Application of Company Financial Crisis Early Warning Model- Use of "Financial Reference Database"

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Abstract—In July 1, 2007, Taiwan Stock Exchange (TWSE) on market observation post system (MOPS) adds a new "Financial reference database" for investors to do investment reference. This database as a warning to public offering companies listed on the public financial information and it original within eight targets. In this paper, this database provided by the indicators for the application of company financial crisis early warning model verify that the database provided by the indicator forecast for the financial crisis, whether or not companies have a high accuracy rate as opposed to domestic and foreign scholars have positive results. There is use of Logistic Regression Model application of the financial early warning model, in which no joined back-conditions is the first model, joined it in is the second model, has been taken occurred in the financial crisis of companies to research samples and then business took place before the financial crisis point with T-1 and T-2 sample data to do positive analysis. The results show that this database provided the debt ratio and net per share for the best forecast variables.

Keywords—Financial reference database, Financial early warning model, Logistic Regression.

I. INTRODUCTION

TAIWAN'S Financial Supervisory Commission (TFSC) in August 1, 2002 to require disclosure of the issue since reunification should notice and declaration of the company's financial information, and this information to declare the site on public Information observatory. In July 1, 2007, TWSE on MOPS adds a new "Financial reference database" for investors to do investment reference. This database as a warning to public offering companies listed on the public financial information and it original within eight targets but in September 1, 2008 to create an indicator of the nine indicators built into the existing financial early warning system. However, "Financial reference database" by the financial early warning model used to predict the variables are different domestic and foreign scholars, therefore this study was to test the database want to construct indicators for listed companies in Taiwan's financial early warning model of whether there is more high predictive power.

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Research purposes of this study are three: (1) "Financial reference database" within the indicator information is forecast to have a high degree of Taiwan's listed companies for the future accuracy of the financial crisis. (2) This database provided by the indicators of the warning indicators which took place for the company's future financial crisis is more highly significant. (3) Over the same period and cross-period sample comparison to find out the optimal prediction model.

II. LITERATURE REVIEWS

A. Defined Company Financial Crisis

[2] In 1966 to bring up companies in bank account within a large overdraft funds, the priority is not to pay dividends and corporate debt default, are all summed up as companies have a financial crisis. [1] Consider that the companies's financial crisis is that the law of each country's bankruptcy and restructuring. [4] Consider that at the closure, there is no ability insolvent, or for benefit of creditors have been liquidated liquidation of the company for the financial crisis. [6] Explain distinguish between enterprise crisis five stages: (1) financial stability (2) does not release or reduce the dividend payment of dividends, (3) financing loan default, (4) enterprise applications to the court of bankruptcy, (5) the court bankruptcy and liquidation. Comprehensive survey above, the definition of company financial crisis can be divided legal aspects and the process with the crisis.

B. "Financial Reference Database"

"Financial reference database" is the each company input financial information in MOPS, if any false information by the company responsible by law. This database only MOPS disclosed the information to make a financial focus of the entire department to facilitate users to query information and to remind investors to achieve the effect of attention. In order to strengthen the TWSE and OTC information to expose and enhance public Information observatory information expose effectiveness, TWSE since July 2, 2007, the MOPS to add "Financial reference database" announced the relevant finance department of the entire hearing for the convenience of investor's attention to recent financial problems.

C. Company Financial Crisis Early Warning Model

1) Univariate data model

[2] Proposed the first to use univariate data model proposed early warning model of company financial crisis, the sample data for 1954-1964, total of 11-year period, the crisis from all 79 companies randomly selected for the sample companies, and then to 1:1 for a sample of companies to find the same industry, similar to the normal size of the company as a financial crisis compare companies matching samples. Its research results showed that cash flow/total liabilities to predict the best indicator of company crisis followed by net after-tax profit/total assets and net income/total assets.

2) Multivariate discriminate analysis model

[1] Use of multivariate analysis methods to construct a financial crisis early warning model to enhance the univariate data analysis method deficiencies. He in 1946 to 1965 for the study period, a total of two decades, according to the company's industry and the size of randomly selected samples matching similar conditions, a total of 66 selected enterprises. Financial crisis are 33 companies. This research related to the company's 22 financial ratios. The study results showed that the five most predictive powers of financial ratios, for working capital/total assets, retained earnings/total assets, pretax income before the net profit/total assets, rights and interests of the market value/total liabilities, sales revenue/total assets better forecast variables.

3) Logistic Regression Model

[7] Is the first to use Logistic Regression Model to create a financial crisis early warning model. He selected 25 financial ratios as independent variables, respectively, the forecast financial crisis two years ago the chances of companies may collapse. In fact, evidence showed that net profit/total assets, operating expenses/operating income, commercial loans/total loans, bad debt/operating profit, total assets/risk of the assets of the five financial ratios for the enterprise's financial crisis had significant predictive power.

[9] Subsequently the use of Logistic regression model future to establish the distinction between financial crisis forecast model, the study period from 1970 to 1976 for a total of seven years in the United States listed companies samples, to exclude public utilities, transportation companies, the Pan-financial industries were selected by the financial crisis in 105 companies and 2,058 for the study of normal samples in order to do the matching ratio of 1:19.6. Its final use of empirical results also proved that the establishment of binary Logistic regression model of enterprise financial Crisis Prediction Model for the interpretation of the capacity is indeed better than Altman used the difference between multivariate analyses.

[13] also use Logistic Regression Model to explore business cash flow, free cash flow-to-business impact of financial crisis, Amman, Jordan, selected sample of listed companies to 1989 to 2003, the total of 196, empirical results, free cash flow and cash flow increased to reduce the probability of failure will increase the enterprise; the financial structure of enterprise financial crisis for predicting important dimensions.

4) Model of others

[14] distinguish between the use of Probit Model future financial difficulties of companies and normal company, [10] adopted by the types of Neural network analysis compared the difference between the sub-types of the correct rate; [5] using Neural network model and Probit Model, to 1978 to 1985 financial crisis between the 165 companies in the same industry, select the size of the company close to financial normal samples matching for 1:1, explanatory variables for the crisis in the company, and quick ratio, equity market value/total assets, debt ratio, pre-tax income before the net profit, return on assets, retained earnings/total assets of six. Research results showed that neural network model to predict the crisis better than Probit model.

[12] To CUSUM time series model is applied to company's financial crisis early-warning mode. Use from 1970 to 1980 between the U.S. manufacturing and retail companies, the selected samples of the premise for the need to have 20 years of complete financial information, and finally took out the financial crisis in 62 companies and 197 financial and normal samples for research to explain the variable to fixed assets/total assets, net of working capital/total assets, earnings per share/per share price, with a total inventory/sales, operating income/total assets of five. The study concluded that the financial crisis and financial companies of the financial characteristics of normal company there were significant differences to the model constructed by CUSUM highly predictive capability.

[11] Proposed by DEA-DA model. DEA-DA model combining understand the difference between analysis and goal programming, this is data envelopment analysis (DEA; Data Envelopment Analysis) an analysis method.

Comprehensive survey above, this study used Logistic Regression Model Construction of company financial crisis early-warning model Logistic distribution, since the number of variables affect the contingency approach is based on the index approach to changes that do not have a Logistic Regression Model in line with the normal distribution assumption. Logistic Regression Model in the analysis, since the variables for Category Variable, also available for continuous variables. In addition to this study used "Financial reference database" Since the variables for a single point in time variable, will use the Logistic Regression Model for the financial crisis as the basis of predictive analysis.

III. Sample Data and Research Methods

A. Sample Data

In this study, samples from Taiwan Economic Journal Data Bank (TEJ) of the definition of default companies database, the sample period from 2004 to 2008 and a total of five years. Select the TWSE public offering and the financial crisis has occurred has a total of 90 samples, comparing samples taken 1:1 matching, and in order to avoid the sampling error, the study on normal company mining companies and financial

crisis in the same industry categories, similar to the size of to randomly selected and the selection, so the total sample of this study for 180.

This study use Logistic Regression Model construction of company financial crisis early warning model, Dependent Variable for 0 or 1. When it is 0, the companies as the normal operation of financial companies; when it is 1, this business is in TEJ is defined as companies with financial crisis. Independent Variable is "Financial reference database" for investors to do investment reference, have 9 items. Respectively with T-1 and T-2 period the sample data to a separate model with the model I and II. Model I without adding backward Conditional logistic regression analysis; Model II to join backward Conditional logistic regression analysis.

B. Logistic Regression Model

Logistic Regression Model Analysis of the samples before the data do not obey normal assumption, and there is no collinearity between variables such issues, but the diagonal covariance matrix to be equal with the residual distribution of items subject to Weibull, the reaction function of ideology for the curve shape, was S or inverted S, while the number of the estimated value of the Dependent variable will not be located in the (0,1) outside. Therefore, this study Dependent variable for company financial crisis (set to 1) or normal operation of enterprises Corporation (set to 0); since changed the number for the "Financial reference database" provided by factors. Logistic Regression Model is as follows:

P that some events so that the chances of success, it is subject to the impact of factors x.

$$P = \frac{e^{f(x)}}{1 - e^{f(x)}} \quad (1)$$

$$f(x) = \alpha + \sum_{i=1}^{k} \beta_i x_i \quad (2)$$

Its failure probability for the:

$$1 - P = \frac{1}{1 - e^{f(x)}} \quad (3)$$

By (2) and (3) calculate of odds ratio

$$\frac{P}{1 - P} = e^{f(x)} \quad (4)$$

(4) Is expressed as the odds ratio of an event, and its significance for the incident rate of success probability of accounting for the incident intensity unsuccessful. Then both sides of the same from the natural logarithm (*ln*), the odds ratio in the form of linear equations, the results are as follows:

$$\ell n \frac{P}{1 - P} = f(x) = \alpha + \sum_{i=1}^{k} \beta_i x_i \quad (5)$$

$f(x)$: When $f(x) = 0$, normal operation of companies; When $f(x) = 1$, companies financial are in a crisis.

x_i: "Financial reference database" in the reference index.
α: Intercept of the total forecast model.
β_i: The reference index of the slope.

And follow-up to compare the probability of the event, shall be the formula (5) the results of both sides at the same time of *e* reversal in exchange for the formula (4) that form the odds ratio for comparison. Model II for backward conditional Logistic Regression Model, the definition of the other variables remain unchanged under a variable significant when greater than 0.1 to remove their variables, this approach is to delete the study model is not significant variables.

IV. EMPIRICAL ANALYSIS

A. Model of whether to Join the Backward Conditional Logistic Regression Cross-Data Empirical Comparison

1) Are not parties to backward Conditional Logistic Regression Model-A1 A3 model

First, observe the model from Table I of the overall model Nagelkerke R^2 total variance can be added to the independent variables explained by the degree of variation in, A1 and A3 models were 0.599 and 0.306 on samples observed in this study data has not been back conditions When logistic regression-type, T-1 period information in relation to T-2 period information is whether the company to predict the financial crisis took place more significant explanatory power; more crisis around the company's de facto information, the more able to predict a company the possibility of a crisis. The total model fit Hosmer & Lemeshow test in Table I, A1 and A3 model fitness test values were 0.612, 0.768 that A1 and A3 model observed samples to predict whether the company is a financial crisis occurred in the prediction model for the construction.

From Table I are not parties to observe the conditional logistic regression back when, A1 and A3 model forecasts more accurate, the total rates were 83.3%, 69.4%, the findings also show that more observation samples near the financial crisis that occurred at the reference time-point, regardless information for the year, quarter or more information on the company to predict whether there is fat in the future into the possibility of financial crisis.

2) Adding backward conditional Logistic Regression Model-A2 A4 model

Model by adding backward conditional logistic regression for the A2 and A4 models, mainly with the deletion of the A1 and A3 models do not observe significant variables to explain the variables to predict the company's financial crisis significant. Table I Observation model Nagelkerke R^2 overall model can be added to the total variance of the variables explained the variation in the degree, A2 and A4 models were 0.583, 0.264 that observed in this study samples of the information through another backward conditional logistic return, T-1 period information in relation to T-2 period information to predict whether the company or a financial crisis occurred in a more significant explanatory power. This results show that, regardless of whether or not to join backward model conditional logistic regression, the more

close to the company's point of crisis information, the more the company can predict the possibility of a crisis. The total model fit Hosmer & Lemeshow test in Table I A2 and A4 models fitness test values were 0.797, 0.949, A2 and A4 models that observed in the samples to predict whether the company is a financial crisis occurred in the prediction model for the construction.

From Table I observation model by adding back after conditional logistic regression, A2 and A4 models predict accurately the total rates were 82.2%, 69.4%, to observe once again that the more samples near the company's de facto financial crisis, whether for In information, season information or on information than can be identified with the official forecast that the company in the next whether there is any fat into the possibility of financial crisis.

B. To Join or not Join the Backward Conditional Logistic Regression in the Same Period of Empirical Comparison

1) T-1 period model Empirical Comparison-A1 A2 model

T-1 period logistic regression model for the A1 and A2 model, A1 and A2 model to build the main model for the A1 to delete variables in the prediction model of the company's financial crisis is not a significant variable in the A1 model significant variables observed significant level greater than 0.1, the deletion of the A1 model, X_5, X_6, X_8, X_9, X_{10} total of five variables.

Observe the model from Table I of the overall model Nagelkerke R^2 total variance can be added to the independent variables explained by the degree of variation in, A1 and A2 model 0.599, 0.583 respectively on samples of the Institute of observation data, A1 model of observation information in relation to A2 model to predict whether the financial crisis took place more significant explanatory power, but the results occurred mainly because the A2 model of observation, only six variables, the deletion of the five variables, only to observe a decrease of the total variance explained 1.6%; while the A1 model of observation more than five variables, only to explain the variation of the total increase of 1.6% of explanatory power, which can illustrate the five variables in the forecast model of the company's financial crisis is not significant, the empirical results with The results of this study was in line with forecasts.

The total model fit Hosmer & Lemeshow test in Table I, A1 and A2 model fitness test values were 0.612,0.797 that A1 and A2 model observed samples to predict whether the company is a financial crisis occurred in the prediction model for the construction.

From Table I observation period T-1 model is not a significant variable deleted under, A1 and A2 model forecasts more accurate, the total rates were 83.3%, 82.2%, the empirical results with samples Nagelkerke R^2 total variance for the ability to explain the interpretation of results the same. The empirical results indicate the A2 model is mainly due to the remaining six observation variables observed in the deletion of the five variables, only to decline in the overall prediction accuracy rate of 1.1%, the empirical results with the results of this study was in line with forecasts.

Then observe the A1 model of type I error is 17.8%, Type II error is 15.6%, with a total of forecasting accuracy rate of 83.3%. In the A2 model, the total prediction accuracy rate of 82.2% over the total A1 model forecasts more accurate, lower in type 1 error and type II errors were part of 16.7% and 18.9%. Type I error is the actual occurrence of the financial crisis the company is forecast to be normal operating companies; Type II error is the actual operating company is a normal occurrence of financial crisis is forecast to the company. Comparison of two models of the type I and type II error was found; A2 model of type 1 error higher than the A1 model of type 1 error, note A1 model is more suitable as a crisis A2 model's forecasting model.

2) T-2 period model Empirical Comparison-A3 A4 model

T-2 period logistic regression model for the A3 and A4 models, A3 and A4 models to build the main model for the A3 to delete variables in predicting the company's financial crisis is not a significant variable model, in the A3 model observed variables significantly large in a significant level of 0.1, the deletion of the A3 model X_1, X_3, X_4, X_6, X_7, X_8, X_9, X_{10} eight variables.

Table I observation model Nagelkerke R^2 overall model can be added to the total variance of the variables explained by the degree of variation in, A3 and A4 models were 0.306, 0.264 that observed in this study samples of the information, A3 model observations compared with the A4 model to predict whether the financial crisis took place more significant explanatory power, however, occurred mainly because of the results of A4 model observation only three variables, the deletion of the eight variables, only to observe a decrease of the total explained variation 4.2%; and A3 models to observe more than eight variables, only to explain the variation of the total increase of 34.2% of the explanatory power, there is no substantial increase in the ability to explain the variability, indicating the eight variables in the forecast model of the company's financial crisis not significant, the empirical results with the results of this study was in line with forecasts.

The total model fit Hosmer & Lemeshow test in Table I, A3 and A4 models fitness test values were 0.768, 0.949 on A3 and A4 models observed in the samples to predict whether the company is a financial crisis occurred in the prediction model for the construction.

Table I observation periods Model T-2 is not a significant variable deleted under, A3 and A4 models are the total forecast 69.4% accuracy rate, the empirical results with the Nagelkerke R^2 samples for the total variance explained in the ability to explain the same result. The empirical results indicate the A4 model is mainly due to observation of the remaining three variables; the deletion of eight observed variables did not decline after the model of the total forecast accuracy. Then observe the A3 model of type 1 error and type II errors were 31.1% and 30.0%, with a total of forecasting accuracy rate of 69.4%. In the A4 model, the total prediction accuracy rate of 69.4%, type 1 error and type II errors were 33.3% and 27.8%. A4 model in this type of error is higher than an A3 model of type 1 error, note A3 model A4 model more suitable for the crisis as the company's forecasting

model, the empirical results is not in line with the forecast results of this study.

The empirical results of this study will be grouped into the following findings: (1) The "Financial reference database" provided a reference indicator really can predict the future of Taiwan's listed companies is the probability of occurrence of financial crises. (2) T-1 sample period information to predict the financial crisis in the company's total forecast accuracy is better than T-2 sample data period. (3) Backward conditional logistic regression to delete the variables are not significant, the overall prediction model does not significantly improve the fitness and Nagelkerke R^2 and total accuracy rate forecast also no significant upgrade. (4) Within this area the best predictor for the X_2 and X_{11}, respectively, with net per share and net debt ratio.

TABLE I
EMPIRICAL RESULTS

Model	A1	A2	A3	A4
Time-point	T-1	T-1	T-2	T-2
Nagelkerke R^2	0.559	0.583	0.306	0.264
Hosmer & Lemeshow P-value	0.612	0.797	0.768	0.949
The total forecast probability	83.3%	82.2%	69.4%	69.4%
Type I error	17.8%	16.7%	31.1%	33.3%
Type II error	15.6%	18.9%	30.0%	27.8%

Cut point: 0.5

V. CONCLUSION

With the progress of the times caused by the improvement of national income, the public financial management autonomy of investment has already become a trend, but the vast majority of investors on the investment target for the stock market. In view of this, the TWSE for investors to set up counters listed companies "Financial reference database" for investors to do investment in the reference standard. The purpose of this study on the response to this "Financial reference database" provided by the investment benchmark, as forecast whether the company's model of financial crisis occurred, verify that the area to predict whether the financial crisis occurred in the exact capacity. Empirical results, "Financial reference database" provided in the reference index for predicting Taiwan indeed listed company's financial problems are helpful, for investors with a reference value. The empirical results with the domestic and foreign scholars have put forward the results are generally consistent results are as follows: (1) The more the more recent data to predict the trading company's current financial situation, (2) In addition to the overall forecast accuracy, the type I error is Construction of the company's financial crisis, the focus of the model analysis, if there can be high-impact type of a high and low error indicators are worth watching more factors, (3) Net per share and debt ratios in this study as the best forecast variables.

APPENDIX

APPENDIX I
FINANCIAL REFERENCE DATABASE INDEX

Index	Content of index
1	Transaction a change or to stop the sale of those.
2	The most recent financial report net earnings per share lower than the ten-dollar and after the listing of the most recent three consecutive annual losses from.
3	The most recent financial report net earnings per share lower than the ten-dollar and 60% higher than the debt ratio and liquidity ratio is less than one.
4	The most recent financial report net earnings per share lower than the ten-dollar and the last two years and the most recent of net cash flows from operating activities were all negative.
5	Recently month of all directors, supervisors and holding more than 10% the number of major shareholders holding a total mortgage rate of more than 90%.
6	Recent month loan with others in the balance of funds accounted for the most recent financial report net rate of more than 30%.
7	The recent endorsement of the month to ensure that the balance of the most recent financial report accounting for the net rate of more than 150 percent
8	Director, Supervisor, held for three consecutive months into less than.
9	TWSE composite other considerations should be made public.

Source: MOPS

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