Study on the Financial Crisis Warning Based on Cash Flow

Shaofang Ding[1], Donglin Wang[2], Yan Wang[3] and Zhe Sun[4]
[1]Beijing Polytechnic, China, 100176
[2]Beijing Polytechnic, China, 100176
[3]Beijing College of Finance and Commerce, China 101101
[4]North China University of Technology, China 100144

***Abstract*—The paper elaborates the value and effectiveness of the model aiming at protect the company in the complex market and provide the effective and timely decision in the minute to minute market.The paper has selected 200 functioned well companies and special treatment companies which are from multiple industries. The paper establishes the financial warning system based on the relevant literature and eliminate the linear effects with the factor analysis. The paper classify the financial performed well company and financial crisis company with logistic regression analysis model and neural network model and construct the model system and verify the model eventually.**

Keywords-logistic regression analysis, RBF neural networ

I. INTRODUCTION

To establish the model of financial crisis warning, there are generally three key elements—index selection, model building and empirical verification. As a large number of annual accounting reports are involved in scandal, more companies have had serious doubts about the data in the balance sheet. Therefore, cash flow indicators draw attention of researchers. Like the blood of enterprises, cash flow is the most active and liquid corporate assets. The paper establishes a financial crisis warning model based on cash flow indicators, which are intuitive and useful to predict the financial position.

II. THE DESIGN AND VERIFICATION OF FINANCIAL CRISIS WARNING MODEL BASED ON THE CASH FLOW

The paper has taken ST and non-ST companies' data as sample data, which is divided into construction samples to build the sample model and verification ones to test the accuracy of the model. First of all, the construction samples are used to construct the sample model as follows: KS test is first used to observe whether the sample data is under the normal distribution. If it is a normal distribution, T-test is used to verify significant differences among financial indicators. But, if it is not a normal distribution, Wilcoxon rank sum test will be used to test significant differences. In this way, the indicators with significant difference can be selected in the ST and non-ST companies. And then, the factor analysis is applied to exclude the linear effects among indicators to look for the final indicators. Next, two financial crisis warning models based on cash flow indicators are respectively set up by logistic regression and RBF neural network. Finally, verification samples will be used to test their accuracy.

A. Sample Selection of Financial Crisis Early Warning Model

The paper chooses 94-ST listed companies and 106-non-ST companies since the cash flow statement was issued in 1998, including such 11 industries as comprehensive industry, wholesale and retail trade, real estate, manufacturing and other industries. In terms of the selection of sample companies, a ST company and its similar non-ST one first will be chosen in order to eliminate the effect of the industry factors in model building.

Next, the amounts of corporate assets the chosen ST and its similar non-ST companies have held will be compared in order to minimize the size effect. Finally, the scale of corporate assets should have the priority over the industry factors if the two factors could not be compatible.

B. Variables Screening

According to the theoretical analysis by Li Bingcheng (2003), cash flow indicators mainly show the ability to obtain cash and the ability to pay, that is, an enterprise should have a certain amount of cash to meet the daily operational needs. Such an enterprise is in danger that it could not cover routine operating expenses or employees' wage settlements even if there is a huge profit. Ability to obtain cash and ability to pay can be subdivided into: 1 solvency, whether a company has enough cash to repay the debt; 2 financial flexibility, whether a company can be flexible to deal with incidental expenses, including to pay shareholder dividends and grab the right investment opportunities; 3 growing ability, whether a company has sufficient funds to expand its scale of operation and business scope. Financial indicators are considered in the paper as follows:

Solvency indicators:

Cash flow ratio = net operating cash flow / current liabilities

All debt ratio = net operating cash flow / total liabilities

Financial flexibility:

Capital acquisition ratio = net operating cash flow / capital expenditures

All cash flow ratio = net operating cash flow / (financing cash outflow + investing cash outflow)

Index of ability to obtain cash:

Total assets ratio = net operating cash flow / total assets

Equity current rate = net operating cash flow / equity

Cash flow structure ratio:

Total outflow structure 1 = operating cash outflow / total outflows

Total outflow structure 2 = cast camp cash outflow / total outflows

C. The Examination of Financial Indicators

1. Normality testing

In this paper, KS test is used to verify whether the distribution among indicators is normal:

TABLE I. STATISTICS (KS TEST METHOD)

	Cash flow ratio	All debt Cash Ratio	capital acquisition ratio	All cash flow ratio	Cash flow ratio of total assets	equity current rate	Outflow structure 1	Outflow structure 2
Kolmogorov-Smirnov Z	1.163	1.441	1.441	.730	1.386	.652	3.214	5.977
Asymptotic significance (bilateral)	.134	.081	.031	.661	.073	.788	.760	.830

The above data shows that only capital acquisition ratio of

The eight indicators is normally distributed (P <0.05). Therefore, The paper cannot construct such models as Z model and F model, whose Indicators should have normal distribution.

2. Mean test of financial indicators

Wilcoxon rank-sum test method is a nonparametric test that can be used to compare indexes whose normal distribution is not clear and two separate paired groups whose variance not equal. If P <0.05, the null hypothesis is rejected, indicating that there are significant differences between the means in the paired groups; when P≥0.05, the null hypothesis is accepted, indicating that there is no significant difference between the means in the paired groups.

Wilcoxon rank sum test finds that the closer it is when ST occurs, the more significant the mean difference of the model indicators will be. In contrast, the longer it is when ST happens, the less obvious the mean difference will be.

III. MODEL BUILDING

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

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A. Logistic Mode

Since the selected financial indicators are not normal, Z value and F value are not suitable to establish early warning models. Therefore, Logistic model is here adopted.

Logistic regression assumptions are:

1. The data must come from random samples.

2. As the dependent variable is assumed to be K independent variables, the relationship between variables and independent variables is non-linear.

3. There is no multicollinearity among the independent variables.

The Logistic regression analysis based on the value of the dependent variable is divided into binary Logistic regression model and multinomial logistic regression model. The dependent variables in this paper come out in the distressed companies and no crisis companies (ST = 1 or ST = 0). In this case, the paper chooses binary Logistic regression model to establish a financial crisis warning model.

The factor analysis is used to construct a common factor for a financial crisis prediction model which can be applied to compute the probability of business financial distress. If P is greater than 0.5, it is indicative that the company has the possibility of financial distress. If the P value is less than 0.5, it is determined that the company is in the normal financial state.

Logistic functional form is:

$$Ln(\frac{p_i}{1-p_i}) = \alpha + \sum \beta_i \mathrm{F}_i$$

$$P = \frac{\exp(a + \sum \beta_i F_i)}{1 + \exp(a + \sum \beta_i F_i)}$$

Among them, means independent variables; is a given independent variable, indicating how probable an incident occurs, is intercept and regression coefficient.

TABLE II. COMPREHENSIVE TEST OF MODEL COEFFICIENTS

		chi-square	df	Sig.
Step 1	Piece	121.357	2	.000
	Model	121.357	2	.000
		121.357	2	.000

TABLE III. VARIABLES IN EQUATIONS

		B	S.E,	Wald	df	Sig.	Exp (B)
Step 1a	FAC1_1	-1.213	.369	10.819	1	.001	.297
	FAC2_1	1.080	.127	72.290	1	.000	2.945
	FAC3_1	.037	.095	.151	1	.697	1.038
	Constant	.210	.092	5.222	1	.022	1.234

Wald test is used to determine the importance of each independent variable. The greater the Wald statistic is or the less the difference is, the more significant the variable is. According to the above results, it is obvious that the second common factor is more important and of greater explanation to the model than the first one:

$$P = \frac{\exp(0.21 - 1.213F_1 + 1.08F_2 + 0.037F_3)}{1 + \exp(0.21 - 1.213F_1 + 1.08F_2 + 0.037F_3)},$$

Which is used to analyze the accuracy of the prediction sample model.

TABLE IV. THE RESULTS OF THE ACCURACY RATE BY LOGISTIC REGRESSION

	Time ST occurs	Prediction	accuracy rate
	4 years before ST		
Correct prediction	1	7	0.58
Error prediction	FALSE	5	
	3 years before ST		
Correct prediction	1	10	0.625
Error prediction	FALSE	6	
	2 years before ST		
Correct prediction	1	14	0.7
Error prediction	FALSE	6	
	1 year before ST		
Correct prediction	1	19	0.79
Error prediction	FALSE	5	
	The year when ST occurs		
Correct prediction	1	22	0.88
Error prediction	FALSE	3	

As can be seen from the above table, the model predicts correctly the risk of financial distress of 22 companies in the year of the occurrence of ST. Its accuracy rate can reach 88%. The prediction of previous year before ST occurs is still higher, with the correct rate of 79%, announcing 19 companies' financial state. 2 years Prior to ST occurrence, 14 companies are accurately foreseen about their financial state, with the rate decreasing to 70%. In the 3 years before ST happens, the model has only 62.5% accuracy rate, predicting the risk of financial crisis of 10 companies. 4 years prior to ST occurrence, the accuracy rate drops to 58%, a total of 7 companies anticipated their financial position. In sum, as the closer it is when ST happens, the higher level the model has; while the longer ST occurrence is, the lower the accuracy rate will be.

B. Artificial Neural Network Model

Input variables in this model are consistent with those of the Logistic regression. There is m001a cash flow ratio, m002a all debt cash ratio, m003a capital acquisition ratio, m010a outflow structure 1 and m011a outflow structure 2. Desired output value is the value of ST. Radial Basis network structure is similar to BP neural network structure, a kind of a three-tier forward network architecture, which consists of an input layer, a hidden layer and an output layer.

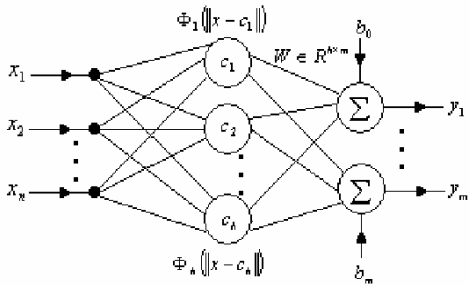

FIGURE I. RBF NEURAL NETWORK STRUCTURE

The above picture is a RBF map of n-h-m structure, where there are N inputs, H hidden nodes and M outputs. Among them, x=(x1,x2,⋯,xn)T∈Rn means network input vector; W ∈Rhxm is output weight matrix; b0, ..., bm represents the output offset unit and y = [y1, ..., ym] T is network output.

The cash flow indicators constructed in Logistic Regression Model are reused to set up RBF neural network model with the same training samples and test samples.

TABLE V. NETWORK INFORMATION

Input layer	factor	1	m001a cash flow ratio
		2	m002a all debt cash ratio
		3	m003a capital acquisition ratio
		4	m010a outflow structure 1
		5	m011a outflow structure 2
		Number of Unit	3392
Hidden layer		Number of Unit	2[a]
		Activation Function	Softmax
Output layer	Dependent Variable	1	ST
	Number of Unit		1
	Rescaling method for scale dependent variables		Standardization
	Activation Function		Identical
	Error Function		quadratic sum

(1) Determined by the standard test data, hidden units' "best" number of training data is to produce the smallest unit of BIC.

TABLE VI. THE RESULTS OF THE ACCURACY RATE BY RBF NEURAL NETWORK MODEL

	Time ST occurs	Prediction	accuracy rate
	4 years before ST		
Correct prediction	1	6	0.5
Error prediction	FALSE	6	
	3 years before ST		
Correct prediction	1	9	0.5625
Error prediction	FALSE	7	
	2 years before ST		
Correct prediction	1	13	0.65
Error prediction	FALSE	7	
	1 year before ST		
Correct prediction	1	18	0.75
Error prediction	FALSE	6	
	The year when ST occurs		
Correct prediction	1	23	0.92
Error prediction	FALSE	2	

As can be seen from the above table, the model predicts correctly the risk of financial distress of 23 companies in the year of the occurrence of ST. Its accuracy rate can reach 92%. The prediction of previous year before ST occurs is still higher, with the correct rate of 75%, announcing 18 companies' financial state. 2 years Prior to ST occurrence, 13 companies are accurately foreseen about their financial state, with the rate decreasing to 65%. In the 3 years before ST happens, the model has only 56.25% accuracy rate, predicting the risk of financial crisis of 9 companies. 4 years prior to ST occurrence, the accuracy rate drops to 50%, a total of 6 companies anticipated their financial position. In sum, as the closer it is when ST happens, the higher level the model has; while the longer ST occurrence is, the lower the accuracy rate will be.

Thus, the RBF neural network forecasting method is better than the Logistic regression model when it is used to predict the financial crisis in the year of ST occurrence. But, it is lower when used to forecast previous years of the financial position, which explains that neural network is less stable and explanatory than the linear model.

IV. Conclusions and Implications of Warning of Listed Companies financial crisis Based on Cash Flow

(1)Cash flow index contains a lot of information forecasting the financial situation. The paper makes use of this information to establish an effective early warning model of financial crisis to help business owners, investors, creditors assess the risk of financial position.

(2)During the establishment of financial crisis prediction model, we find that the current models are built in large multi-index models. We can read from the results of the factor analysis that these 3-4 indicators chosen can cover most of the corporate financial information, while a model with only one indicator covers a small amount of information, where it is likely for the manager to whitewash the target of severe financial crisis. Therefore, we should adopt multivariate models to build financial crisis prediction model.

(3)In selecting indicators, the greater difference does not mean the index is more representative. Before Logistic regression analysis, we conducted a mean test and the factor analysis. In spite of great difference and significance, some variables have evident collinearity with other indicators, which will blur the forecasting accuracy of Logistic regression model. Therefore, we still have to weed out the categories of indicators.

(4)RBF neural network model has a much higher accuracy than Logistic regression model when predicting the probability of one year from the ST, but a much lower accuracy of the prediction farther away from the time of ST occurrence. This explains that the characteristics of neural networks are less stable and poorer in explanation.

(5)The closer the prediction time is to the period of financial distress, the higher the accuracy rate is. On the contrary, the rate is lower and lower.

(6)The paper has conducted financial crisis warning models based on cash flow-related indicators, but does not deny the value and utility of accrual basis. From other aspects, the paper hopes to explore the establishment of the financial crisis early warning models, which is more approximate to the reality.

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