The Study on Corporate Financial Distress Forecasting Model: An Application of Dynamic Distress Threshold Value

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Abstract

In this study, we have employed factors such as Financial Ratios, Corporate Governance variables and Intellectual Capital to construct a financial distress forecasting model by Logistic Regression. The data consists of 54 electronics companies listed in Taiwan Stock Exchange (TSE) and Over the Counter (OTC) during year 2012 to 2015 to be our observation samples. 18 companies out of the 54 has been financially distressed in 2015. Instead of the traditional one-half criteria (the probability of success is 0.5), we adopted the criteria of the Dynamic Distress Threshold Value (0.01~0.99) to improve the maximizing prediction accuracy of model. In empirical results, we have found out the maximizing prediction accuracy (MPA) will be higher with Dynamic Distress Threshold Value than the Tradition (threshold value =0.5) model. This study has also found that the prediction accuracy would be even higher after including Intellectual Capital into our prediction model.

Key Words: Financial distress, intellectual capital, dynamic distress threshold value.
1. Introduction

The recent financial markets have developed improvement, but there were many hidden crisis. Such as the 2000 Internet bubbles, the 2008 financial tsunami, the 2011 European debt crisis. Many companies encountered a financial distress. It often results in substantial loss of investors. Therefore, we would build a corporate financial distress model. In Taiwan, the electronics industry contributes about 60% of the total exports. The electronics industry has a great influence on the economy in Taiwan. Intellectual Capital was to be valuable factor of electronics industry since that professional know-how and expertise employee contributes greatly to the competitiveness of electronic companies. Some previous literature only adopted Financial Ratio and Corporate Governance to be important factors of financial distress warning system. This study will further more to include Intellectual Capital to be another important factor. Intellectual Capital consists three parts - human resource capital, structural capital and customer capital. These three parts shall cover four different variables which are human resource capital -sales per employee and equipment per employee, structural capital - operation expense ratio and customer capital - sales growth ratio. The purposes of this study, one is to improve the prediction accuracy of the model by adding the Intellectual Capital. Second, we attempt to maximize the prediction accuracy of the financial distress model through introducing the criteria of the Dynamic Distress Threshold Value.

2. Literature Review

The definition of a financial distress firm is the company with bankruptcy, bond default, an overdrawn bank account, and nonpayment of a preferred stock dividend, reduction in the principal and interest or change in the full delivery of shares (Beaver, 1966¹; Deakin, 1972²; Lee and Yeh³, 2004; Ohlson⁴, 1980).

³Lee, T.S., Yeh, Y.H., Corporate Governance and Financial Distress: Evidence from Taiwan. Corporate Governance, 12(3), 378-388; 2004
Stewart\(^5\) (1997) proposed that Intellectual Capital is the sum of all the knowledge and ability of each employee and team to bring the company a competitive advantage. Masoulas\(^6\) (1998) pointed out that Intellectual Capital is the sum of all the intangible assets, so that the products provided by the enterprise have a more added value. Chen\(^7\) (2001) empirically showed that Intellectual Capital, knowledge, experience, ability, wisdom and innovation have relationship.

Beaver (1966) employed the single variable model to construct the financial early-warning model, the paper obtained 79 financial distress firms during the periods from 1954 to 1966, the result found "cash flow / total liabilities" to be the best forecast. Using financial ratio to construct the logistic regression model, Ohlson (1980) empirically found business size, financial structure, business performance and liquidity are useful variables. Shleifer and Vishny\(^8\) (1997) confirmed that when the major controlling shareholders have the ability to effectively dominate the company, their decision would affect the interests of other smaller shareholders. Claessens et al\(^9\) (2000) found that many controlling shareholders of the listed companies use pyramid structure, cross-shareholding and other methods to increase their voting rights of the company to achieve the purpose of controlling the company. Lin et al\(^10\) (2010) have shown that with the chosen corporate governance, the prediction model provided higher prediction accuracy. Liang et al\(^11\) (2016) and their study results shown that the Financial ratios categories of solvency and profitability and the corporate governance categories of board structure and ownership structure are the most important.

\(^10\)Lin, F., Liang, D., Chu, W.S. The Role of Non-Financial Features Related to Corporate Governance in Business Crisis Prediction. Journal of Marine Science and Technology, 18(4), 504-513; 2010
features in bankruptcy prediction. Sullivan\textsuperscript{12} (2000) found that the distinction between human capital and Intellectual Capital is particularly important for the owner of a knowledge-based company. Lee and Tang\textsuperscript{13} (2004) found that the Intellectual Capital can improve the financial distress model forecasting ability. Liang et al\textsuperscript{14} (2005) found that the efficiency of model could be improved by using the criteria of dynamic distress threshold value.

\section*{3. Empirical Methodology}

This paper has collected samples from the period of 2012 to 2015 in Taiwan Stock Exchange (TSE) and Over the Counter (OTC) listed electronic industries in Taiwan. Based on the logistic regression model, this paper uses the data of 2012, 2013 and 2014 for observation period to determine whether a company is a financial distress company or a financial normal company in 2015. The following definitions of financial distress company are given by Taiwan Economic Journal (TEJ) to distinguish financial crisis companies, bounced cheque, bankruptcy, CPA comments, restructuring, relief-financial distress, take-over, full-cash delivery stock, finance tight or net negative. In 2015, there are 18 financial distress companies provided by TEJ and otherwise, we have taken another 36 normal companies with similar size to for comparison.

In our study, the logistic regression model was established. If the company is financial distress then \( Y \) is set to “1” and otherwise, \( Y \) is set to “0”. The independent variables consist of Financial Ratios (including current ratio (CR), debt ratio (DR), average collection turnover ratio (ACTR), fixed asset turnover ratio (FATR), net profit margin (NPM), and cash reinvestment ratio (CRR)), Corporate Governance factors (Stocks Holding ratio by directors and supervisors (SHRDS), Intellectual Capital factors (including sales per employee (SPE), equipment per employee (EPE), operating expense ratio (OER), sales growth rate (SGR)).

This paper has selected 11 variables from Financial Ratio information, Corporate Governance, and Intellectual Capital to examine the significance of financial crisis companies and financial normal companies by using t test from each observation year.

Most of the data presented are significant in Table 1, which indicating it is feasible to identify the company as financial distress company or financial normal company.

Table 1 The Differences Analysis in Financial Structures between Financial Crisis Companies and Financial Normal Companies

<table>
<thead>
<tr>
<th>Classification</th>
<th>Variables</th>
<th>Companies</th>
<th>2014</th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Ratios</td>
<td>CR</td>
<td>FNC</td>
<td>208.556</td>
<td>127.408</td>
<td>201.774</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>FCC</td>
<td>97.505</td>
<td>116.905</td>
<td>105.653</td>
</tr>
<tr>
<td></td>
<td>ACB</td>
<td>FNC</td>
<td>1126.844</td>
<td>2928.928</td>
<td>798.413</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>FCC</td>
<td>398.667</td>
<td>639.763</td>
<td>232.236</td>
</tr>
<tr>
<td></td>
<td>SGR</td>
<td>FNC</td>
<td>33.573</td>
<td>67.752</td>
<td>22.753</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>FCC</td>
<td>-42.543</td>
<td>153.938</td>
<td>-13.186</td>
</tr>
<tr>
<td>Corporate Governance</td>
<td>SHRDS</td>
<td>FNC</td>
<td>2.281</td>
<td>2.900</td>
<td>2.433</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>FCC</td>
<td>0.993</td>
<td>1.771</td>
<td>0.481</td>
</tr>
<tr>
<td>Intellectual Capital</td>
<td>SGE</td>
<td>FNC</td>
<td>0.993</td>
<td>1.771</td>
<td>0.863</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>FCC</td>
<td>1.174</td>
<td>2.876</td>
<td>1.289</td>
</tr>
</tbody>
</table>

Note: FNC is financially normal company, FCC stands for financial crisis company. ",", "***", "****" denote that these are significantly different from 0 under the significance level of 10%, 5%, 1%, respectively.

The logistic regression model is stated as follows.

\[
\ln \frac{p}{1-p} = \alpha + \sum_{i=1}^{n} \beta_i X_i \quad (1)
\]

Where \( p = p (Y = 1) \), \( 1-p = (Y = 0) \), Y is 1 for the financial distress company, Y is 0 for the financial normal company, \( X_i \) represents independent variable, \( n \) is the number of independent variables.

An optimal model could accurately forecast a company with a financial distress. According to a logistic regression model, usually using a fifty-fifty rule (0.5) as the threshold value, that any company with \( p \) value larger than 0.5 would be identified as a possible financial crisis firm. Otherwise it would be considered as a financial normal firm. This study of the Dynamic Distress Threshold Value
constructs 99 threshold values from 0.01 to 0.99 in order to maximize the prediction accuracy of the model. In logistic regression model, predictive accuracy can be done using a Classification Table (Chen et al. 2005). In Table 2, Samples A and D are the correct number of the observations, B and C are the wrong number of the observations. The Overall Correct Percentage is \( \frac{A + D}{N} \times 100\% \), \( N = A + B + C + D \).

<table>
<thead>
<tr>
<th>Item</th>
<th>Predicted Samples</th>
<th>Correct Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed</td>
<td>1 (financial crisis)</td>
<td>0 (financial normal)</td>
</tr>
<tr>
<td>1 (financial crisis)</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0 (financial normal)</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Overall Correct Percentage</td>
<td>( \frac{A + D}{N} ) \times 100%</td>
<td></td>
</tr>
</tbody>
</table>

The maximizing prediction accuracy of model is as follow.

Maximizing Prediction Accuracy \( (p) = \sum_{i=1}^{N_1} I_j \left( \frac{e^{\sum_{j=1}^{N_1} \beta_j x_{ij}}}{1 + e^{\sum_{j=1}^{N_1} \beta_j x_{ij}}} > p \right) + \sum_{j=1}^{N_0} I_j \left( \frac{e^{\sum_{j=1}^{N_0} \beta_j x_{ij}}}{1 + e^{\sum_{j=1}^{N_0} \beta_j x_{ij}}} < p \right) \) \( (2) \)

Where \( p \) is Dynamic Distress Threshold Value, \( I_j \) is indicator function. If \( \frac{e^{\sum_{j=1}^{N_1} \beta_j x_{ij}}}{1 + e^{\sum_{j=1}^{N_1} \beta_j x_{ij}}} > p \), it is financial distress company. If \( \frac{e^{\sum_{j=1}^{N_1} \beta_j x_{ij}}}{1 + e^{\sum_{j=1}^{N_1} \beta_j x_{ij}}} < p \), it is financial normal company. \( x_i \) is the explanatory variable of the financial distress company \( i \), \( x_j \) is the explanatory variable of the financial normal company \( j \), \( N_1 \) is the total number of financial distress companies, \( N_0 \) is the total number of financial normal companies, \( N \) is \( N_1 \) plus \( N_0 \).

4. Empirical Results

This paper has constructed two logistic regression models. Model I selected financial ratio and corporate governance with a total of 7 independent variables. Model II selected financial ratio corporate governance and Intellectual Capital factor with a total of 11 independent variables. The purpose of this research is to determine whether or not taking in Intellectual Capital factors would be able to improve our financial crisis early warning model. The empirical results from

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Model I and Model II (Fig 1~6), we could find out the maximizing prediction accuracy (MPA) would be higher in the model with Dynamic Distress Threshold Value than those on the basis of the Tradition Threshold Value (0.5). This study has also found that the prediction accuracy would be even higher after including Intellectual Capital into our prediction model.

**Model I: Financial Information + Corporate Governance**

![Fig. 1: The Year before the Crisis](image1)

![Fig. 2: Two Year before the Crisis](image2)

![Fig. 3: Three Year before the Crisis](image3)

**Model II: Financial Information + Corporate Governance + Intellectual Capital**

![Fig. 4: The Year before the Crisis](image4)

![Fig. 5: Two Year before the Crisis](image5)
5. Concluding Remarks

In this study, we have taken 54 electronics companies listed in TSE and OTC in Taiwan during year 2012 to 2015 for samples, 18 companies out of the 54 has been financial distress in 2015. We have selected 11 variables from Financial Ratio information, Corporate Governance information, and Intellectual Capital information to construct the Corporate Financial Distress Forecasting Model. We used Logistic Regression Model and the data of 2012, 2013 and 2014 to determine whether a company is possibly financial distress or financial normal in 2015.

In Table 3, the Maximizing Prediction Accuracy (MPA) for model I and model II would be higher in Dynamic Distress Threshold Value than those by employing the criteria of one half rule 0.5. We could find out that Dynamic Threshold Values is better than Tradition Threshold Value.

Finally, as shown in Table 4, after we join the Intellectual Capital factors, the Maximizing Prediction Accuracy (MPA) will be higher in Model II than Model I. The improvement of prediction accuracy will be increased 1.85% to 11.11%. The Intellectual Capital could improve the prediction accuracy of the financial distress model.
Table 3: Comparison of Tradition Distress Threshold Value and Dynamic Distress Threshold Value

<table>
<thead>
<tr>
<th>Year</th>
<th>Method</th>
<th>Model I</th>
<th>Model II</th>
<th>Model I</th>
<th>Model II</th>
<th>Model I</th>
<th>Model II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tradition Threshold Value</td>
<td>83.33%</td>
<td>90.74%</td>
<td>83.33%</td>
<td>85.18%</td>
<td>77.77%</td>
<td>77.77%</td>
</tr>
<tr>
<td></td>
<td>Dynamic Distress Threshold Value</td>
<td>87.03%</td>
<td>92.99%</td>
<td>87.03%</td>
<td>88.88%</td>
<td>77.77%</td>
<td>88.88%</td>
</tr>
</tbody>
</table>

Table 4: The Prediction Accuracy of Models and the Best Threshold Value

<table>
<thead>
<tr>
<th>Year</th>
<th>Results</th>
<th>2014</th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model I Prediction Accuracy (best threshold value)</td>
<td>87.04% (p=0.36-0.43)</td>
<td>87.04% (p=0.4-0.42)</td>
<td>77.78% (p=0.5-0.52, 0.57-0.6)</td>
</tr>
<tr>
<td></td>
<td>Model II Prediction Accuracy (best threshold value)</td>
<td>92.39% (p=0.4)</td>
<td>88.89% (p=0.33-0.35, 0.39-0.4, 0.42)</td>
<td>88.89% (p=0.42)</td>
</tr>
</tbody>
</table>

References

of Financial-Distress Probability in Taiwan. Master Thesis, Ming Chuan University; 2005


