so we can decide and measure the financial risk through the comparison of cash flow during a certain period. This article expects to make progress on financial risk prediction model by taking cash flow information into account.

Keywords: financial risk, prediction model, factor analysis, stepwise method, logit model, industry difference

I. INTRODUCTION

Since 1966 Beaver put up with the single variable model for financial risk predicting ,the study on financial risk prediction model has been the principle part of financial risk studies step by step, and lots of researchers has devoted themselves to this field. Because of the limitation of conditions, especially of the imperfection of Chinese capital market, we have started much late in studying financial risk prediction model. In 1999, Chenjing has become the first researcher to study financial distress prediction model of listed firms, but the samples selected by her research are limited to 27 listed firms that were specially treated in 1998 in that the policy of special treatment (ST) has just been taken into effect. In recent years, China has issued new accounting system and a series of accounting standards, and there are several batches of listed firms that are ST treated as well, which has asked for the further improvement for prediction model of financial risk.

Moreover, there did exist some statistic faults in Chenjin's research. In 2000, Zhangling selected 60 firms(30 firms with special treatment and 30 firms with good performance) from 160 listed firms, calculated 15 relevant financial ratios, and got a discretionary function with 4 variables finally. Meanwhile ,Gaopeiye et selected non-listed firms in Shenzhen as object to make the study of financial distress, and took whether the firm could pay off the principle and interest of their bank loans at the end of 1997 as criterion. He constructed different models for manufacture firms and non-manufacture firms respectively, took financial data of relevant firms from the financial statement of 1997, and determined the discretionary model for enterprise failure. Wushinong et(2001) took 70 listed firms ST treated from 1998 to 2000 as samples, paired with 70 non-ST firms, and data collecting was extended to the last five years before its ST. Their research has used a lot of study ways, and put up with univariable model and three kinds of multivariable. So far, our studies on financial risk prediction model have achieved a lot, but there still existed some faults because of the limitation of surrounding conditions, the most prominent of which was the simplification of variables selection. Theoretically, earnings per share(EPS) can reflect the profitability of firm most, but operating cash flow per share can reflect the quality of EPS most. At present , the issue of false financial statement for Chinese listed firms is still very serious, and false-makers always focus on how to make false earning numbers. Generally, one of the common ways to discern false financial statement is to investigate the cash flow of firm, because it is much more difficult to distort cash flow than make fake contract for listed firms, sometimes it is even impossible. Cash numbers are the deposit balance on the firm's account, which have to be in line with the deposit balance on the bank's account, so it is very difficult to make false. In addition, firm's cash numbers can be influenced by the change of market and financial environment directly, so we can decide and measure the financial risk through the comparison of cash flow during a certain period. However, the alternative variables used in

current researches of financial risk prediction model were limited to the financial index and financial ration appeared on the annual report, but ratios of cash flow were scarcely used. The main reason is that listed firms have no obligation to prepare cash flow statement until 1998, so the samples would have be not enough if researchers had only focused on the date after 1998. If we used other way to calculate cash flow(cash flow from operating activities= operating profit + depreciation of fixed asset + amortization of intangible asset and deferred asset), it would be not so correct due to a lot of firms did not disclose the information of depreciation and amortization. This article expects to make progress on financial risk prediction model by taking cash flow information into account.

II. CONSTRUCTION OF FINANCIAL RISK PREDICTION RATIOS SYSTEM FOR CHINESE LISTED FIRMS

This article constructs the financial risk prediction ratios system for Chinese listed firms with the core of cash flow information illustrated as table 1, referring to the features of financial risk in Chinese listed firms.

TABLE 1. FINANCIAL RATIO SYSTEM DESIGN

Capability index	Financial ratios & Function	Variable
Capital structure	Debt ratio	X1
	Total capitali-zation to net fixed asset	X2
Liquidity	Current ratio	X3
	Acid-test ratio	X4
	Times interest earned	X5
Cash liquidity and solvency	Cash ratio	X6
	Interest coverage by operating cash flow before interest and tax	X7
	Cash flow to current debt ratio	X8
	Cash flow to total debt ratio	X9
	Cash flow ratio	X10
Effici-ency	Accounts receivable turnover = Net credit sales/average accounts receivable	X11
	Fixed asset turnover	X12
	Inventory turnover = Cost of goods sold/average inventory	X13
	Total asset turnover	X14
	Net asset turnover t	X15
Opera-ting growing	Operating revenue growing rate	X16
	Gross profit growing rate	X17
	Operating income growing rate	X18
ability	Earning before tax (EBT) growing rat	X19
Ptofita-bility	Return on total asset	X20
	Return on equity	X21
	Net profit margin	X22
	Earnings per share	X23
	Gross profit margin	X24
	Operating profit margin	X25
	Operating profit to paid-in capital	X26
	Earnings before tax to paid-in capital	X27
Cash return	Cash return on total asset	X28
	Cash r Return on total capitalization	X29
	Cash return on equity	X30
	Cash flow per share	X31
Cash investment and financing	Cash reinvestment ratio	X32
	Operating investment ratio	X33
	Non-operating investment ratio	X34
	Cash flow from debt financing ratio	X35
	Cash flow from equity financing ratio	X36

III. SAMPLES SELECTION

Starting from the convenience of samples selection, this article selects the ST treated listed firms due to financial abnormalities. First, although Bankruptcy Act has been issued in 1986 ,there are still no listed firms going into bankruptcy to some strict degree, and there is not of significance to take listed firms as samples to study bankruptcy. Second, our stock market put ST treatment policy into force in 1998 for the listed firms with abnormal status, which included financial abnormalities and other abnormalities. Because other abnormalities is of large uncertainties, it is difficult to study it from the point of financial analysis, and it can no represent that the firm is sure to face high financial risk as well. Correspondingly ,the definition of financial abnormalities is much more suitable for the study of financial risk, especially after the further interpretation by stock exchange committee of Shenzhen and Shanghai in the April of 2000. By the 1st July 2010, it is totaled 77 firms ST treated due to financial abnormalities, so this article select these 77 firms as ST samples. This article also chooses 92 normal firms as paired samples according the de definition of Booth(1983) ' the margin between normal firms and financial crises firms is in 40 percent negative and positive'. Then, the samples are added up to 169 firms, from which we retained control samples to predict the accuracy of model. We select 12 firms from 77 ST samples and 22 firms from paired samples totaled 39 firms randomly to form

control samples, other 137 firms left as basic samples. because of the specialty of financial industry, we do not consider these firms.

IV. POSITIVE ANALYSIS

As univariable method concentrates on the analysis of single financial ratio and some general financial ratios are always used as the referring ratios when measuring firms' other aspects , it is much easier to be manipulated subjectively. For example, State Securities Regulatory Commission(SSRC) has been taking ROE(return on equity) as one of the standard to decide whether the listed firm can be endowed with right issuing, so this ratio has been always manipulated by the listed firms. What's more, analysis based on different ratios usually becomes paradox for the complicated relationship among them, and single financial ratio can on afford enough information as well. Based on the preceding, this article directly take the multivariable analysis method and LOGIT regression method but not the univariable method. Considering that it will be too complicated to include all selected variable into LOGIT model and make the effect of different variable more vague, we use factor analysis method and stepwise method to choose variable and find out important variables first to improve the accuracy of model.

A. Factor analysis

Because the variables are overabundance, we use factor analysis method to choose the factors with the significant value exceeding 0.8 among the 36 variables from the fiscal year t-1 to the fiscal year t-3. The results are shown as table2.

TABLE 2 . SELECTED VARIABLES USING FACTOR ANALYSIS METHOD

t-1		t-2		t-3	
Financial ratios					
X2	X21	X2	X17	X3	X9
X3	X22	X3	X20	X4	X20
X4	X23	X4	X21	X5	X23
X6	X24	X5	X23	X6	X25
X7	X25	X6	X27	X7	X27
X13	X27	X7	X29	X11	X29
X14	X29	X11	X30	X14	X30
X15	X31	X13	X31	X13	X31
X9	X32	X14	X32	X14r	X33
X20		X15	X33	X15	
		X16			

B. Stepwise method

After the first selection using factor analysis method, then we use the backward selection procedure to reselect 36 variables from the fiscal year t-1 to the fiscal year t-3. The results are shown as table3.

TABLE 3.SELECTED VARIABLES USING STEPWISE METHOD

t-1	t-2	t-3
Financial ratios		
X3	X2	X21
X13	X21	X33
X23		
X32		

C. Results of Logit model

If we assume that the probability distribution of financial risk belongs to the accumulative probability distribution function of standard Logit, the function of Logit distribution will be as following:

$$Y^* = \frac{1}{1+\exp^{-Z_i}} = \frac{\exp^{Z_i}}{1+\exp^{Z_i}} \tag{1}$$

$Z_i = \beta_0 + \sum_{j=1}^{k} \beta_j X_{ij} + e_i$ represents the probability of financial risk,which is affected by the factor X . Z_i means dependant variable. $Z_i = 0$ means the event will not occur, and $Z_i = 1$ refers to the occurrence of the event. X_{ij} means explanatory variable; β_j means the coefficient of every explanatory variable ; e_i means outliers, which is the independent random variable with the expected value equaling to 0.

Because the value of Z_i is not certain to be between 0 and 1, it is necessary to use Logit distribution to rotate to ensure the probabilities are between 0 and 1 and the model is non-digression function. Then it can be changed as follows:

$$P_i = F(Z_i) = \frac{1}{1+\exp^{-z_i}} \tag{2}$$

P_i means the density of accumulative probabilities.

In this function , there already exist non-linear relationship between P_i and X_i or β , so it can be changed to linear function and the odds ratios representing whether the financial risk will occur as follows:

$$\frac{P_i}{1-P_i} = \frac{1+\exp^{Z_i}}{1+\exp^{-Z_i}} = \exp^{Z_i} \tag{3}$$

After the Logit exchange：

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i = X_i\beta \tag{4}$$

So, it is can be seen that if we change the condition to the odds ratio and make Logit value, then it can be changed into a

linear function. After that, dependant variable becomes the logit of odds ratio and become the linear function of explanatory variable. The bigger the Z_i (intensity of financial risk) is, the bigger the P_i (probability of financial risk)is. After this exchange, we can ensure that P_i will be between (0，1) then.

V .CONCLUSION

In the usage of Logit regression model, we always set cutoff point in the classification, that is to say, if the probability of a certain case is larger than the cutoff point then the event is believed to have taken place, otherwise, the event is not believed to have taken place. The selection of cutoff point will affect the accuracy of model mainly caused by the change of type error1(classify the crises firm as the normal firm) and type error2(classify the normal firm as the crises firm) with the different division. Type 1 errorwill make losses for investors, however type 2 error will lead the investors to give up opportunities, although there are no losses. This article set the 0.5 as cutoff point, if the prediction value is larger than 0.5, then it is classified as crises firm, otherwise, it is classified as normal firm.

A.Before adjusting industry difference

Positive analysis concludes that the cutoff point is 0.4728.In other word, if the effective value is larger than 0.4728, it is classified as risk firm ,otherwise it is classified as normal firm. Table 4 shows that the weight of cash ratio, EPS, Interest coverage by operating cash flow before interest and tax and ROE are 28.04%、27.19%、10.91% and 9.74% respectively.Cash ratio and interest coverage by operating cash flow before interest and tax can reflect the to which degree the firm holds cash, and EPS and ROE can reflect the firm's profitability. First, how many cash the firm are holding represents its solvency . If the firm is insolvent to repay short-term liabilities, then its ability of going-concern will be questioned. So the financial risk has tightly relationship with the funds liquidity. Second, the profitability ratios can predict crises as well. As the table shows, efficiency ratios is of no significance. Moreover, the weight of total capitalization to net fixed asset has occupied 8.5%，which means that long-term solvency is an important sign of financial risk.

Going back to the capability index, we can see that the weight of the index of cash liquidity and solvency tops by 38.95%，the next is the index of profitability with the weight of 7.2%，and the third is the index of cash return with the weight of 10.35%.

B. After adjusting industry difference

The positive result is shown as table 4 after considering the industry relative ratios of Platt & Platt(1990). First, we can see that the

cutoff point is 0.3450 now. Second, we can see that the weight of cash flow per share, cash flow to total debt ratio, Interest coverage by operating cash flow before interest and tax, and Cash reinvestment ratio are 35.77%,13.13%,11.41% and 9.60%repectively. These four ratios are related to cash ,and their explanatory ability are more strong than that before adjusting industry difference. It can be seen that cash is the most important current asset when estimating the financial risk. At last, we look back into capability index, now we can see that the weight of the index of cash return tops by 35.77%，the following are cash liquidity and solvency and profitability respectively. It is noted that the weight of cash liquidity and solvency has dropped from 38.95% to 24.54%.

TABLE 4..POSITIVE RESULT AFTER ADJUSTING INDUSTRY DIFFERENCE

Capability index	Financial ratio	weight
Capital structure	Total capitalization to net fixed asset	0.6%
Liquidity	Current ratio	2.3%
	Acid-test ratio	0.0%
Efficiency	Fixed asset turnover	8.6%
	Total asset turnover	2.0%
	Net asset turnover	0.0%
Profitability	Return on total asset	2.2%
	Return on equity	6.0%
	Net profit margin	6.2%
	Earnings per share	0.0%
	Gross profit margin	0.1%
	Operating profit margin	1.2%
	EBT to paid-in capital	1.1%
Cash return	Cash flow per share	35.8%
	return on total capitalization	0.0%
Cash liquidity and solvency	Interest coverage by OCBIT	11.4%
	Cash ratio	0.0%
	CF coverage ratio to total debt	13.1%
Cash financing	Cash reinvestment ratio	9.6%

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