

## 4. RESULTS

This chapter aims at complementing and inspecting the positive analysis in Chapter 3. It takes the main component element in Chapter 3 to achieve the research result by Logistic regression analysis. The result is the forewarning crisis model based on pure financial index and the forewarning model of introducing non-financial index. Then it uses back-judge inspection to inspect the accuracy of the two forewarning models in the predicted result of financial crisis.

### 4. 1 Logistic Regression Analysis

#### 4. 1. 1 Logistic Basic Model Formula

Wikipedia (2018) the basic setup of logistic regression is as follows. We are given a dataset containing N points. Each point I consists of a set of m input variables  $x_{1, i} \dots x_{m, i}$  (also called independent variables, predictor variables, features, or attributes), and a binary outcome variable  $Y_i$  (also known as a dependent variable, response variable, output variable, or class), i.e. it can assume only the two possible values 0 (often meaning "no" or "failure") or 1 (often meaning "yes" or "success"). The goal of logistic regression is to use the dataset to create a predictive model of the outcome variable. As in linear regression, the outcome variables  $Y_i$  are assumed to depend on the explanatory variables  $x_{1, i} \dots x_{m, i}$ .

The basic formula of Logistic model refers to:  $\text{Logit}P = \ln(P / 1-P) = B_0 + B_1X_1 + B_2X_2 + \dots + B_KX_K$ . For briefly expression and the convenient of calculation, the formula can be changed to:

$$P = \frac{e^{(B_0 + B_1X_1 + B_2X_2 + \dots + B_KX_K)}}{1 + e^{(B_0 + B_1X_1 + B_2X_2 + \dots + B_KX_K)}}$$

#### 4. 1. 2 The Logistic Regression Analysis Based on the Pure Financial Index

(1) The last three years (T-3 year) regression analysis based on pure financial index model before financial crisis.

Based on the result of obvious inspection and element analysis in Chapter 4, it takes logical regression to analyze 3 main component elements that is abstracted in T-3 year. This research will set the independent variable of the company has financial crisis as 1 and the independent variable of the company has normal finance as 0. So the smaller rate of occurring financial crisis P value means lower financial crisis. In general research, in condition of the ratio of critical samples and non-critical samples as 1:1, the P value will be

set as 0.5. But in this study, the ratio of critical samples and non-critical samples is about 1:2. Therefore, this study set P value as 0.3. When  $P > 0.3$ , the finance can be normal, conversely, the enterprise has financial crisis, P must be greater than 0.3. Sheet 4.1 to 4.2 refers to Logistic regression analysis result based on pure financial index of T-3 year.

**Table 4- 1: Pure Financial Index – Variables in Equation (T-3 Year)**

		B	S.E	Wals	Df	Sig.	Exp(B)
Step	F1	-1.068	0.45	5.633	1	0.017	0.342
	F2	-2.476	0.828	8.925	1	0.002	0.083
	F3	0.157	0.347	0.208	1	0.651	1.172
	Constant	-1.233	0.371	10.966	1	0.001	0.289

As shown in Table 4.1, the Wals values of F2 profitable competence element and F1 profitable competence element are max, which means the two elements to play a significant function in the model. According to the analytical result of Sheet 5.1, it can be no hard for us to find the forewarning model based on pure financial index of year T-3 is:

$$P = \frac{e^{(-1.233 - 1.068F_1 - 2.476F_2 + 0.157F_3)}}{1 + e^{(-1.233 - 1.068F_1 - 2.476F_2 + 0.157F_3)}} (P < 0.3 \text{ means normal finance, } P > 0.3 \text{ means critical financial situation}).$$

**Table 4- 2: Pure Financial Index – Summary of Models (T-3 Year)**

Step	Negative 2 Log Likelihood	Cox&Snell R Square	Nagelkerke R Square
1	61.815 <sup>a</sup>	0.332	0.468

Table 4.2 is the inspection of degree of fitting of the T-3 year model. The smaller -2 log likelihood means higher fitting degree of the model. The -2 log likelihood based on pure financial index in T-3 year model is 61.815, which means general model fitting degree. The value range of Nagelkerke R is from 0 to 1. When the Nagelkerke R value closes to 1, it has good model fitting degree. The Nagelkerke R value of this study is 0.468. On the whole, above comprehensive fitting degree of forewarning model is not good.

(2) The regression analysis of the model based on pure financial index before two years of financial crisis (T-2 year)

From Table 4.3 to Table 4.4 includes the Logistic regression analytical result based on pure financial index in T-2 year.

**Table 4- 3: Pure Financial Indicators - Variables in the Equation (T-2)**

	B	S.E	Wals	Df	Sig.	Exp(B)
Q1	-5.791	1.85	9.817	1	0.003	0.002
Q2	-2.455	0.731	11.293	1	0.001	0.087
Q3	0.968	1.071	0.814	1	0.367	2.63
Q4	-0.756	0.685	1.221	1	0.27	0.471
Q5	2.271	1.031	4.849	1	0.027	9.699
Constant	-1.775	0.627	8.001	1	0.005	0.171

According to the analytical result of Table 4.3, it can find the forewarning model based on pure financial index in T-2 year:

$$P = \frac{e^{(-1.775-5.791Q_1-2.455Q_2+0.968Q_3-0.756Q_4+2.271Q_5)}}{1 + e^{(-1.775-5.791Q_1-2.455Q_2+0.968Q_3-0.756Q_4+2.271Q_5)}}$$

(P<0.3 means normal finance, P>0.3 means critical financial situation). In this model, the Wals value of cash flow element Q2 is max, which means the element plays a decided role in this model.

**Table 4- 4: Pure Financial Index – Summary of Models (T-2)**

Step	Negative 2 Log Likelihood	Cox&Snell R Square	R	Nagelkerke R Square
1	30.042 <sup>a</sup>	0.565		0.796

Table 4.4 refers to the fitting degree inspection of the model in T-2 year. The -2 log likelihood of T-2 year is 30.042. The model performs general fitting degree, but its model fitting degree result increases in a large number comparing with T-3 year. The Nagelkerke R value in the diagram is 0.796, which increases in a large number comparing with the 0.468 of T-3 year with obviously better fitting degree in T-3 year.

#### 4. 1. 3 The Logistic Regression analysis considering Non-Financial Index

Considering the non-continuity of non-financial index time, the study doesn't abstract the relevant information of non-financial index when analyzing the element analysis. Now it takes the non-financial index of obvious inspection and the abstracted main component element to establish forewarning model with the non-financial index (T3 year) including K<sub>1</sub> (The stock ratio of the first biggest stock holders), K<sub>3</sub> (National stock ratio), K<sub>4</sub> (Z index) and K<sub>9</sub> (Auditing opinion). The indicators related to the T-2 year include K<sub>1</sub> (Share of the largest shareholder), K<sub>3</sub> (Proportion of state-owned shares) and K<sub>9</sub> (Audit opinion).

(1) The Forewarning Model Establishment Introduced Non-financial Index of Last Three Years (T-3 year)

**Table 4- 5: Introduces non-financial indicators. Variables in equations (T-3 Year)**

	B	S.E	Wals	Df	Sig.	Exp(B)
F1	-0.752	0.480	2.435	1	0.121	0.473
F2	-2.421	1.051	5.304	1	0.019	0.089
F3	0.355	0.582	0.393	1	0.529	1.442
K1	0.914	3.282	0.076	1	0.780	2.493
K3	0.188	0.131	2.060	1	0.152	1.207
K4	-0.043	0.033	1.811	1	0.177	0.957
K9	-19.429	12086.962	0.000	1	0.999	0.000
Constant	17.603	12086.962	0.000	1	0.999	44171943.675

According to the study result of Sheet 4.5, it can achieve the Logistic financial forewarning model of comprehensive non-financial index in T-3 year is:

$$P = \frac{e^{(17.603 - 0.752F_1 - 2.421F_2 + 0.355F_3 + 0.914K_1 + 0.188K_3 - 0.043K_4 - 19.429K_9)}}{1 + e^{(17.603 - 0.752F_1 - 2.421F_2 + 0.355F_3 + 0.914K_1 + 0.188K_3 - 0.043K_4 - 19.429K_9)}}$$

By analyzing the Wals value, the profitable element F<sub>2</sub> has the biggest influence in the whole forewarning model.

**Table 4- 6: Introduces non-financial indicators. Model summary (T-3 Year)**

Step	Negative 2 Log Likelihood	Cox&Snell R Square	Nagelkerke R Square
1	41.112 <sup>a</sup>	0.495	0.697

According to the study data of Table 4.6, after comprehensive non-financial index, the -2 log likelihood of T-3 year decreases 20.703 with high model fitting degree. The Nagelkerke R value just increases 0.149 with unchangeable model obvious degree. On the whole, after adding non-financial index, the model fitting effect of T-3 year obviously increases.

(2)The Forewarning Model Establishment Introduced Non-financial index of last two years (T-2 year) Before Financial Crisis

**Table 4- 7: Introduces non-financial indicators. Variables in equations (T-2 year)**

	B	S.E	Wals	Df	Sig.	Exp(B)
Q1	-0.570	2.272	8.369	1	0.004	0.001
Q2	-2.781	1.887	2.174	1	0.141	0.061
Q3	1.791	1.456	1.509	1	0.221	5.989
Q4	-0.962	1.062	0.819	1	0.364	0.385
Q5	2.504	1.263	3.941	1	0.046	12.247
K1	-2.324	5.111	0.208	1	0.651	0.099
K3	0.082	0.041	3.645	1	0.055	1.085
K9	-17.518	11625.575	0.000	1	0.999	0.000
Constant	15.676	11625.575	0.000	1	0.999	6421781.598

According to the study result of Table 4.7, it can achieve the Logistic financial forewarning model of comprehensive non-financial index in T-2 year is:

$$P = \frac{e^{(15.676 - 0.57Q_1 - 2.781Q_2 + 1.791Q_3 - 0.962Q_4 + 2.504Q_5 - 2.324K_1 + 0.082K_3 - 17.518K_9)}}{1 + e^{(15.676 - 0.57Q_1 - 2.781Q_2 + 1.791Q_3 - 0.962Q_4 + 2.504Q_5 - 2.324K_1 + 0.082K_3 - 17.518K_9)}}$$

**Table 4- 8: Introduces non-financial indicators. Model summary (T-2 Year)**

Step	Negative 2 Log Likelihood	Cox&Snell R Square	R	Nagelkerke R Square	R
1	22.025 <sup>a</sup>	0.610		0.869	

According to the study data of Sheet 4.8, after comprehensive non-financial index, the -2 log likelihood of T-2 year decreases 7.992 with higher model fitting degree. The Nagelkerke R value just increases 0.1 with unchangeable model obvious degree. On the

whole, after adding non-financial index, the model fitting effect of T-2 year obviously increases.

#### 4.2 Model regression test

This section selects the relevant data of 15 enterprises having practical financial crisis and 35 logistical enterprises having healthy finance as inspection samples to make confidence test on logical regression model. The final inspection result can be seen in Table 4.9 and Table 4.10.

**Table 4- 9: Retrospective classification test based on pure financial indicator model**

T-3 Year	Observed		Predicted		
			Forecast Situation		Predicted Success Rate
	Failure	Success			
Sample Category	Normal	9	26	74.28%	
	Crisis	3	12	80.00%	
Total Percentage		12	38	77.00%	
T-2 Year	Observed		Predicted		
			Forecast Situation		Predicted Success Rate
	Failure	Success			
Sample Category	Normal	4	31	88.57%	
	Crisis	1	14	93.33%	
Total Percentage		5	45	90.00%	

**Table 4- 10: Comprehensive retrospective classification test non-financial indicator model**

T-3 Year	Observed		Predicted		
			Forecast Situation		Predicted Success Rate
	Failure	Success			
Sample Category	Normal	5	30	85.71%	
	Crisis	3	12	80.00%	
Total Percentage		8	42	84.00%	
T-2	Observed		Predicted		

Year			Forecast Situation		Predicted Success Rate
			Failure	Success	
	Sample Category	Normal	2	33	94.28%
	Crisis	1	14	93.33%	
Total Percentage		3	47	94.00%	

Comparing Table 4.9 and Table 4.10, in the inspection type of not introduced non-financial index establishment, 12 enterprises of 15 enterprises having financial crisis in T-3 year are predicted successfully with 80% accurate ratio. And there are 26 enterprises of 35 healthy logistical enterprises with healthy finance with 74.28% accurate ratio. Finally, the whole accurate ratio of prediction of T-3 year is 77%.

In T-2 year, there are 14 enterprises of 15 enterprises having financial crisis in T-2 year are predicted successfully with 93.33% accurate ratio. And there are 31 enterprises of 35 healthy logistical enterprises with healthy finance with 88.57% accurate ratio. The whole accurate ratio of prediction of T-2 year is 90%.

Summarizing the above studies, the forecast accuracy rate of the enterprises in the financial crisis of the model for the first two years is 13.33 percentage points higher than the previous three years (T-3 year). Comparing the enterprises having healthy finance in T-2 year and T-3 year, it also increases 14.31 percentage points. The whole accurate ration increases from 77% to 90%, which means to increases 13 percentage points. According to the comprehensive back-judge result, it can easily find that the prediction accurate ration of the model based on pure financial index having a big improvement than T-3 year.

After summarizing the non-financial index, the study has confidence test on the data of 50 sample enterprises in T-3 year. The research result shows that the model prediction accurate ratio of the enterprises having financial crisis is 80%, which has no change with pure financial analytical model. The prediction accurate ratio of the enterprises having normal finance increases from 74.28% to 85.71%. The whole accurate rate increases from 77% to 84%. It is obvious that the forewarning model adding non-financial index can improve the prediction competence of the financial situation of the sample enterprises in T-3 year.

As well, after the whole forewarning models summarizing the non-financial index, the study achieves the similar result when inverse calculating the enterprise samples in T-2 year: the model prediction accurate ratio of the enterprises having financial crisis is 93.33%, which keeps the same with the ratio not adding non-financial index. But the prediction accurate ratio of the enterprises having normal finance increases to 94.28%

comparing with 88.57% before adding non-financial index. Its whole prediction ratio increases to 94% after integrating comparing with 90% before.