Predicting Bankruptcy by Liquidity Ratios Analysis

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Abstract

In this critical study, cash ratios obtained from cash flow statement have been used in order to predict bankruptcy of companies. For this purpose, we used logistic regression models and a model for predicting bankruptcy of listed companies in Tehran Stock Exchange has been developed. Using data from two groups of listed companies in Tehran Stock Exchange, estimation model of research has been developed. The first group included 50 non-bankrupt companies and the second group included 50 bankrupt companies. The developed model uses four ratios: cash flows to assets ratio, cash flows to debt ratio, cash flows to current liabilities ratio and cash flows to sales ratio reflects the company's liquidity. Statistical results of model indicate prediction power parity and the existence of a linear relationship between the ratios of cash flows on assets and cash flows on sales. The results indicate that this model and selected ratios were valid. The results of prediction ability test of model indicate this fact that the model is capable to predict bankruptcy accurately up to two years before companies' bankruptcy. And as passing away from the time of bankruptcy, the prediction power of model will be reduced because predictive indicators of bankruptcy will be less important and faded.

Key words: Cash ratio, Cash flow, Prediction, Bankruptcy.

Introduction

Rapid technological developments and broad environmental changes, gave economy the increasing acceleration. Increasing competitiveness of enterprises has limited achieving the benefit and has increased probability of bankruptcy. Meanwhile the role of accounting information in distinction between the companies with the financial crisis (bankrupt) and companies without the financial crisis (Non-bankrupt companies) and predicting bankruptcy was a controversial topic in recent decades. One of the ways that we can use, is helpful for the proper utilization of investment opportunities and also avoidance of wasting resources, is prediction of financial crisis and consequently bankruptcy. In this way, first, we can inform companies of financial crisis by the necessary warnings so they can take essential actions according to these warnings. Second, investors can distinguish the desirable investment opportunities from undesirable ones, and can invest their resources in desirable opportunities. Usually the signs of the financial crisis in the company include:

1. Increase of total liabilities to total assets or current liabilities to the current assets;
2. Unfavorable financial ratios in compared with the industry average and financial ratios of the previous periods;
3. Inability of timely payment of accounts payable (large average payment period)
4. Excessive reliance on short-term borrowing to finance long-term assets.

As can be seen, much of the factors influencing the financial crisis are due to liquidity problems of business.
These signs could be calculated and extracted from financial ratios based on figures contained in financial statements if they were produced based on accruals and also liquidity ratios derived from the cash flow statement. But prepared financial statements based on the accruals do not reflect information on cash flow and this is one of its main drawbacks. In addition, further information available on balance sheet is static and measures status of enterprise in a particular time while cash flow statement reports changes in other financial statements and eliminates the effect of optional allocation on financial ratios. This study seeks to evaluate the ability of existing ratios in cash flow statement in order to predict bankruptcy of companies. And if these ratios have necessary ability, we can design a model to predict bankruptcy before it occurs and directors, stockholders and other stakeholders can take modifying actions using these warnings. Therefore, the aim of this research is to develop a model using available ratios in cash flows that predicts bankruptcy in listed companies in Tehran Stock Exchange.

A review of literature background
Prediction of bankruptcy using accounting information was done for the first time by Beaver (1966) Was. He used univariate models and tested accounting ratios. He eventually came to this conclusion that the ratio of cash flows to total debt has high ability to predict bankruptcy. And net profit to total assets has this feature. Altman (1968) was the first to release the multivariate model for predicting bankruptcy. By applying multivariate model and the use of his known financial ratios, he developed his well-known model called Z-score model. He chose 5 out of 22 financial ratios that he thought they were the best to predict bankruptcy and he developed his model by combining these 5 ratios. In later years, there were raised objections about his model and he could correct problems successfully and developed his new Z model. (Altman, 2000).

Where:
\[ X_1 = \text{Working capital to total assets} \]
\[ X_2 = \text{Accumulated profits to total assets} \]
\[ X_3 = \text{Profits before interest and tax on total assets} \]
\[ X_4 = \text{Book value of stockholders’ equity to book value of the total debts} \]
\[ X_5 = \text{Sales to total assets} \]
\[ Z = \text{value of the dependent variable obtained from the model (GSI)} \]
\[ Z < 1.21 \text{ Bankrupt company} \]
\[ Z > 2.90 \text{ Non-bankrupt Company} \]

Norton & Smith (1979) used multiple linear analysis model using stepwise method to predict bankruptcy. They used ratios include cash flow to sales, cash flows to total assets, cash flows to equity of total debts, respectively. Their two sample groups were designed based on the size and type of industry. Their results showed that operating cash flows to total assets and operating cash flows to total debts provides the best indicator for predicting bankruptcy in three years before bankruptcy. Zmigewski (1984) used financial ratios, liquidity, performance, and leverage to develop his model. These ratios were not selected based on theoretical basis but were mostly based on previous studies. His model was established based a sample of 40 bankrupt companies and 80 non-bankrupt manufacturing companies. He used ratios of net profits to total assets, total debts to total assets and current assets to current debts in his model. This model is one of the simplest models to predict bankruptcy in which the rule of low numbers of independent variables in models is well respected.

The importance of research
Lack of awareness about the critical situation of the company and consequently its bankruptcy imposes large losses on each of the stakeholders, by predicting the collapse of the company necessary planning can be scheduled to be done to prevent bankruptcy. Thus the purpose of this study is to provide a method for predicting bankruptcy, according to the accounting information of the listed companies on the Stock Exchange in Tehran. In most recent studies,
foreign models were used to predict bankruptcy in Iran. Also limited number of industries was used or cash flows as one of the main factors of survival have been ignored. Therefore, this research believes that these shortcomings in previous investigations should be resolved and the Iranian model appropriate to the circumstances of this country and combination of all industries and using cash flows should be designed.

Research hypotheses

Main hypothesis
- Information on cash flow statement has the ability to predict bankruptcy of listed companies in the capital market.

Sub-hypotheses
- Ratio of operating cash flows to total assets is effective for predicting bankruptcy of the company.
- Ratio of operating cash flow to total debts is effective for predicting bankruptcy of the company.
- Ratio of operating cash flows to total current debts is effective for predicting bankruptcy of the company.
- Ratio of operating cash flows to sales is effective for predicting bankruptcy.

Research Methodology

The population of the study includes all companies listed in the Tehran Stock Exchange. The sample includes a number of companies that are divided into two groups of bankrupt and non-bankrupt companies. The first group included 50 bankrupt companies and the second group includes 50 non-bankrupt companies. In this study, bankrupt companies are companies that their financial statements by the end of 2013in accordance with article 141 of the Commercial Code of Iran due to accumulate losses. The activity indexes of these companies id their profitability in four consecutive years of 2010-2013 and their continuous trading of their stock. Then data and liquidity ratios required by research for 3 years including year of bankruptcy and two years before it were collected. The basic steps in implementing the project are as follows:
2. Calculation of financial ratios or parameters needed as independent variables for years studied.
3. Study of verification of bankrupt and non-bankrupt samples separation using a F-test for the comparison of two variables averages.
4. Testing research hypotheses to evaluate the predictive ability by using logistic regression.
5. Designing of a model using all independent variables and logistic regression.
6. Checking linearity phenomenon to remove one of the independent variables.
7. Evaluation and testing the model with the numbers of one and two years before the bankruptcy. So that the desired ratio of the two groups in year of bankruptcy were analyzed using logistic regression and model was developed using this information. And data for one and two years before the bankruptcy were used to evaluate the predictive ability of model (Capinski, Marek (2007,August). A model of credit risk based on cash flow).

Verification test of bankrupt and non-bankrupt samples separation with article 141 of the Commercial Code:
In order to verify the separation of two bankrupt and non-bankrupt samples with article 141 of the Commercial Code, F-test was used for comparison two independent variables. One of the assumptions of mentioned test is normality of data. But since the normalization of data to four independent variables, using Kolmogrov - Smirnov we concluded that our research data are not normal and Mann-Witney test was used that is nonparametric equivalent of F-test.

For the above test, we have:

\[
\begin{align*}
H_0 & : \mu_1 = \mu_2 \\
H_1 & : \mu_1 \neq \mu_2
\end{align*}
\]
Results of Mann - Whitney are presented in the table below.

Table 1: Results of Mann - Whitney test

<table>
<thead>
<tr>
<th>Variables Test</th>
<th>ratio of cash flow to assets</th>
<th>Ratio of cash flows to total debts</th>
<th>ratio of cash flows to current debts</th>
<th>ratio of cash flows to sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann-Whitney U</td>
<td>57,000</td>
<td>19,000</td>
<td>26,000</td>
<td>106,000</td>
</tr>
<tr>
<td>Wilcoxon W</td>
<td>877,000</td>
<td>839,000</td>
<td>846,000</td>
<td>926,000</td>
</tr>
<tr>
<td>Z</td>
<td>-7.150</td>
<td>-7.515</td>
<td>-7.448</td>
<td>-6.678</td>
</tr>
<tr>
<td>P-Value</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

In table 1, each of four ratios in two groups are significant according to Mann – Whitney test and all studied independent variables considered appropriate to separate the two groups of bankrupt and non-bankrupt and Ho has been rejected.

**Test of research hypotheses**

Sub hypotheses were examined using logistic regression. Test results of all four sub-hypotheses are presented in table 2.

Table 2: Results of four hypotheses

<table>
<thead>
<tr>
<th>hypotheses</th>
<th>( \chi^2 ) Statistics</th>
<th>P-values</th>
<th>( R^2 )</th>
<th>Adjusted ( R^2 )</th>
<th>result of hypothesis testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>5.396</td>
<td>0.715</td>
<td>0.592</td>
<td>0.789</td>
<td>Rejection of Ho</td>
</tr>
<tr>
<td>H2</td>
<td>2.170</td>
<td>0.975</td>
<td>0.667</td>
<td>0.889</td>
<td>Rejection of Ho</td>
</tr>
<tr>
<td>H3</td>
<td>2.719</td>
<td>0.951</td>
<td>0.645</td>
<td>0.861</td>
<td>Rejection of Ho</td>
</tr>
<tr>
<td>H4</td>
<td>11.902</td>
<td>0.156</td>
<td>0.488</td>
<td>0.651</td>
<td>Rejection of Ho</td>
</tr>
</tbody>
</table>

According to the table 2, we see that all four sub-hypotheses can be confirmed. And so the research main hypothesis is confirmed because confirming any of the sub-hypotheses conclude that the information contained in the cash flow statements have ability to predict bankruptcy of companies. Because here all four sub-hypotheses were confirmed, we realized that information of cash flow statements containing valuable information for predicting bankruptcy of companies and as a result, the main hypothesis will be confirmed.

**Development of model**

After confirmation of main hypothesis now we can use these confirmed independent variables in a model to predict bankruptcy. We use logistic regression once more but here we apply four independent variables than one independent variable. The results of the logistic regression and constant coefficients and coefficients for the variables shown in the table below.
### Table 3: Model coefficients and their significance in four ratios and bankruptcy

<table>
<thead>
<tr>
<th>Ratio for Analysis</th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio cash flows to total assets</td>
<td>-5/038</td>
<td>5/284</td>
<td>0/909</td>
<td>1</td>
<td>0/340</td>
<td>0/006</td>
</tr>
<tr>
<td>Ratio of cash flows to total debts</td>
<td>119/983</td>
<td>46/136</td>
<td>6/763</td>
<td>1</td>
<td>0/009</td>
<td>3E + 052</td>
</tr>
<tr>
<td>Ratio of cash flows to current debts</td>
<td>-38 / 945</td>
<td>16/173</td>
<td>5/801</td>
<td>1</td>
<td>0/016</td>
<td>0.000</td>
</tr>
<tr>
<td>Ratio of cash flows to sales</td>
<td>-5/912</td>
<td>2/378</td>
<td>6/179</td>
<td>1</td>
<td>0.013</td>
<td>.003</td>
</tr>
<tr>
<td>Constant</td>
<td>-5/358</td>
<td>1/878</td>
<td>8/137</td>
<td>1</td>
<td>0.004</td>
<td>.005</td>
</tr>
</tbody>
</table>

$$Y = \frac{e^{\alpha_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4}}{1 + e^{\alpha_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4}}$$

Constant and variable coefficients and constants for above model using table 2 are as follow:

Constant coefficient: $$\alpha_0 = -5/358$$

Variable coefficients:
- $$\beta_1 = -5/038$$, $$\beta_2 = 119/983$$, $$\beta_3 = -38 / 945$$, $$\beta_4 = -5/358$$
- $$Y$$ = dependent variable (Bankruptcy)
- $$X_i$$ = Independent variable (i = 1,2,3,4)
- $$e = 2/71828182$$ (Neper)

The table above shows that, the probability calculated from data is
- For $$\beta_2$$ (P.Value = 0.340 = $$\beta$$ (P.Value=0.009)), $$\beta$$ (P.Value=0.016)
- For $$\beta$$ (P.Value=0.013) = $$\alpha_0$$ (P.Value=0.004)

That as a result, for $$\alpha_0, \beta_4, \beta_3, \beta_1$$ is less than significance level for model ($$\alpha = 0 / 05$$); In fact, significance level for $$\alpha_0, \beta_4, \beta_3, \beta_1$$ is greater than %95, so regression model for them is significant. There is a significant relationship between $$X_1, X_2, X_3$$ and $$Y$$ but because for $$\beta_1$$ (05/0P.Value>) then we cannot confirm the existence of relationship between dependent and independent variables in this model for $$x_1$$.It can be concluded that there is a strong significant relationship between ratio of cash flows to total debts, cash flows to total current debts and cash flows to sales and bankruptcy of studied companies and by increasing such ratios the possibility of bankruptcy will be decreased. But ratio of cash flows to total assets and bankruptcy have no significant relationship. The reason to remove independent variable in ratio of cash flows to total assets despite the confirmation of H1 is the existence of linearity phenomenon between this variable and one of independent variables. This phenomenon is shown by plotting and Pearson correlation coefficient. After analyzing and plotting, there is linear relationship between variable of cash flows to total assets and ratio of cash flows to sales.
The chart above shows that there is linear relationship between the variables $X_1$ and $X_4$. Now we want to calculate the extent of this relationship and for this purpose we use Pearson’s correlation coefficient.

Table 4: The correlation and significant amount between the ratio of cash flows to total assets and cash flows to sales

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation (r)</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>ratio of cash flows to sales</td>
<td>0.799</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Because here P-value < 0.05, as a result, there is a significant relationship between two variables. The relationship between two variables and Pearson correlation coefficient is 0.80 and linear relationship between these two variables is proved. The linear relationship between two variables suggests that two variables of cash flows to total assets are similar to ratio of cash flows to sales in terms of prediction ability and it does not add any information to model so it should be excluded from model.

**Modification of Model**

The final model includes three variables of $X_2$, $X_3$, $X$. And to choose the correct model, the logistic regression test is done with three independent variables once again. Model coefficients and their significance level in a model with three ratios and bankruptcy

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>D f</th>
<th>Sig.</th>
<th>Exp (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of cash flow to total debts</td>
<td>107.647</td>
<td>39.644</td>
<td>7.373</td>
<td>1</td>
<td>.007</td>
<td>.005</td>
</tr>
<tr>
<td>Ratio of cash flows to total current debts</td>
<td>-35.256</td>
<td>14.225</td>
<td>6.142</td>
<td>1</td>
<td>.013</td>
<td>.000</td>
</tr>
<tr>
<td>Ratio of cash flows to sales</td>
<td>-5.537</td>
<td>2.154</td>
<td>6.608</td>
<td>1</td>
<td>.010</td>
<td>.004</td>
</tr>
<tr>
<td>Constant</td>
<td>-5.104</td>
<td>1.767</td>
<td>8.342</td>
<td>1</td>
<td>.004</td>
<td>.006</td>
</tr>
</tbody>
</table>

$$Y = \frac{e^{a_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3}}{1 + e^{a_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3}}$$
Constant coefficient:
\[ a_0 = \frac{-5}{104} \]

Variable coefficients
\[ \beta_1 = \frac{107}{242}, \beta_2 = \frac{-35}{256}, \beta_3 = \frac{537}{5} \]

\[ Y = \text{dependent variable (Bankruptcy)} \]
\[ X_i = \text{Independent variable (} i = 1, 2, 3 \) \]
\[ e = \frac{2}{71828182} \text{ (Neper)} \]

The table above shows that, the probability calculated from data is
\[ \beta_2 \text{ (P.Value} = 0.007) = \beta_3 \text{ (P.Value} = 0.010) \]
\[ = \alpha_0 \text{ (P.Value} = 0.004) \]

That as a result, for \( \alpha_0, \beta_1, \beta_2, \beta_3 \), is less than significance level for model \( \alpha = 0.05 \); In fact, significance level for \( \alpha, \beta_1, \beta_2, \beta_3 \) is greater than %95, so regression model for them is significant. There is a significant relationship between \( X_2, X_3, X_4 \) and \( Y \). It can be concluded that there is a strong significant relationship between ratio of cash flows to total debts, cash flows to total current debts and cash flows to sales and bankruptcy of studied companies and by increasing such ratios the possibility of bankruptcy will be decreased. So final result of model is as below:

\[
Y = \frac{e^{-5.104 + 107 \cdot .647 X_1 - 35 \cdot .256 X_2 - 5.537 X_3}}{1 + e^{-5.104 + 107 \cdot .647 X_1 - 35 \cdot .256 X_2 - 5.537 X_3}}
\]

The above model:
\[ X_1 \text{ ratio of operating cash flow to total debts} \]
\[ X_2 \text{ ratio of operating cash flow to total current debts} \]
\[ X_3 \text{ ratio of operating cash flow to sales} \]
\[ Y \geq 0 / 5 \text{ If the company is not bankrupt} \]
\[ Y < 0 / 5 \text{ if the company is bankrupt.} \]
\[ e = \frac{2}{71828182} \text{ (Neper)} \]

**Predictive ability test of the model**

To test the ability of model, financial statements of sample companies within the two years before the bankruptcy has been used. We used ratios in 100 companies in sample and following results were obtained. The following information is for year of bankruptcy that for present study is 2013.

Table 5: Number and percentage of correct predictions of bankruptcy by model in 2013

<table>
<thead>
<tr>
<th>Default group</th>
<th>The number predicted by the model.</th>
<th>The overall accuracy of the model in the original sample</th>
<th>Total</th>
<th>Percentage predicted by the model</th>
<th>Percentage of bankrupt ones</th>
<th>Percentage of non-bankrupt ones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankrupt</td>
<td>45 5</td>
<td>95 5</td>
<td>100</td>
<td>0.95 0.05</td>
<td>100</td>
<td>93-75</td>
</tr>
<tr>
<td>Non-bankrupt</td>
<td>7 43</td>
<td>925 0.075</td>
<td>100</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
</tbody>
</table>
The results suggest that model has classified around 94% of total model correctly. Type I error is %5 and type I is %7.5 and obtained results show the high ability of model to separate bankrupt companies from non-bankrupt ones according to data of financial statements in year of bankruptcy. The following information is for a year before the bankruptcy that is 2013 for present study.

Table 6: Number and percentage of correct predictions of bankruptcy by model in 2012

<table>
<thead>
<tr>
<th>Default group</th>
<th>The number predicted by the model</th>
<th>Percentage predicted by the model</th>
<th>The overall accuracy of the model in the original sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number of bankrupt ones</td>
<td>number of non-bankrupt ones</td>
<td>Total</td>
</tr>
<tr>
<td>Bankrupt</td>
<td>40</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Non-bankrupt</td>
<td>12</td>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>----</td>
<td>100</td>
</tr>
</tbody>
</table>

Assessing the predictive ability of the model has been done using data of one year before the bankruptcy of the sample companies and results can be seen in Table 6. The results suggest that model has classified around 79% of total model correctly. Type I error is %17 and type I is %7.5 and obtained results show the high ability of model to predict bankruptcy using financial statements of two years before bankruptcy. Data below are for two years before bankruptcy that in present study is 2011.

Table 7: Number and percentage of correct predictions of bankruptcy by model in 2011

<table>
<thead>
<tr>
<th>Default group</th>
<th>The number predicted by the model</th>
<th>Percentage predicted by the model</th>
<th>The overall accuracy of the model in the original sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number of bankrupt ones</td>
<td>number of non-bankrupt ones</td>
<td>Total</td>
</tr>
<tr>
<td>Bankrupt</td>
<td>42</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>Non-bankrupt</td>
<td>13</td>
<td>37</td>
<td>50</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>----</td>
<td>100</td>
</tr>
</tbody>
</table>

The results suggest that model has classified around 80% of total model correctly. Type I error is %15 and type I is %7.5 and obtained results show the high ability of model to separate bankrupt companies from non-bankrupt ones according to data of financial statements of two years before bankruptcy.

Conclusion
Due to the lack of sufficient information about the critical financial situation of companies and eventually their bankruptcy lead to loss of business owners and other stakeholders, thus a major aim of this study is to provide a way to predict bankruptcy of companies using ratios of cash flows statements including ratios of cash flows to assets, cash flows to debts, cash flows to current debts and cash flows to sales and these ratios show the liquidity of companies. To this end, logistic regression model has been used. In order to study the statistical population that includes total listed companies in Stock Exchange of Tehran and The results indicate that the ratio of cash flows to total assets, the ratio of cash flows to total debts, cash flows to total
debts and total current debts and the ratio of cash flows to sales are effective for predicting bankruptcy. Thus data of cash flow statements have valuable information for predicting bankruptcy. Following model is proposed to predict bankruptcy of companies:

\[
Y = \frac{e^{-5.104 + 107.647 X_1 - 35.256 X_2 - 5.537 X_3}}{1 + e^{-5.104 + 107.647 X_1 - 35.256 X_2 - 5.537 X_3}}
\]

In above model: \( e = \frac{2}{271828182} \) (Neper)

\( X_1 \) : ratio of operating cash flow to total debts
\( X_2 \) : ratio of operating cash flow to total current debts
\( X_3 \) : ratio of operating cash flow to sales

If \( Y \geq 0.5 \) is non-bankrupt and if \( Y < 0.5 \) is bankrupt.

The results also show that by moving away from the date of financial crisis and bankruptcy, prediction ability will be reduced. This is due to decrease of clarity of predictive indexes of bankruptcy. Proposed model in this study is useful to assess companies by investors during decision making on purchasing stocks, statements by auditors about survival of companies and also to predict bankruptcy and financial crisis before occurrence for directors. It is hoped that using the model we can prevent the damages to the economy and stakeholders of companies and stakeholders predict bankruptcy of these companies before occurrence and prevent its harmful consequences by taking necessary measures.

**Reference**